TORREYA

A Bi-Monthly Journal of Botanical Notes and News

John Torrey, 1796-1873

EDITED FOR
THE TORREY BOTANICAL CLUB
BY
WILLIAM J. BONISTEEL
AND
HAROLD H. CLUM

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TORREYA

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Thomas Horsfield—American Naturalist and Explorer

James B. McNair

The eighty-six years of Thomas Horsfield's life may be divided into three periods—the American period of twenty-six years from 1773 to 1799, the Javan period of twenty years from 1799 to 1819, and the British period of thirty-nine years from 1820 to 1859. But before taking up Dr. Horsfield's career in detail it might be well to devote some time to a study of his ancestry.

Thomas Horsfield's grandfather was Timothy Horsfield[1] who was born in Liverpool, England in 1708 and was educated in the parish school. In 1725 he emigrated to New York and joined his brother Isaac, with whom he learned the trade of butcher. In 1735 they leased two stands in the Old Slip Market where their business became large and profitable.

Although a member of the Church of England, he became interested in the Moravian Church in 1739. In 1748 he applied to the authorities at Bethlehem, Pennsylvania for permission to reside there, but because he was one of the executors of the estate of Thomas Noble, a prominent merchant of New York, and a member of the newly organized Moravian congregation, as well as being entrusted with the building of the Irene, he was requested to postpone his removal. He, however, took his children to Bethlehem to be educated in the schools. The year following he moved there himself where, except for a short sojourn in Nazareth, Pennsylvania, he resided until his death.

On the founding of Northampton County in 1752, Timothy Horsfield was appointed a justice of the peace by Governor Hamilton. In 1763 he was commissioned colonel of the forces in the county for the defense of its frontiers against Indian raids. This appoint-

[1] Timothy Horsfield, perhaps the great grandfather of T. Horsfield, appears in the parish register of St. Nicholas Church, Liverpool in 1694 and 1704.

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ment excited jealousy, so he soon resigned and lost his justiceship in consequence. Squire Horsfield lived in what was known as the Oerter house, which stood on Market Street opposite the graveyard.

In 1731 Timothy Horsfield was married to Mary, daughter of John Doughty, a prominent butcher of Long Island, and a lineal descendant of the Reverend Francis Doughty, who, in 1632, preached the first Presbyterian sermon. Both Timothy and Mary Horsfield died in 1773 on Long Island.

Thomas Horsfield's best known uncle was Joseph Horsfield who was chosen a delegate to the Pennsylvania convention to ratify the Federal Constitution in 1787 and one of the signers of the ratification. In 1792 he was appointed by President Washington to be the first postmaster of Bethlehem.

Thomas Horsfield's father was Timothy Horsfield, Jr., who married Juliana Parsons at Philadelphia in 1738. She was the daughter of William Parsons, surveyor general and founder of Easton, Pennsylvania. Timothy Horsfield died April 11, 1789 and his wife died January 17, 1808.

Thomas Horsfield was born at Bethlehem, Pennsylvania, May 12, 1773. He received his early education in the Moravian schools at Bethlehem and Nazareth. Very early in life his tastes led him to the study of botany, and a similar inclination to the pursuit of all branches of biological science may have caused him to select medicine as a profession. He pursued a course in pharmacy with Dr. Otto of Bethlehem and devoted special attention also to botany. This Dr. Otto was probably John Frederick Otto, M.D., of Halle who arrived from Europe in 1750. He was widely known as physician and surgeon and died at Nazareth in 1779.

Thomas Horsfield graduated in medicine at the University of Pennsylvania in 1798 in the twenty-fifth year of his age and served as "medical apprentice" in the Pennsylvania Hospital from 1794 to 1799. While at the University he was a pupil of Dr. Benjamin Smith Barton. "His graduation thesis is remarkable for its painstaking clinical description of the toxic symptoms of the poisoning produced by sumac and poison ivy, and for the record of well-conceived experiments carried out upon himself and upon animals concerning the pharmacological action of this interesting poison. It ranks as a pioneer contribution in the history of experimental pharmacology in America."

The year after his graduation, in October 1799, he accepted service as surgeon on the China, a merchant vessel about to sail for Java. In the course of the voyage he visited Batavia, in the island of Java. He was impressed with the beauty of the scenery, the richness of the vegetation, and certain drugs in common use by the natives which were extracted from local plants. He decided to investigate these substances, so upon his return home he secured such books, scientific instruments and materials as he could get together in Philadelphia and undertook a second voyage to Batavia in 1801. There he secured, upon application, an appointment as surgeon in the Dutch Colonial Army, and this gave him an opportunity to visit and study the flora, fauna and geology of the various parts of the island. This was the beginning of eighteen years of study which linked his name inseparably with the natural history and especially the botany of Java.

In the prefaces of his various works he tells the story of his collections and travels. It appears that between 1802 and 1811 his facilities were poor and many of his most valued specimens decayed owing to inadequate preservation. For several years his researches were confined to the vicinity of Batavia, but beginning with 1804 he visited nearly all parts of Java and made brief trips to several of the neighboring islands.

In 1811 Java became a British possession, administered by the East India Company. The temporary commissioner authorized Horsfield to continue his investigations along the same lines as hitherto, and before the end of the year a new governor, Sir Thomas Stamford Raffles (after whom the genus Rafflesia and family Rafflesiaceae were named) confirmed his appointment in the service of the East India Company. This connection enabled him to pursue his studies on a more elaborate scale. Dr. Horsfield thoroughly explored every part of the island in quest of its natural products. From Java he visited Banca and gave the fullest and best account which exists of the mineralogy, geology, botany and zoology of that island. After the restoration of Java to the Dutch in 1816, Dr. Horsfield made a long sojourn in Sumatra and there continued his favorite studies.

He secured the warm friendship of Sir Stamford Raffles, who, it is believed, acquired from Dr. Horsfield that love of natural history by which he was distinguished, and which rendered him so zealous in its promotion. Dr. Horsfield followed that eminent man to England in 1818 and soon after was made Keeper of the Museum of the East India Company, which charge he held until his death on July 24, 1859 in the eighty-seventh year of his age.

In regard to Dr. Horsfield's work in Java, Sir Stamford Raffles says in his History of Java that "For all that relates to the natural history of Java, I am indebted to the communications of Dr. Thomas Horsfield. Though sufficient for my purpose, it forms but a scanty portion of the result of his long and diligent researches on the subject."

It is not strange that one who graduated in medicine and whose graduation thesis should be a study of the action of a poisonous plant should be interested in other plants of pharmacological action. And so we find that upwards of sixty of the medicinal plants of Java were described for the first time by Dr. Horsfield in the Batavian Transactions. One of these studies which gained especial notice was his work on the Upas tree in which he refuted the falsehoods and fabulous traditions which had been published concerning this subject.

Sir Stamford Raffles also states that "Upwards of a thousand (Javanese) plants are already contained in the herbaria of Dr. Horsfield, of which a large proportion are new to the naturalist." This extensive collection was sent to England and later (1858) presented by the East India Company to the Linnean Society of London. A selection only of his botanical collections was published as a monograph "Plantae Javanicae Rariores." This is a beautifully illustrated work, prepared with the assistance of the botanists Robert Brown and J. J. Bennett. In it 2,196 species are described, all of which Horsfield had collected himself.

Dr. Horsfield although eminent as a botanist and equally versed in mineralogical knowledge, was perhaps most eminent as a zoologist. The most important of his zoological publications and the earliest of his independent works after his coming to England, was his "Zoological Researches in Java and the Neighbouring Islands," published in 1821 and the following years. His other zoological writings are chiefly the valuable illustrated catalogues of mammals, birds and lepidoptera of the several zoological departments of the East India Company's museum, and numerous papers on zoological subjects contributed to the "Linnean Transactions."

the "Zoological Journal" and the "Proceedings of the Zoological Society." His latest publication was the "Catalogue of the Lepidopterous Insects in the East India Museum." It was compiled by Mr. Moore, his assistant, from Dr. Horsfield's materials and manuscripts, and under his direction. Dr. Horsfield had some years before commenced a catalogue of these insects, of which only two parts were published (1828–29). This publication, though incomplete, deserves notice, as it contains an elaborate introduction, with a general arrangement of the Lepidoptera founded on their metamorphosis. The importance of the transformations of insects in reference to their classification had indeed become early impressed on Dr. Horsfield's mind. He accordingly spent three seasons during his stay in Java in collecting the larvae of numerous species of Lepidoptera, watching their development, and making careful descriptions and drawings of their successive changes up to the perfect state.

Dr. Horsfield always took the deepest interest in the progress of natural history, and especially in the systematic arrangement of animals, in which he adopted the views of Mr. McLeay. His classification of the diurnal lepidoptera and of birds exhibits great powers of philosophical analysis.

His numerous scattered papers, if put together, would constitute several large and valuable volumes, and many of them, more especially those on geology and natural history of the Eastern Archipelago, well deserve to be collected in a separate form.

Dr. Horsfield was a man of retiring habits, but of amiable character and unblemished integrity. He was one of the few Americans who became a Fellow of the Royal Society of London (in 1828). He was a member of many other societies including the Batavian Society, the Zoological Society of London and the Geological Society of London. He was elected a Fellow of the Linnean Society in 1820 and later became one of its vice-presidents.

Three genera of plants have been named Horsfieldia at different times. Horsfieldia of Willdenow (1805) is the oldest and comprises plants of the Myristicaceae. It is in current use and included more than fifty species of nutmegs. The genus Horsfieldia of Blume (1830) was composed of a species of the Araliaceae. Chifflot (1909) designated the genus Horsfieldia for some of the Gesneriaceae. Because Horsfieldia was first used by Willdenow in a generic sense the genus Horsfieldia of Blume was changed to Harmsiopanax Warb. and that of Chifflot to Monophyllaea Reichb. Many species of plants and insects also bear Horsfield's name.

References

Anonymous. 1859. Obituary. The Times. London. July 29, 1859.

———. 1859. Obituary. Proceedings of the Royal Society of London. **10**: xix–xxi.

———. 1861. Obituary. Proceedings of the Linnean Society of London. Anniversary meeting May 24, 1860. Jour. of the Proc. of the Linn. Soc. Zoology. **5**: xxv–xxvi.

———. 1858. Proceedings of the Linnean Society of London. Meeting of Nov. 4, 1858. Jour. of the Proc. of the Linn. Soc. Zoology. **4**: i.

Candolle, A. P. de 1830. Prodomus systematis naturalis regni vegetabilis, sive Enumeratio contracta ordinum, generum specierumque plantarum. **4**: 87.

Carson, J. 1869. A history of the medical department of the University of Pennsylvania. pp. 131–132.

Chifflot, J. B. J. 1909. Sur quelques variations du Monophyllaea Horsfieldii R. Br. Compt. rend. Acad. Sci. Paris. **148**: 939–941.

Egle, W. H. 1887. The Federal Constitution of 1787. The Pennsylvania Mag. of Hist. and Biogr. **11**: 213–222.

Gray, Asa. 1859, 1860. Amer. Jour. of Science. Second series (1859) **28**: 444; (1860) **29**: 441.

Jordan, J. W. 1896. Timothy Horsfield. Notes and Queries. Edited by W. H. Egle. Harrisburg, Pa. **3**: 166–168. Reprinted edition.

———. 1909. William Parsons, Surveyor General and Founder of Easton, Pa. The Pennsylvania Mag. of Hist. and Biogr. **33**: 345–346.

Levering, J. M. 1903. A History of Bethlehem, Pennsylvania. p. 171.

McNair, J. B. 1923. Rhus dermatitis, its pathology and chemotherapy. University of Chicago Press. pp. 83, 101, 116, 119, 126, 127, 139, 141, 142, 145, 147, 193.

Oliver, D. 1860. Notes on the British Herbarium of the Linnean Society. Jour. of the Proc. of the Linn. Soc. Botany. **4**: 194–198.

Raffles, Sir T. S. 1817. The History of Java. London. Vol. 1.

Willdenow, C. L. 1805. Species plantarum. **4**: 872.

Publications

Horsfield, Thomas. 1798. An experimental dissertation on the *Rhus vernix, Rhus radicans* and *Rhus glabrum;* commonly known in Pennsylvania by the names of poison-ash, poison-vine and common sumach. By Thomas Horsfield of Bethlehem, Pennsylvania. Philadelphia. Printed by Charles Cist, No. 104 North Second Street. Published also in Charles Caldwell's "Medical Theses," Philadelphia 1805. pp. 113–163.

———. 1805. An account of a voyage to Batavia in the year 1800. The Philadelphia Medical Museum. Edited by J. Redman Coxe. Vol. 1.

———. 1814. Scheikundige ontleding van een vulkaansch zand en een yzer-erts. (Chemical analysis of some volcanic sand and an iron ore.) Batav. Genootsch. Verhand. 7.

———. 1814. Over de Rivier van Solo. (Beyond the River Solo.) Batav. Genootsch. Verhandl. 7.

———. 1814. Reis naar de Ooster-streken van Java. (Journey to the East-stretch of Java.) Batav. Genootsch. Verhandl. 7.

———. 1814. Beschrijving van den Gatip-Boom. (Description of the Gatip-Tree.) Batav. Genootsch. Verhandl. 7.

———. 1814. Beknopte beschrijving van het *Crinum asiaticum*. (Brief description of *Crinum asiaticum.*) Batav. Genootsch. Verhandl. 7.

———. 1814. Scheikundige ontleding der vruchten van den Rarak-Boom. (Sapindus saponaria, Linn.) (Chemical analysis of the fruit of the Rarak-Tree.) Batav. Genootsch. Verhandl. 7.

———. 1814. On the Oopas or Poison-tree of Java. Batav. Genootsch. Verhandl. 7; Thomson Ann. Phil. 9: 202–214, 265–274 (1817); Jour. de Phys. 84: 259–266 (1817); Amer. Med. Recorder, Phila. 1: 64–80, 587–600 (1818); Jour. de Physiol, exper. et pathologique (Magendie's), Paris. 7: 334–384 (1827).

———. 1816 (?) On the mineralogy of Java. Batav. Genootsch. Verhandl. 8: 141–173.

———. 1816 (?) Essay on the geography, mineralogy, and botany of the western portion of the territory of the native princes of Java. Batav. Genootsch. Verhandl. 8: 175–312.

———. 1822. Systematic arrangement and descriptions of birds from the island of Java. (Read April 18, 1820.) Linn. Soc. Trans. 13: 133–200. Oken, Isis, 1825, col. 1053–1087.

———. 1824. Zoological researches in Java, and the neighbouring island. London.

———. 1824–25. Description of the Riman-Dahan of the inhabitants of Sumatra, a new species of Felis (*F. macrocelis*) discovered in the forests of Bencoolen by Sir Stamford Raffles. Zool. Jour. 1: 542–554; Ferussac, Bull. Sci. Nat. 6: 400–402 (1825); Oken, Isis, 1830, col. 825–827.

———. 1825. Description of the Helarctos Euryspilus, exhibiting in the Bear from the island of Borneo the type of a sub-genus of Ursus. Zool. Jour. 2: 221–234 (1826); Ferussac, Bull. Sci. Nat. 6: 399–400 (1825); Oken, Isis, 1830, col. 1023–1027.

———. 1827. Notice of a species of Ursus (U. isabellinus) from Nepal. (Read June 20, 1826.) Linn. Soc. Trans. 15: 332–334.

———. 1827–28. Notice of two new species of Vespertilionidae found in Cuba (Molossus velox, Phyllostoma Jamaicense). Zool. Jour. 3: 236–240.

———. 1828–29. Notice of a new species of Mustela (M. Hardwickii) found in India by Major-General Thomas Hardwicke. Zool. Jour. 4: 238–240; Ferussac, Bull. Sci. Nat. 20: 322 (1830).

———. 1828–29. Part I (-II) of a descriptive catalogue of the lepidopterous insects contained in the Museum of the East India Company . . . with . . . observations on the general arrangement of this order of insects. London.

———. 1829–30. Descriptions of several oriental lepidopterous insects. Zool. Jour. 5: 65–70.

———. 1831. Observations on two species of bats, from Madras (Megaderma lyra), one of them new (Nycticejus Heathii), presented by Mr. Heath. Zool. Soc. Proc. 1: 113–114.

———. 1832. On the specific distinction of Viverra Rasse, Horsf. and Viverra Indica, Geoffr. Zool. Soc. Proc. 2: 22–23.

———. 1839. A list of Mammalia and birds collected in Assam by J. McClelland. Zool. Soc. Proc. 7: 146–147; Ann. Nat. Hist. 6: 366–374, 450–461 (1841); Oken, Isis, 1846, col. 631–634.

———. 1848. Report on the island of Banka. Jour. Ind. Archipel. 3: 373–427, 705–724, 779–819; Silliman, Jour. 7: 86–101 (1849).

———. 1849. Brief notice of several Mammalia and birds discovered by B. H. Hodgson, Esq., in Upper India. Ann. Nat. Hist. 3: 202–203.

———. 1851. A catalogue of the Mammalia in the Museum of the Hon. East India Company. London.

———. 1855. Brief notices of several new or little known species of Mammalia, lately discovered and collected in Nepal, by Brian Houghton Hodgson, Esq. Ann. Nat. Hist. 16: 101–104.

———. 1856. Catalogue of a collection of Mammalia from Nepal, Sikkim and Tibet, presented to the H. E. I. C. by Mr. Hodgson in 1853. Zool. Soc. Proc. 24: 393–406.

———, J. J. Bennett and R. Brown. 1838–1852. Plantae Javanicae rariores, descriptae iconibusque illustratae, quas in insula Java, amis 1802–1818, legit et investigavit T. Horsfield; e siccis descriptiones et characteres plurimarum elaboravit J. J. Bennett; observationes, structuram et affinitales praesertim respicientes, passim adjecit R. Brown. London.

———, et al. 1826–35. Illustrations of ornithology by Sir W. Jardine, Bart., and P. J. Selby, with the cooperation of J. E. Bicheno, J. G. Children, T. Hardwicke, T. Horsfield, R. Jameson, Sir. T. S. Raffles, N. A. Vigors. Vol. 1, 2. Edinburgh.

———, and F. Moore. 1854. A catalogue of the birds in the Museum of the Hon. East India Company. By Thomas Horsfield assisted by F. Moore. London.

———, and F. Moore. 1857. A catalogue of the lepidopterous insects in the Museum of the Hon. East India Company. By T. Horsfield and F. Moore. London.

———, and N. A. Vigors. 1827. A description of the Australian birds in the collection of the Linnean Society, with an attempt at arranging them according to their natural affinities. (Read June 21, 1825 and January 17, 1826.) Linn. Soc. Trans. 15: 170–321; Oken, Isis, 23, col. 258–312 (1830).

——— and ———. 1827–28. Notice of a new genus of Mammalia (Gymnura), found in Sumatra by Sir T. Stamford Raffles. Zool. Jour. 3: 246–249; Ferussac, Bull. Sci. Nat. 18: 443–444 (1829); Oken, Isis, 1830, col. 1168–1169.

——— and ———. 1827–28. Descriptions of two new species of the genus Felis in the collection of the Zoological Society (F. planiceps and F. Temmincki). Zool. Jour. 3: 449–451.

——— and ——— 1828–29. Observations on some of the Mammalia contained in the Museum of the Zoological Society. Zool. Jour. 4: 105–113, 380–384; Ferussac, Bull. Sci. Nat. 20: 321.

Macleay, W. S. 1825. Annulosa Javanica; or an attempt to illustrate the natural affinities and analogies of the insects collected in Java by T. Horsfield, etc. No. 1. London.

Notes on the Flora of Arizona

LYMAN BENSON

In this article the following topics are discussed: (1) A New Haplophyton from the Southwest; (2) *Triodia eragrostoides* in Arizona; (3) The California Poppy in Arizona.

1. A New Haplophyton from the Southwest

Dr. D. M. Crooks, head of the division of drug and related plants of the Bureau of Plant Industry, Washington, D. C., pointed out to the writer a difference in appearance of the Arizona plants of *Haplophyton cimicidum* from figures of the same species grown in Mexico. Investigation of the characters of specimens obtained from the United States National Herbarium and in the University of Arizona Herbarium has resulted in the following segregation:

HAPLOPHYTON CIMICIDUM A. DC. var. **Crooksii** L. Benson, *var. nov.* Leaves lanceolate, 15–27 or rarely 32 mm. long, 4–8 or 10 mm. broad; seeds 6–7.5 mm. long, somewhat grooved and ridged, commonly with part of the surface with broad papillae resembling pebble-grained leather. Foliis lanceolatis, 15–27 mm. rariter 32 mm. longis, 4–8 mm. rariter 10 mm. latis; seminis 6–7.5 mm. longis, striatis vel partim papillatis. Southeastern Arizona to Western Texas; southward into Northern Mexico. Type collection: "Prison Road," Santa Catalina Mountains, Pima County, Arizona, *D. M. Crooks & Robert A. Darrow,* Dec. 27, 1939. Type mounted on three sheets in the Herbarium of the University of Arizona.

The corresponding characters of typical *Haplophyton cimicidum* are as follows: Leaves ovate-attenuate, 35–45 mm. long, 14–22 mm. broad; seeds 8–10 mm. long, deeply grooved and ridged. The species is common in southern and central Mexico, and it occurs as far northward and westward as Guaymas, Sonora (*Palmer* in

1887, *U. S.*). Specimens of the variety with leaves large enough to be considered almost but not clearly transitional are the following: Baboquivari Mountains, Arizona, *Peebles, Harrison & Kearney 2795, U. S.;* Rio de los vueltos, Mexico (state not given), *Liebmann 11993, U. S.;* Eulalia Plains, Chihuahua, *Wilkinson* in 1885, *U. S.*

Haplophyton cimicidum is known as "hierba de la cucaracha" or cockroach plant, and the vegetative parts contain an insecticide used with cornmeal to kill cockroaches.

2. Triodia eragrostoides in Arizona

Triodia eragrostoides Vasey & Scribn. is one of many species growing in northern Mexico, which occur in Arizona and Texas but not in the intervening area in New Mexico. It has not been reported heretofore for Arizona. Mesquites along a small wash at the Barbeque Area of the Colossal Cave State Park, Pima County, Arizona, *L. Benson 9174,* Sept. 28, 1938, *L. Benson 9801,* Oct. 9, 1939. Range, cf. A. S. Hitchcock, Manual of the Grasses of the United States 213. 1935, "Florida Keys, Texas, and northern Mexico; Cuba," or, cf. W. J. Beal, Grasses of North America **2:** 465. 1896, "Florida, Texas, and Mexico."

3. The California Poppy in Arizona

The California poppy, *Eschscholtzia californica* Cham. presents a classification problem to the systematic botanist, wherever he may find it, and it is not surprising that the plant occurring on the desert plains and hills in central and southern Arizona is unusual in some respects. It is difficult to discover enough characters in the California poppy to match the hundred or so specific names proposed by Greene, Pittonia **5:** 205–293. 1905, but the species is variable in California. The annual form growing in Arizona is readily matched by some California plants, but it does not agree in some characters with the bulk of plants in that state. The torus rim is either not present or reduced to a ring not more than 2 mm. broad, the stems have a tendency to be scapose, and most years the flowers are smaller and paler. However, the excellent rainy spring of 1941 afforded an opportunity for study of the Arizona plant under conditions approximating those in various parts of California. According to the field observations of the writer, there is no reason to provide the

Arizona plant with a name other than *Eschscholtzia californica,* and specific names such as *E. mexicana* Greene, *E. aliena* Greene, *E. Jonesii* Greene, *E. arizonica* Greene, and *E. paupercula* Greene (cf. Greene loc. cit. pp. 260–263) are merely metanyms.

It is noteworthy that flower color is more variable than in the California forms of the species. In the poppy fields near Tucson colors included orange, yellow with orange center, white with yellow center, white, and numerous variations in color intensity within the major groups. Similar color-types occur in California, but those other than orange or orange-yellow are uncommon in the springtime, while in Arizona they are remarkably prominent.

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The Names of Cornus

H. W. Rickett

So early as 1833 Lindley, in founding his genus *Benthamia* (Bot. Reg. **19:** 1579 et seq.), remarked "We do not understand upon what principle this very distinct genus has been combined with Cornus, from which it differs essentially both in flower and fruit. Whether or not *C. florida,* which agrees with it in habit, is also a species of Benthamia, our materials do not enable us to determine." In 1828 Rafinesque (Med. Bot. 132) had distinguished *C. florida* as section *Cynoxylon,* which in 1838 he elevated to generic rank (Alsog. Am. 59). This early tendency to divide the genus has continued, with varying success, until modern times. For instance, Moldenke (Rev. Sudam. Bot. **6:** 177. 1940) says: "There is certainly no doubt in my mind that the genus *Cornus* as regarded by many botanists today is actually an aggregate of several distinct generic elements. The true genus *Cornus* is typified by *Cornus mas* L. and contains the so-called Cornelian-cherries. The cornels or osiers represent the genus *Svida,* the bunchberries represent the genus *Chamaepericylmenum,* the American flowering-dogwoods represent the genus *Benthamidia,* and the Asiatic flowering-dogwoods with their coalesced fruit represent the genus *Benthamia.*"

Aside from the taxonomic question here involved, the nomenclature of these segregates repays scrutiny. To begin at the beginning, when Lindley founded *Benthamia* (l.c.) he said of the name: "The Benthamia of Achille Richard being the same as Herminium, we have great pleasure in availing ourselves of the present opportunity of naming this very distinct genus in compliment to our highly valued friend George Bentham, Esq." The sentiment did him honor, but the result is inconformable with our rules of nomenclature, *Benthamia* Richard, an orchid, having been validly published in Mém. Soc. Hist. Nat. Paris **4:** 37 (1838).[1]

Benthamidia Spach (Hist. Vég. Phan. **8:** 106. 1839) is antedated by *Cynoxylon* Raf. (l.c.). I cannot agree with Farwell (Rhodora **34:** 29–30. 1932) that *Cynoxylon* was not intended for generic rank. It is true that Rafinesque did not make combinations under his new name; true also that he did not always make his intentions plain. But to unriddle Rafiinesque's intentions and, above all, to expect consistency in his writings, are beyond the powers and the prerogatives of a scientist. Speaking of his segregates as "G. or subgenera," he lists "255. Subg. MESOMERA Raf. 256. subg. KRANIOPSIS Raf. 257. EUKRANIA Raf. 258. CYNOXYLON Raf. 259. BENTHAMIA Lind." (l.c. 58–59). Each is briefly characterized. He goes on to "mention all the true Cornus," the species included in the first two groups.

Eukrania Raf. (l.c.) included as "types"[2] *C. mascula, C. canadensis, C. suecica*. Of this odd assortment *C. mas* L. ("*C. mascula*") has been designated as the type of *Cornus* L. The change in the circumscription of *Eukrania* by the removal from it of *C. mas* (or, to put it differently, the division of the genus) does not invalidate the name, which must be retained if the "bunchberries" are to be treated as a genus. *Eukrania* Raf. of course antedates *Chamaepericylmenum* Graebner (Asch. & Graebner. Fl. Nordostdeuts.

[1] It is interesting also to note a previous abortive attempt by Lindley to name a genus after Bentham (Nat. Syst. 241. 1830, nomen nudum), apparently a genus of Boraginaceae and according to A. de Candolle (Prodr. **10:** 118. 1846) used on labels in the garden of the Horticultural Society.

[2] Rydberg wrote (Bull. Torrey Club **33:** 147. 1906) that Rafinesque made *C. mas* "the type" of the genus. In 1839 Rafinesque was far from designating nomenclatural types in the modern sense. Actually he named three species as "types," by which he must have meant "typical."

Flachl. 539. 1898), and *Cornella* Rydb. (Bull. Torrey Club **33:** 147. 1906).

Svida is derived from a Czech word for dogwood. Opiz (Seznam 94. 1852) made it a genus-name and referred to it *C. sanguinea* L., the common European shrub called dogwood in England,[3] and *C. alba* L., related to our *C. stolonifera* Michx.; but failed to describe it. Indeed, we can infer his intention to divide *Cornus* only from the existence of *C. mas* on page 33 of his flora. Such a procedure, though legitimate at the time, is contrary to our present rules. *Svida* was first validly published by Small in 1903 (Fl. SE. U. S. 853).

There are those who say that such a disturbance of the dead bones of nomenclature can be prompted only by the disturber's desire to see his name after new names and combinations. Perhaps I should grasp the opportunity to give the Asiatic flowering dogwoods a legitimate name and to make new combinations under *Eukrania* Raf. emend. But botanical bibliography is the servant of taxonomy; this catalogue of oversights is only incidental to the revaluation of the groups. The point is that a consideration of the genus *Cornus* over its entire range renders its division far less easy.

Cornus Volkensii Harms (in Engler, Pflanzenw. Ost-Afr. **C:** 301. 1895), the only known species in Africa, has a paniculate inflorescence much like that of the European *C. sanguinea* but enclosed in four early deciduous bracts like those characteristic of *C. mas* (southeastern Europe and western Asia). The drupe is ellipsoidal as in *C. mas* but dark-colored as in *C. sanguinea.* It fits neatly as an intermediate between the sections which include these species. *C. disciflora* Moc. & Sessé (ex DC. Prodr. **4:** 273. 1830) of Mexico has the "capitate" inflorescence (a reduced panicle) of our *C. florida* but its four bracts are small and early deciduous as in *C. mas* and *C. Volkensii;* its drupe is ellipsoidal and dark-colored. There seems to be a tendency toward dioecism (characteristic of several genera of Cornaceae) in both *C. Volkensii* and *C. disciflora.* The concrescence of the fruit characteristic of the Asiatic *C. Kousa* seems hardly to warrant generic segregation, especially since it is approached by *C. Nuttallii* of our west coast.

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[3] Not, of course, an "osier," though *C. stolonifera* is often called the "red osier." Osiers are properly willows; the name has sometimes been used for other withe-like shrubs similarly used in Europe for constructing wattles.

As for *Eukrania,* it bases its claims to recognition on its "herbaceous" habit and the presence of a small dorsal horn on the petals.[4] In several characters it is intermediate between *C. florida* and the ebracteate dogwoods.

I do not know what we are to understand by such expressions as "an aggregate of generic elements." They may signify that *Cornus* (sensu lato) is polyphyletic, distinct genera having been merged; or that an original stock has become diversified. The latter seems more plausible. Certainly in our ignorance of the history and cytogenetics of the group the burden of proof must fall on him who expounds a polyphyletic origin; present judgment seems premature. If they are really as closely related as they seem to be, I see nothing to be gained by segregating in distinct genera the seven (not five) recognizable sections of *Cornus.*

New York Botanical Garden
New York, N. Y.

Phyllanthus nummulariaefolius Poir. in the United States

Leon Croizat

About five years ago correspondents in Brazil and the Panama Canal Zone sent me seeds of an undetermined species of *Phyllanthus* which they described as a polymorphous and aggressive weed. I planted these seeds in a hothouse, grew out of them a sizable crop of specimens and satisfied myself that *P. nummulariaefolius* Poir. was the entity that had been collected. This plant has proved to be as aggressive and as polymorphous in the hothouse as it has been reported to be in nature, and I must now carefully eradicate it several times a year. The size of the specimens varies from a few inches tall, when the plants happen to grow on a dry bench, to about three feet for material favored by good conditions of soil and temperature.

Pressed specimens of the same plant have also reached me from Argentina, Brazil, Panama and the French West Indies, showing that it is widespread in every one of the tropical American coun-

[4] Rydberg (l.c.) said on the sepals; surely an error.

tries bordering upon the Atlantic Ocean. In no case has the material thus sent proved to be correctly determined, being usually mislabelled as *P. Niruri* L. or *P. lathyroides* H.B.K. These misdeterminations are not always excusable because *P. nummulariaefolius* not only manifestly differs from both those species and their nearest allies, but represents in the American flora a type of vegetation that has no immediate relatives. Its affinities are African and Asiatic.

Léandri, who has contributed several specimens to our herbarium and has extensively collected this weed in its endemic range, that is, Madagascar and the adjacent islands, is the author of a critical study (in Lecomte Not. Syst. **7**[4] :168-169, 171-172, 1939). Here, he stresses the impossibility of using the relative size of the leaf and the length of the fruiting pedicel to separate, even trinomially, the many polymorphous aspects of the species. Léandri treats *P. tenellus* Roxb. as a synonym of *P. nummulariaefolius,* a disposition which is fully justified by the material of the latter which I have seen in the Kew Herbarium, part of which at least was seen by Hooker when preparing the classic illustration of *P. tenellus* (in Hook. Icon. **16:** Pl. 1569. 1887). It is quite evident that *P. minor* Fawcett (in Jour. Bot. **57**:65. 1919) is a synonym of *P. nummulariaefolius,* from which Fawcett attempts to separate it on the basis of minor vegetative characters. An isotype of *P. minor* in the herbarium of the N. Y. Botanical Garden, *Harris 12123,* fully matches specimens of *P. nummulariaefolius* such as grow in moist and shady situations in a hothouse. I believe, moreover, that Lanjouw is justified in suggesting (in Rec. Trav. Bot. Néerl. **31**:452. 1934) that *P. corcovadensis* Muell. Arg. is a synonym of *P. nummulariaefolius* and an African weed introduced into America. I have not yet seen authentic material of Mueller's species, but its description and illustration (in Martius Fl. Bras. **11**[2] :30, Pl. 6 ii. 1873) apply to no other plant better than to Poiret's *Phyllanthus.*

Rio de Janeiro apparently was the original point of introduction of this noxious weed into America, having been brought there probably by ships sailing in colonial times between Mauritius and Brazil. I may note that this is not the only record of an introduction of the kind. *Euphorbia spathulata* Lam., the holotype of which I have seen, is supposed to be endemic to the Plata regions of

Argentina, but is altogether alien to the native flora of South America, and it so well matches *E. dictyosperma* Fisch. & Mey. and the minor segregates in its vicinity as to suggest that the alleged Argentina endemic is but the North American weed, introduced in the regions of the Plata before 1780. It is characteristic that Norton lists (in Rept. Mo. Bot. Gard. **11**:104. 1900) a *Moyer* specimen from Montevideo under *Euphorbia arkansana* Engel. & Gray var. *missouriensis.*

In view of the widespread range and of the aggressiveness of *P. nummulariaefolius* I have been looking forward to finding it recorded within the continental limits of the United States somewhere along the coast between Texas and the Carolinas. My anticipations have been only very recently fulfilled by the finding of two specimens in the herbarium of the N. Y. Botanical Garden, namely: *Moldenke 181,* Orlando, Fla., 1929, and *Rapp 3,* Sanford, Fla., 1932, which unmistakably belong to this species. So far, I have seen no other specimens collected in the United States and accept, consequently, *Moldenke 181* as the first record of *P. nummulariaefolius* for the flora of the United States, exclusive of its territories and dependencies.

Phyllanthus lathyroides is reported by J. K. Small for Florida (Man. Southeast. Fl. 778. 1933), but he does not mention either *P. nummulariaefolius* or its synonyms, *P. tenellus* and *P. corcovadensis.* Since the *Moldenke* and the *Rapp* records have been originally misdetermined as *P. lathyroides,* and the former has certainly been seen by Small when at work on the Manual, I suspect that the record of *P. lathyroides* in Small's work is based upon a misdetermination. I have not seen material of *P. lathyroides* from Florida, but this species is likely to have been introduced there, and Small may thus have seen authentic specimens which are now not preserved in the herbarium of the N. Y. Botanical Garden. He, at any rate, failed to record *P. nummulariaefolius.*

Taxonomists who are interested in learning how to distinguish *P. lathyroides* from *P. nummulariaefolius* should study actual specimens rather than rely upon the compilations and the colorless descriptions so frequently found in the literature. The two species are quite distinct and excellent material of both is preserved in the herbarium of the N. Y. Botanical Garden. The following specimens represent *P. lathyroides* in that herbarium: (1) *Britton,*

Britton & Brown 6995, Portorico; (2) *Britton & Boynton 8201,* Portorico; (3) *Duss 47,* Martinique, French W. I., and are true to the isotype which I have seen in the Parisian Museum.

Phyllanthus nummulariaefolius (=*P. tenellus* Roxb.; *P. corcovadensis* Muell. Arg., syn. nov.; *P. minor* Fawc., syn. nov.) is represented by the following collections: (1) *Ball* s.n., 1882, Tijuca, Rio de Janeiro, Brazil; (2) *Duss 2442-3557* [duplicate sheet], Guadeloupe, French W. I.; (3) *Harris 12157, 12208, 12123* [three sheets, including isotype of *P. minor*], Jamaica.

The best characters of identification of *P. nummulariaefolius* from *P. lathyroides* and the species or forms in the latter's vicinity (*e.g., P. diffusus* Kl., well represented by: *J. S. De La Cruz 3662,* British Guiana, in the herbarium of the N. Y. Botanical Garden) are the following: (a) *Shape of the leaf.* In *P. nummulariaefolius* the leaf, regardless of its size, is more or less gradually narrowed from the center towards the extremities, being ovate to obovate. In *P. lathyroides* and *P. diffusus* the leaf is essentially elliptic, with the sides tending to run more or less parallel. (b) *Length of the pedicel.* In *P. nummulariaefolius* the pedicel, especially that of a fruiting flower, is subcapillary but stiffly produced, always manifestly elongate. In *P. lathyroides* and *P. diffusus* the pedicel is much shorter. In *P. niruri* the pedicel is very short, so that the female flower can here be described as subsessile. (c) *Size of the lobes of the calyx of the female flower.* In *P. nummulariaefolius* the lobes are small, narrowly triangular-acuminate, showing like a minute "star" at the tip of the pedicel. In *P. lathyroides* the lobes are definitely large and subpetaloid. In *P. diffusus* and *P. Niruri* the lobes are much smaller than in *P. lathyroides* and thus tend to approach the size if not the shape of those of *P. nummulariaefolius,* but the length of the pedicel is much shorter, as noticed above.

The seed furnishes good characters of determination in *Phyllanthus,* but only mature seeds can be usefully compared for critical identifications and it is unfortunate that there are all too few specimens in herbaria which have a complement of seeds fit to be used. The vegetative characters listed above will be found adequate, I believe, at least for provisional determinations.

The Arnold Arboretum
Jamaica Plain, Mass.

BOOK REVIEWS

A New Text for College Botany

The Plant World, A Text in College Botany. By Harry J. Fuller. Henry Holt and Co. 1941. Pp. 592. $3.25.

Another excellent text has been added to the ones planned for a first course in college botany. With so many excellent texts already a new one should justify itself by some difference in its approach to the subject, in the aspects of the science stressed, or in the special group of students for which it is planned. In the preface the present text explains that it is for "students who are registered in elementary botany courses principally because of the cultural and general educational value of the subject" and who presumably will take no other courses in biological subjects. With this in mind the author has chosen and arranged the subject matter with the idea of arousing the interest of the students at the start by associating the study of plants with their everyday experiences. The primary objective given is "the presentation of the fundamental features of structures, physiological activities, and reproduction of flowering plants." Considerably more than half the book is devoted to this main objective. Of several secondary objectives the presenting of a generalized account of plant evolution is given last, with the suggestion that the section of the book treating it and plant ecology may be omitted. Thus many students using the text will undoubtedly finish the course without getting even the brief description of evolution given in the text. The structure and classification of plants below the Spermatophytes is given very briefly, as is heredity and plant breeding.

The short introductory chapters on the history of botanical study and on the nature and origin of life are well done and should stimulate interest at the start. Conforming to the announced objectives the classification of plants is taken up only briefly, using as "a pedagogical concession" the old grouping into Thallophytes, Bryophytes, Pteridophytes and Spermatophytes; though an outline of a more modern system of classification is given in an appendix.

Illustrations are many and excellent, the drawings, photographs and photomicrographs are good and well reproduced and are chosen to really illustrate the text. The frontispiece is a beautiful colored picture of a Cattleya, but, as is often the case in text books, it is merely a pretty picture not in any way important to the book.

As in nearly all college science texts—and the same is true in only slighly less degree of high school texts—the student will meet here nearly as many new terms as he will new words in the first year of a foreign language. The glossary gives nearly 600 technical terms, most of which will be new to the student, while others (such as xeromorphic, polyploidy, photophobic) used in the text are not given in the glossary. It may be difficult to draw the line as to which scientific terms should be included and which omitted in a book of this kind, but for students most of whom will take no further botany it seems unreasonable to require the learning of scores of words used but once in the text—and there with an explanation—and which they may never in their lives meet again.

There is nothing in the text to suggest laboratory or field work, nor references to further reading. Each chapter is followed by a concise summary, which correctly used, will be a definite help in mastering and organizing the facts given. The language throughout is clear and easily understood, so that the book may be read by a beginner with pleasure. It should satisfactorily fulfill the author's objective for the course. It will be a valuable text wherever a cultural course in botany, not to be followed by more advanced work, is given. The reviewer hopes that whenever the text is used part IV—"The Distribution of Plants in Time and Space" will not be omitted.

George T. Hastings

The Advance of the Fungi

The Advance of the Fungi. By E. C. Large. Henry Holt and Co., New York. 1940. Pp. 488. $4.

Under the above title one would naturally expect to find a discussion of either the phylogeny of fungi in general or a mycological treatise. A glance at the chapter headings may have a rather discouraging effect on the young plant pathologist, for here he would find little information about individual plant diseases, which might be expected in a work on plant pathology. Nevertheless, the author deals primarily with plant-pathological problems, availing himself on every occasion of setting forth some of his philosophical or sociological ideas.

The two opening chapters on potato murrain and the famine in Ireland contain little not already familiar to the mature plant pathologist. The young student might expect to find at the close of these chapters something on the modern methods of the control of the disease. We might also expect the author to take this opportunity to answer some of those who have been criticizing the scientist because of the way his discoveries have been utilized in the construction of the deadly weapons of modern warfare. He could, in accord with Dr. Blakeslee's recent address as retiring president of the A. A. A. S., have pointed out the great contributions for good made by scientists who have shown how, for example, potato blight can be easily controlled so that famines in Ireland are no longer necessary or probable. In later chapters on Bordeaux mixture and "New Sprays for Old" methods are given for controlling the blight.

When one considers the author's sociological viewpoints he finds an excuse for a good discussion of *Phylloxera* even though aphids are not very closely related to the fungi! This chapter on *Phylloxera* would naturally be the last place one would look to find an account of Craigie's discovery of the functioning of the spermatia of wheat rust, which would naturally be included in the chapter on the "Barberry and the Wheat." Craigie's work, however, is also mentioned in the chapter "Towards Immunity" where the origin of many of the new biologic races is properly attributed to hybridization in the wheat rust.

A chapter on degeneration and virus diseases is included, no doubt because viruses as well as fungi cause disease. Here the author has briefly yet effectively given us the latest information on this type of disease.

On the whole one cannot help enjoying a leisurely reading of various chapters because the historical accounts of certain of our most destructive plant diseases are enlivened with ideas on human relations well worth pondering.

B. O. Dodge

New York Botanical Garden

An Unusually Good Book

Hunger Signs in Crops. A symposium written by a group of fifteen specialists in agronomy, horticulture, plant nutrition, and plant diseases. Published by the American Society of Agronomy and the National Fertilizer Association. Judd and Detweiler, Inc., Washington, D. C. 1941. Pp. 340. $2.50

Hunger Signs in Crops gives in a very practical manner the symptoms that develop in growing crops when they lack needed mineral elements. The book is timely, for nutritional experts inform us that our diets are woefully lacking in vitamins, proteins and minerals. When plants lack minerals they cannot grow normally, and man and animals that feed upon these plants do not obtain the essential food elements.

The seventy-nine color plates in the book are well chosen and illustrate clearly the many points emphasized throughout the volume. As an example, the picture of a grapefruit with aborted seed and gum pockets in its axis clearly shows boron deficiency. The normal fruit in section is shown for comparison. In addition to the colored plates there are ninety-five halftones that vividly show the results of mineral deficiencies in the plants. The plants discussed are the ones we deal with in our daily life. The pictures illustrate the poor vegetables and fruits that we often purchase unwittingly from the store.

The opening chapter deals with general considerations but follows with a discussion of tobacco, corn and small grains, potato, cotton, vegetables or truck crops, deciduous fruit, legumes and citrus fruits.

The book was designed to be non-technical so as to increase its usefulness. The material was planned for county agents, agricultural teachers, progressive farmers and a source book for libraries and scientists. The clear pictures show at a glance what is wrong with a plant. Thirty minutes spent in the projection of the splendid plates will teach a student more about mineral deficiencies than ten hours of didactic work. Botanists and all lovers of nature cannot afford to ignore this book if they wish to be classified among the well informed.

As one turns the pages of the book one is confronted with the need of the following fertilizers in the soil: nitrogen, potassium, phosphorus, sulfur, magnesium, calcium, iron, manganese, boron, zinc and copper. When these elements are lacking, we have the ready picture which shows the deficiency and the loss of yields that one may expect. As a defense measure crops must be of high quality, and proper plant nutrition is absolutely necessary if we are to produce in abundance.

Sales of this book have been unusually high which testifies to its real worth. Credit, however, must be given to its sponsors who contributed freely of their time and to the Soil Improvement Committee of the National Fertilizer Association who agreed to be responsible for the sale of enough copies so that the price of the book would be within reach of all.

FORDHAM UNIVERSITY WM. J. BONISTEEL.

FIELD TRIPS OF THE CLUB

TRIP OF SEPTEMBER 28, 1941, TO LAKE BEAR SWAMP (LAKE OWASSA) AND SPRINGDALE, N. J.

This was a joint outing with the American Fern Society. Our first find was made before reaching the swamp. Among the revegetating species in a long abandoned field at the edge of the swamp we found the two gentians typical of north Jersey, *Gentiana quinquefolia* and *G. Andrewsii.* Two species of Botrychium were taken here also. In rapid succession as we entered the swamp the Massachusetts fern, and the two chain ferns were encountered. All of the species commonly to be expected in this habitat were found. Our trip had been prompted by the leader's interest in a press report that "mining" operations were in progress in the vicinity. It seems that a so-called "peat" is obtained from the root masses (tussocks) of Osmunda. No evidence of such activity was encountered though Osmunda was plentiful. This is a large swamp and we did not cover it all, though the difficulty of crossing a sector of Rhododendron thicket convinced most of the party that they had travelled miles. The reward here was a good feed of wild grapes in their prime. Before leaving the parking place many of the group were successful in finding Isoetes along the shore of Lake Owassa.

After lunch we returned to Newton and the leader obtained permission from Mr. Whittingham to cross his pasture to the well-known Springdale swamp region. Many previous visits to this area have been made. Clinton's and Goldie's ferns are abundant in parts of the swamp as well as numerous other species of Dryopteris. During the past forty years many hybrid forms have been discovered by the members of the two clubs. One such colony of *Goldiana x Marginalis* was visited. This colony was first reported by Philip Dowell. At this time it was found to contain several plants, generally in good condition despite the dry season. Two plants of hart's tongue fern were planted here by the Fern Society some years ago. Mr. Leon Bowen had reported them in good condition last winter. We found one plant to have nine good-sized leaves, eight of them fertile. No signs of reproduction were to be seen. The other plant was in poor condition so it was reset in the hope of finding more congenial surroundings. The leader pointed out that the soil and rock conditions of the native habitat in central New York are similar but the slopes are higher and cooler there. No visit to the Springdale swamp would be complete without including the Big Spring. There is a large colony of the common water buttercup here, *Ranunculus delphinifolius*. It was in flower at this date. On other trips we have collected it in flower as early as May 15, indicating a possible flowering period of nearly five months. Attendance: about 30. Leader: R. C. Benedict.

John A. Small

Trip of June 21-July 5—Eastern New England Tour

This trip of some 1800 miles was held substantially as announced in the field schedule. The hotel selected on Mt. Monadnock was the Half Way House which we found completely adequate. Plants of the Canadian and sub-alpine zones were seen on Mt. Monadnock, some of them in great beauty and abundance. Forestry practices and the destruction caused by the hurricane in 1938 were seen at the Caroline A. Fox Research and Demonstration Forest. Both of these walks were led by Dr. Henry I. Baldwin. Dr. Albion Hodgdon gave us some good trips in the Durham vicinity, stressing the behavior of plants at the end of their range. A northern bog, cedar swamp, and various upland situations were examined.

Mr. Arthur H. Norton of the Portland Society of Natural History, assisted by the botanists of the University of Maine, gave us a tour of York County in southwestern Maine. Sand barrens, bog lake, seashore, salt marsh, and fresh marsh were included. Intermediate stops were made at stations for particular plants of local occurrence. We climbed Mt. Agamenticus (alt. 673 ft.) for a grand view of the surrounding country. This is the high point of York County and is of local importance in being near the shore, forming a landmark in the monotonous coastline as viewed from the sea. Of course it figures in local nautical yarns. To us it brought *Selaginella rupestris, Juniperus communis,* and a dwarf species of Amelanchier, in addition to the more common species of the maple-oak forest. An old friend *Arctostaphylos Uva-ursi* was found here growing over the exposed granite.

Mt. Washington was a high point in many ways. Both Pinkham Notch Camp and Glen House were delightful though quite different. We had two splendid days. The two endemics, *Geum Peckii* and *Houstonia caerulea* var. *Faxonorum* were abundant and in full bloom. Dr. Baldwin arranged a fine symposium in the Alpine Garden with speakers who knew the region from first-hand research. These included Dr. Richard Goldthwaite on geology, Dr. R. F. Griggs on ecology, Mr. Norton on birds, Dr. C. F. Jackson on mammals, Dr. S. K. Harris on plants, a representative of the Mt. Washington Observatory on climate, and a member of the Forest Service on management policy of the White Mt. National Forest.

Two equally spectacular days awaited us at Mt. Katahdin. A five-mile hike to and from the northern terminus of the Appalachian Trail. A climb down and up the Chimney. Overnight in lean-tos on bough beds. Meals by a Maine guide or at a Maine sporting camp. Crossing the summit in clouds. All these conspired to enhance our pleasure in seeing the many species of alpine plants to which Dr. F. H. Steinmetz led us. The heat of the sun on the mountain table-land, the cold of the mild storm, snow in protected ravines, high winds, steep slides, cliffs, dry exposed rock, springs, and Chimney Pond were some of the varied habitats that we examined. The response of forest species to altitude and these other factors was carefully noted by Dr. Pierre Dansereau of the Montreal Botanical Garden.

The trip through eastern Maine was no less outstanding for Dr. Steinmetz went to unending pains to show us unique habitats and particular species of plants. Streams, the stony coastal headlands, the raised bogs or high moors, and the blueberry barrens were accompanied by most interesting elaboration of their environment and floristics. Good lodgings and intriguing meals ranging from a picnic with "makings" obtained at a four corners store (which had been in business for over 100 years) to a complete Maine shore dinner kept us in trim for the long days collecting and the short evenings (nights) for pressing.

Finally a day in Acadia National Park with Maurice Sullivan, Park Naturalist, brought our tour to a close. Species have not been mentioned in this report because of the vast number that were of interest and the limitations of space. Lists from characteristic habitats and local stations of botanical significance have been previously recorded by others and are available. A possible extension of range in the discovery of *Iris setosa* at Jonesport by Dr. Jacques Rousseau of the University of Montreal is our only chance of contributing to botanical science. Daily attendance fluctuated from seventeen to fifty-eight. Total participation was seventy-five. A final word of thanks to all who guided us.

John A. Small

PROCEEDINGS OF THE CLUB

Minutes of the Meeting of October 15, 1941

The meeting was called to order by the First Vice-President, Dr. E. B. Matzke, at the New York Botanical Garden at 3:30 P.M. Thirty-five members and friends were present.

In the absence of the Recording Secretary the Corresponding Secretary read the minutes of the previous meeting. These were adopted with correction.

It was voted that Miss Mary Gojdics, Duchesne College, Omaha, Neb., be unanimously elected to annual membership.

The Corresponding Secretary requested the permission of the Club to have its name used in the press as being opposed to the proposed amendment to the State Constitution which would permit construction of a ski trail on Whiteface Mountain. After discussion, it was moved by Dr. Camp that this permission to use the Club's name be granted. Dr. Kolk seconded the motion and the Club so voted.

The scientific part of the program consisted of two discussions illustrated by lantern slides and living specimens. The first speaker, Dr. John D. Dwyer, spoke on "Interesting plants of Litchfield County, Connecticut." The speaker's abstract follows:

A summer and fall survey of the flowering plants and ferns growing on a 4,000-acre tract of land in Litchfield County, Connecticut, and supervised by the State Board of Fisheries and Game, yielded approximatetly 600 species. Since the tract surrounds Bantam Lake and includes several ponds, opportunities for the study of aquatic vegetation were offered. Seventeen species of *Potamogeton,* including seven varieties, were collected. Numbered among these is *P. bupleuroides* Fernald, hitherto not reported for Connecticut west of Windsor Locks. Special collections and study of the complex species, *Arisaema triphyllum* were made. Kodachrome studies of exceptional and attractive plants were featured.

The second speaker, Mr. Jerome Metzner, spoke on "Observations on Local Volvocales." The speaker's abstract follows:

The three local species of *Volvox* may be distinguished from each other easily on the basis of certain differences in vegetative characteristics. *V. globator* has lobate protoplasts which are connected to each other by stout protoplasmic connections containing contractile vacuoles. *V. aureus* is about one-half the size of *V. globator.* Its protoplasts are not lobate and are connected by very delicate strands of protoplasm. *V. weismannia* is approximately the same size as *V. aureus* but lacks completely any protoplasmic connections. The oospores of *V. globator* are large and possess stout conical spines. The oospores of *V. aureus* lack spines. In *V. weismannia* there are slight spiny projections from the surface of the oospore.

Our knowledge of the life cycle of the genus *Volvox* is incomplete since fertilization has never been seen in any species. Preliminary studies made at Barnard College seem to indicate a complete lack of fertilization in *V. weismannia.* The oospores may be partenospores. Studies made on the development of the juvenile colony from the oospores in *V. weismannia* reveal the presence of protoplasmic connections in the early stages. This is possibly indicative of the ancestral condition.

The meeting was adjourned at 4:35 P.M. to enjoy the refreshments served by the members of the Garden staff.

Respectfully submitted,

JOHN W. THOMPSON, JR.
RECORDING SECRETARY

MINUTES OF THE MEETING OF NOVEMBER 3, 1941

The meeting was called to order by the President, Dr. J. S. Karling, at the American Museum of Natural History at 8:15 P.M. One hundred and eleven members and friends were present.

The minutes of the previous meeting were adopted as read.

It was voted that Dr. Flora Murray Scott, University of California, 405 Hilgard Street, West Los Angeles, Calif., be admitted by unanimous ballot to annual membership in the Club.

The scientific part of the program consisted of a talk by Dr. E. B. Matzke of Columbia University on "Autumn Coloration." The speaker's abstract follows:

When the green pigments, chlorophyll a and chlorophyll b, break down in the fall of the year, the carotene and xanthophyll, which are yellow to reddish-orange, become evident; anthoxanthins may be pale yellow. Anthocyanins are responsible for the brilliant red to violet colors of certain plants; their formation is governed by the genetic make-up of the plant, internal nutriment, light, temperature, available water, fixed nitrogen, and oxygen. The final brown is caused largely by tannins.

Through New England the sugar maple is the tree most largely responsible for the colors of autumn—varying from yellow to brilliant red. Its counterpart farther south is the scarlet oak, though other species of oak are also important. Red and purple colors are also added to the landscape by the dogwood, sour gum, sweet gum, sassafras, and white ash. The yellows are largely furnished by the hickories, tulip tree, and ginkgo. Black cherry, last of our trees to turn, takes on all colors, from purple to yellow.

Among the shrubs, purples, reds, and yellows are added by the sumachs, blueberries, barberry, and spicebush. Vines like cranberry, Virginia creeper, and Boston ivy, add their more modest bit. In the salt marshes glasswort is brilliant red. Beard grass paints the poorer hillsides tawny orange. Fruits, like those of holly, bittersweet, hawthorne, and barberry, each add their touch of red or yellow.

This display is characteristic of eastern Asia and eastern North America; in Europe, the Danube valley and parts of Switzerland are also showy, but to a less extent.

This final fanfare of color has no deep underlying biological significance.

The meeting was adjourned at 9:25 P.M.

Respectfully submitted,

JOHN W. THOMPSON, JR.
Recording Secretary

Minutes of the Meeting of November 19, 1941

The meeting was called to order by the First Vice-President, Dr. E. B. Matzke, at 3:35 P.M. at the New York Botanical Garden. Thirty-two members and friends were present.

In the absence of the Recording Secretary, the Corresponding Secretary read the minutes. The minutes of the previous meeting were adopted as read.

Mr. John T. Presley, Sacaton, Ariz., was elected by unanimous ballot to annual membership.

The scientific program consisted of three talks. The first speaker, Mr. Robert Hulbary, discussed "A fungus disease of Austrian pine." The speaker's abstract follows:

In blighted needles of Austrian pine collected in northern Illinois in the fall of 1938, immature stromata indicated the cause of the blight. Infected needles were wintered out-of-doors and examined periodically. The stromata remained quiescent through the winter but very early in the spring began to develop and by March 1 had emerged as strongly erumpent, loaf-shaped structures. A month and a half later, pycnidial locules were becoming differentiated, and by May 15 conidia were being produced.

The distinctive dothideaceaceous structure of the stroma distinguished the fungus from every described group. For it the new genus *Dothistroma* is proposed.

The well-marked dothideaceous structure of the stroma and the spore characters place the new fungus in the scolecosporous group of the Phomaceae close to *Hemidothis* Sydow. and *Septocyta* Petrak.

The second speaker, Mr. John Dodd, discussed "Some reactions to grafting in *Viola*."

The third speaker, Dr. Sydney Greenfield, discussed "Chemical inhibition of photosynthesis." The speaker's abstract follows:

The rates of photosynthesis as measured by oxygen evolution in Warburg manometers were determined with *Chlorella vulgaris* cells pretreated with solutions of various inorganic compounds, and compared with control rates. Several substances, including $ZnSO_4$, $CuSO_4$, $(NH_4)_2SO_4$, H_3BO_3, $NiSO_4$, $CoSO_4$, KCl, KI, and $HgCl_2$ were found to inhibit photosynthesis, whereas others like $MnSO_4$, KNO_3, and $MgSO_4$ did not retard the process. Inhibition was studied at five light intensities, from a range where light was limiting to where it was in excess, in order to determine the effects of these inhibitors on the photochemical and dark reactions in photosynthesis. A comparison of control and pre-treated cell rates revealed differential inhibition. $ZnSO_4$, $NiSO_4$, and KCl were found to inhibit the dark reaction without appreciably affecting the light stage. $CuSO_4$, H_3BO_3, and KI inhibited the dark reaction but also retarded the light reaction to a lesser extent. $(NH_4)_2SO_4$ and $CoSO_4$ caused a relatively equal inhibition of both reactions. No substance was found which inhibited the light reaction alone.

The meeting adjourned at 4:40 P.M. to enjoy the delicious refreshments provided by members of the Garden staff.

Respectfully submitted,

JOHN W. THOMPSON, JR.
RECORDING SECRETARY

Minutes of the Meeting of December 2, 1941

The meeting was called to order by the President Dr. J. S. Karling, at the American Museum of Natural History at 8:20 P.M. Eighty-seven members and friends were present.

The minutes of the previous meeting were adopted as read.

Dr. Earl H. Newcomer, University of North Carolina, Chapel Hill, N. C., was elected by unanimous ballot to annual membership.

The deaths of Professor W. J. Himmel, University of Nebraska, annual member since 1924, and Mr. Severin Rapp, Sanford, Fla., associate member since 1941, were announced with regret.

The President announced that the 75th Anniversary Committee had selected the week of June 22, 1942, to hold the 75th Anniversary Celebration meetings.

The scientific part of the program consisted of a talk by Professor William Seifriz, of the University of Pennsylvania, on "Recent advances in the study of protoplasm." Professor Seifriz illustrated his talk with motion pictures of the protoplasm of slime molds.

The meeting was adjourned at 9:40 P.M.

Respectfully submitted,

JOHN W. THOMPSON, JR.
Recording Secretary

Minutes of the Meeting of December 17, 1941

The meeting was called to order by the President, Dr. John S. Karling, at 3:30 P. M. at the New York Botanical Garden. Fifty-seven members and friends were present.

In the absence of the Recording Secretary, the Corresponding Secretary read the minutes of the previous meeting. The minutes were approved as read.

The following were elected by unanimous ballot to annual membership: Mr. Russel Lee Walp, Marietta College, Marietta, Ohio; Miss Doris A. Bach, 823 Park St., Kalamazoo, Mich.; Mr. Patrick Murray, St. Albert College, Middletown, N. Y.; Miss Dorothy Day, Smith College, Northampton, Mass.; Miss Margaret S. Brown, 36 Kent St., Halifax, N. S.; Mr. W. J. Nickerson, Harvard University, Cambridge, Mass.; Miss Clara S. Hires, Mistaire Laboratories, 152 Glen Ave., Millburn, N. J.; Mr. Victor M. Cutter, Cornell University, Ithaca, N. Y.; and Mr. D. G. Smith, 5 West 63rd St., New York, N. Y. To associate membership: Mr. I. E. Ehrenreich, 2944 West 28th St., Brooklyn, N. Y.; Rev. P. H. O'Neill, S.J., Fordham University, New York, N. Y.; Miss Laura Filmyer, 2916 Grand Concourse, New York, N. Y.; Miss Hope Mathewson, 82 East End Ave., New York, N. Y.; Miss Margaret Fife, 82 East End Ave., New York, N. Y.; Mr. Fred A. Buttrick, 184 Columbia Heights, Brooklyn, N. Y.; Miss Fairchild Bowler, 1075 Park Ave., New York, N. Y.

The transfer of Dr. Hettie M. Chute, New Brunswick, N. J., from annual to associate membership was approved.

The following resignations were accepted with regret: from annual membership: Dr. Alfred S. Goodale, Amherst College; Miss Ernestine Ball, Columbus, Ohio; Dr. Themistocles Acconci, Manhattan College; Mrs. D. C. Boyce, Pittsburg, Pa.; Mr. Charles W. Slack, Atlanta Ga.; Dr. Arthur W. Proetz, St. Louis, Mo.; Mr. G. M. Soxman, Dallas, Tex.; Miss Lena B. Henderson, Lynchburg, Va.; Dr. J. E. Weaver, University of Nebraska; Dr. J. W. Roberts, Beltsville, Md.; Dr. Valentine C. Baker, New York, N. Y.; Miss Abigail O'Brien, Remsen, N. Y.; and Mrs. F. L. Keays, Great Neck, N. Y.; from associate membership: Mrs. Cora Roe Smith, Branchville, N. J.; Mrs. Regina Jais, New York, N. Y.; Mr. Spencer Scott Marsh, Madison, N. J.; Dr. Myrtle L. Massey, Brooklyn, N. Y.; Miss Sarah J. Woodward, Brooklyn, N. Y.; Mr. Arthur E. Woods, East Orange, N. J.; and Miss Ethelwyn Doolittle, New York, N. Y.

Dr. Robbins moved that Dr. Barnhart be delegated to represent the Torrey Botanical Club at the celebration of the 50th Anniversary of the foundation of the Philadelphia Botanical Society in Philadelphia on Friday, December 18, 1941. The motion was seconded by Dr. Dodge and passed by the Club.

The scientific part of the program consisted of a talk and demonstration on "Vitamins and growth of plants" by Dr. W. J. Robbins of the New York Botanical Garden. The speaker's abstract follows:

It is now well established that the growth of many fungi is limited by their inability to make adequate quantities of one or more vitamins. Such fungi do not grow or grow poorly in a medium limited to pure sugars, minerals and asparagine but on the addition of various substances of natural origin or of one or more chemically pure vitamins, they develop satisfactorily. Ten species or strains of *Ceratostomella* were investigated.

The *Cerastostomellas* I used may be grown readily in media to which various natural products have been added, for example, malt agar, media containing a decoction of tree bark, and so on. However, of the ten strains or species reported here one only makes any considerable growth in a medium limited to minerals, sugar and asparagine. This is *Ceratostomella pseudotsugae*. However, the addition of vitamin B_1 and of vitamin B_6 to the medium materially increases the growth of that fungus. Biotin has no effect. *C. pseudotsugae* shows a partial deficiency primarily for vitamin B_1

and secondarily for vitamin B_6. *Ceratostomella piceaperda* grows very slowly in a medium of minerals, sugar and asparagine. The addition of biotin and vitamin B_6 markedly increases its growth. While *C. pseudotsugae* evidences partial deficiencies for B_1 and B_6, *C. piceaperda* suffers from partial deficiencies of biotin and B_6.

Ceratostomella ips isolated from *Pinus ponderosa* does not grow in the basal medium. It suffers from a biotin deficiency and on the addition of biotin to the medium grows quite satisfactorily. *C. fimbricata* and the *Ceratostomella* from London Plane have a complete B_1 deficiency. *C. ulmi* has a nearly complete B_6 deficiency. *C. pini* isolated from *Pinus echinata* and *C. pini* isolated from *Pinus ponderosa* though differing somewhat in appearance of growth are alike in having complete deficiency for both biotin and B_1. *C. montium* and *C. ips* isolated from *Pinus echinata* suffer from major deficiencies of B_1, B_6 and biotin. They grow little or not at all unless all three vitamins are present in the medium. Among these ten species or strains of *Ceratostomella* seven different types of vitamin deficiencies exist:

1. Major or complete deficiency for B_1—little affected by B_6 or biotin.
2. Major or complete deficiency for B_6—little affected by B_1 or biotin.
3. Major or complete deficiency for biotin—little affected by B_1 or B_6.
4. Partial deficiency B_1 and B_6—little affected by biotin.
5. Partial deficiency biotin and B_6—little affected by B_1.
6. Major deficiency biotin and B_1—little affected by B_6.
7. Major deficiency B_1, B_6 and biotin.

By selecting a suitable species of *Ceratostomella* it is possible by its growth or failure to grow to demonstrate the presence or absence of B_1, B_6 or biotin or substitutes therefor. In the course of these experiments it was discovered by accident that an extract of cotton batting added to a medium of minerals, sugar and asparagine permitted good growth of *Ceratostomellas* which showed deficiencies for B_1, B_6 or biotin or combinations. It seems justifiable to conclude that unbleached and unwashed cotton contains significant quantities of all three of these vitamins.

In the same way, that is by the growth of various species of *Ceratostomella,* the presence of B_1, B_6 and biotin in unpurified Difco agar also was determined.

Since cotton and Difco agar are both commonly used in laboratory procedures, it is clear that due consideration must be given to them as possible sources of vitamins. Knight and his associates working with the so-called sporogenes vitamin found that stray filaments of cotton falling in their media invalidated their bacterial experiments.

In presenting these results I have emphasized the more marked deficiencies of the *Ceratostomellas* for the three vitamins B_1, B_6 and biotin. Less marked deficiencies have been observed. For example, a species which grows little or not at all unless B_1 is added to the medium may grow somewhat more rapidly if all three vitamins are added. It is probable also that some of these organisms suffer from partial deficiencies for other vitamins or vitamin-like growth substances. I am not sure that reproduction will occur in media supplemented with B_1, B_6 and biotin as satisfactorily as it does in media containing natural products, for example, malt agar. Some evidence for the deficiencies for unidentified growth substances is furnished by the more rapid growth in some natural media than in a basal medium containing twelve pure vitamins and twenty-one pure amino acids.

These results with *Ceratostomella* are of interest:

1. Because of the diversity of vitamin deficiencies in representatives of a single genus.
2. Because the discovery of a fungus with nearly complete vitamin B_6 deficiency suggests that it may be used for bio-assay for this vitamin. Assay methods for vitamin B_6 are at present unsatisfactory.
3. Because of the determination of the presence of significant quantities of biotin, B_6 and B_1 in cotton batting and unpurified agar.
4. Because the results show that a fungus may suffer from a complete deficiency of three vitamins, a situation which approaches more nearly the condition of the animal where many complete deficiencies exist. This emphasizes again the fundamental likeness of the basic physiological processes in all living things.

The meeting was adjourned at 4:20 P.M. and many members and guests remained to continue the discussion informally at tea provided by the Garden staff.

Respectfully submitted,

JOHN W. THOMPSON, JR.
RECORDING SECRETARY

THE FIELD COMMITTEE of the Club announced 168 botanical events in its schedules during 1941. Of these 85 were actual field trips, many of them in cooperation with one or more other botanical societies. Reports were received from 78 of these field trips. Total attendance was 1456 or an average of about 19 persons to each field trip. The high mark was the Branchville Nature Conference, attended by 97.

THE TORREY BOTANICAL CLUB

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OTHER PUBLICATIONS

OF THE

TORREY BOTANICAL CLUB

(1) BULLETIN

A journal devoted to general botany, established in 1870 and published monthly, except during July, August, and September. Vol. 68, published in 1941, contained 694 pages of text and 55 full page plates. Price $6.00 per annum. For Europe, $6.25.

In addition to papers giving the results of research, each issue contains the INDEX TO AMERICAN BOTANICAL LITERATURE—a very comprehensive bibliography of current publications in American botany. Many workers find this an extremely valuable feature of the BULLETIN.

Of former volumes, 24-68 can be supplied separately at $6.00 each; certain numbers of other volumes are available, but the entire stock of some numbers has been reserved for the completion of sets. Single copies (75 cents) will be furnished only when not breaking complete volumes.

(2) MEMOIRS

The MEMOIRS, established 1889, are published at irregular intervals. Volumes 1–18 are now completed. Volume 17, containing Proceedings of the Semi-Centennial Anniversary of the Club, 490 pages, was issued in 1918, price $5.00.

Volume 18, no. 1, 108 pages, 1931, price $2.00. Volume 18, no. 2, 220 pages, 1932, price $4.00. Volume 18 complete, price $5.00.

Volume 19, no. 1, 92 pages, 1937, price $1.50. Volume 19, no. 2, 178 pages, 1938, price $2.00.

(3) INDEX TO AMERICAN BOTANICAL LITERATURE

Reprinted monthly on cards, and furnished to subscribers at three cents a card.

Correspondence relating to the above publications should be addressed to

W. GORDON WHALEY,
Barnard College,
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Volume 42 March-April, 1942 Number 2

TORREYA

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EDITED FOR

THE TORREY BOTANICAL CLUB

BY

WILLIAM J. BONISTEEL

John Torrey, 1796-1873

CONTENTS

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TORREYA

TORREYA, the bi-monthly publication of the **Torrey Botanical Club,** was established in 1901. TORREYA was established as a means of publishing shorter papers and interesting notes on the local flora range of the club. The proceedings of the club, book reviews, field trips and news notes are published from time to time. The pages of TORREYA are open to members of the club and others who may have short articles for publication.

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TORREYA is edited for the **Torrey Botanical Club** by

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Manuscripts for publication, books and papers for review, reports of field trips and miscellaneous news items should be addressed to:

DR. WM. J. BONISTEEL
BIOLOGICAL LABORATORIES, FORDHAM UNIVERSITY
NEW YORK, N. Y.

TORREYA

Vol. 42 March-April No. 2

A Botanist's Summer in Costa Rica

M. A. Chrysler

It was the writer's good fortune to spend July and August of 1940 in the little republic of Costa Rica, which has been characterized by Gunther[1] as "one of the most delightful countries in the world and one of the purest democracies on earth." It has moreover a particularly interesting flora, especially to the student of ferns. According to the North American Flora, it is headquarters for Gleicheniaceae, with an array of endemic species, hence a trip was arranged so as to provide a two-weeks' stay in Jamaica, a week on Barro Colorado Island, C. Z., and the balance of the season in Costa Rica. During most of the time the writer was accompanied by his colleague, Dr. W. E. Roever, whose cooperation was invaluable.

One gains a lasting impression of the vertical distribution of the plant life by looking out of the window from the train which takes him from Port Limon to the capital, San José—a trip of only a hundred miles which nevertheless occupies about six hours. Starting from the banana groves near the coast, the traveler passes through real jungle with reappearance of bananas, coconuts and cacao at every settlement—the *tierra caliente*. Presently the lower stretches of the Reventazon River are reached, and the road begins a series of sharp curves and steep grades as it follows the course of the rushing river. By the time an elevation of 2000 feet is reached, coffee has replaced the banana as the leading crop, giving an entirely different aspect to the landscape, for the coffee shrubs grow in the partial shade of such trees as species of *Inga,* and during August are bright by reason of the ripe red berries which contain the familiar coffee "bean." The railroad banks are enlivened by the brilliant flowers of *Heliconia* and *Costus,* representing monocotyledonous families quite unknown to northern floras.

[1] Gunther, John. Inside Latin America. Harper & Brothers, New York, 1941.

Torreya for March-April (Vol. 42: 33-64) was issued April 10, 1942.

We are now passing into the *tierra templada* of Standley,[2] the region in which most of the population is found. The curves become sharper and the grades if possible more steep, as we realize when a brisk shower descends and the track becomes so slippery that the train is stalled until the rails are sanded and the plucky little engine jerks the train into motion, while we breathe more easily although we realize that perhaps we should have bought some of that fried chicken which was offered at the car windows while we stopped at Turrialba. The view of river and mountains grows more expansive, and Roever's Leica is in frequent use. At length an altitude of 5137 feet is attained at the Continental Divide just beyond Cartago, the former capital, which was levelled by an earthquake thirty-odd years ago. The train slides down the remaining ten miles to San José, situated at an altitude of 3800 feet among the coffee plantations in the saucer-shaped "meseta central."

San José was our headquarters for most of the two months, and was convenient because of the bus lines radiating in every direction. Under the guidance of Director Valerio and Dr. A. Skutch of the Museo Nacional, we made our first excursion to the *tierra fria*, going by auto on one of the few paved roads until an elevation of 6800 feet was reached, where we found the way blocked by a landslide. So we finished on foot the few miles to the hamlet called Varra Blanca, where we spent a memorable week. Here no crops except potatoes are raised, and the universal industry is dairying. Milk, tortillas, beans and rice are the staple articles of diet. As we wandered out into the fields we were at once attracted by huge pink bouquets formed by old oak trunks covered with climbing shrubs belonging to the ericaceous genus *Cavendishia*. The dominance of epiphytes astonished us until it was realized that these plants enjoyed plenty of light, air and water, also immunity from grazing animals. Every tree had its assortment of "air-plants," chiefly ferns and orchids. One large shaggy species of *Trichomanes* (*T. lucens*) attracted attention, also what appeared to be a fleshy spleenwort (*Enterosora spongiosa*). One tree was beautifully mantled by a vigorous specimen of the familiar *Polypodium aureum*, below which a border of *Nephrolepis pendula* was added by way of good measure. The fragrant *Asplenium auritum* adorned the base of most trees,

[2] Standley, P. C. Flora of Costa Rica, part 1. Chicago, 1937.

while the dainty *Rhipidopteris peltata* grew in masses on fallen trunks. Presently the usual afternoon shower drove us to cover, where we hastened to get our treasures into the drier or into pickle ere the quick tropical night descended and we had to depend on candle light.

The scientific peak of the whole trip was reached when on a hillside near our stopping place we found eight species of *Dicranopteris* (a segregate of *Gleichenia*) including the endemic *D. costaricensis* and the remarkable *D. retroflexa*. *D. Bancroftii* (Fig. 1) afforded a surprise, for instead of the single fork bearing two leaflets found

FIGURE 1. *Dicranopteris Bancroftii* filling a small ravine; the branches of the leaves are two feet long. Varra Blanca, C. R. Alt. 6000 ft.

earlier in Jamaican plants, forks of the second, third and even fourth order were characteristic of the plants in a ravine near those endemic species. Stream banks displayed a huge herbaceous *Senecio* (*Cooperi*) and an equally large *Eupatorium* (*angulare*) while the fuchsia used as a house plant was represented by *F. arborescens* 15 feet high. Melastomes of various genera—trees, shrubs, and herbs—were of constant occurrence, some as beautiful as climbing roses (*Blakea spp.*). From Varra Blanca Dr. Roever took a memorable trip to the crater of Volcan Poas (8300 feet), bringing back *Drimys Winteri,* famous because although it is a dicotyledon its wood shows tracheids in place of vessels. Other prizes were certain rare ericads and the immigrant conifer from South America, *Podocarpus montanus.*

Our next trip afforded a chance to sample the rich flora of a region at an altitude of 2,200 feet, San Isidro del General. This village in the midst of a bean growing region has the distinction of having skipped some of the usual evolutionary stages of a community, such as horse and carriage, automobile, railroad, telegraph and telephone, for it has leaped from the ox-cart stage to airplane and radio. Half an hour by plane covered the journey from San José, although by mule-back over the ridges five days used to be consumed. We were particularly impressed at San Isidro by the variety of tree ferns and the pendent species of *Lycopodium.* Although the roadsides showed some highly colored flowers, the only conspicuous angiosperms in the rain forest were the orchid-like *Orchillium Endresii*—a large-flowered member of the bladderwort family—and *Cephaelis* spp. (Rubiaceae) distinguished by two deep red bracts enclosing each inflorescence. But the Selaginellas of stream-banks, a splendid *Lindsaya* (*lancea*) a climbing *Blechnum,* impressive Dennstaedtias made up for paucity of color.

Another area along the 2,000-foot contour was visited—the valley of the Reventazon River near Turrialba village. The calcareous banks of the river support a varied flora, again consisting chiefly of ferns, but including *Zamia Skinneri,* a species interesting because of its trunk-forming habit. We were hospitably entertained at a coffee plantation by Mrs. Goode, the patron saint of botanists in that region, where every hedge-row presents novel plants, and a bewildering assortment of *Dryopteris* challenges one's observing capacity.

The vicinity of Cartago has been made familiar to biologists by Professor and Mrs. Calvert[3] through the notable volume describing a year's work, chiefly on insects but containing many references to plants. Although the region is much changed during the last thirty years, we still found the slopes of Mt. Carpintera well worth exploring, while the thickets and walls could be depended on to furnish

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[3] Calvert, P. P. and A. C. A year of Costa Rican natural history. New York, 1917.

unfamiliar ferns. The chief attraction of the region, however, is the orchid garden of Mr. C. H. Lankester. This is a most remarkable assemblage of orchids of Costa Rica and other tropical countries, blended with ferns and cycads and growing on trees and banks in a charming atmosphere of wildness. The writer was most kindly entertained by the Lankesters, and cannot forget the display of hybrid orchids, some of rich fragrance, which greeted him each morning as he emerged from sleeping quarters. The visit was notable for a number of personally conducted field trips, one to a station for *Ophioglossum palmatum* and another along the newly constructed Pan-American highway.

The difficulties experienced in travelling in Costa Rica are illustrated by another trip. In company with Sr. Leon of the museum we took bus for Heredia, then climbed six miles on a dirt road to the slopes of Volcan Barba. On the way a sudden storm overtook us, as we ate lunch by a friendly bank. Arriving at a schoolhouse we went under the guidance of the schoolmaster to a sulphur spring near which we collected a *Peperomia* which is regarded as a new species. We were allowed to sleep on the floor of the schoolhouse, which we may report as clean and polished, but cold and drafty. It was on this trip that we found *Botrychium cicutarium, B. underwoodianum* and *Ophioglossum reticulatum,* at altitude 6,500 feet. It was in a similar locality that we found *Gunnera insignis,* a plant provided with leaves so large that they are used as umbrellas by the natives.

Our advisers did not encourage us to brave the dangers of malaria by venturing into the Province of Guanacaste, on the Pacific slope. The climate of San José is so healthful, and relatively easy excursions are so many that our remaining trips were made in the neighborhood of the capital. On the last day of August we took train for Port Limon, feeling content at having accomplished at least the main objects of the trip.

Department of Botany
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Collecting Chicle in the American Tropics[1]

John S. Karling

The principal source of chicle, the basic ingredient of chewing gum, is the latex of *Achras zapota,* a species of the family Sapotaceae which occurs in abundance in southern Mexico and Central America. The sapodilla or chicle tree is generally regarded as indigenous to southern Mexico, Central America, northern South America, and the West Indies, but because of its delicious fruit it has been planted extensively and may now be found under cultivation in limited quantities as a fruit tree in most tropical and sub-tropical countries. It is principally in southern Mexico and Central America, however, that it grows in sufficient quantity, size, and height to make tapping for chicle profitable. Here the trees may occasionally attain a height of a hundred feet with straight smooth boles, sometimes as much as eight to twelve feet in circumference; and in these regions during the past half century has sprung up the extensive and unique industry of gathering crude chicle which has no parallel in any other part of the world.

Although the natives in tropical America had been using small amounts of chicle for various purposes in pre-Columbian times (Melendez, 1920), it was not until the discovery of chicle as a suitable base for chewing gum that this product became economically important. This discovery more than half a century ago is said to have been the result of attempts to vulcanize the gum of the sapodilla tree in the same manner and as a possible substitute for rubber. The similarity of chicle to spruce and cherry gums, the best chewing gums in use at that time, and its adaptability to chewing and compounding with adulterants, sugars, and flavors were soon recognized, and from these first modest experiments and an initial outlay of fifty-five dollars the extensive present-day chewing gum industry is said to have had its beginning. Hand in hand with the spread of the gum chewing habit grew the demand for raw chicle, and within a few years a new enterprise sprang up in the jungles of southern Mexico and Central America. Rival American contractors began to push into the jungles to obtain large concession of virgin forests and to offer unheard-of inducements to the natives for gathering chicle. Raw

[1] Address presented before the Torrey Botanical Club, December, 1940.

chicle thus soon became one of the principal exports of several Mexican and Central American states, and in 1930 the import of chicle into the United States had risen to nearly fourteen million pounds (U. S. 1932). In its half century of growth the chewing gum industry has made phenomenal progress, and at the present time ranks among the big American industries. The manufactured output in 1930 was valued at more than seventy million dollars, representing a retail business of over a hundred million dollars.

Chicleros and the Present Native Method of Tapping and Preparing Raw Chicle

The native laborers or Indians who bleed the sapodilla trees and gather the chicle are known as chicleros. No particular group or tribe of natives has a monopoly of skill in this profession, and chicleros of almost every race, color, nationality, and intermixture are to be found. The native Indian of southern Mexico and Central America, however, is generally regarded as the most skillful, careful, and desirable. Steadiness of hand and accuracy in manipulating a machete as well as a certain amount of skill in climbing are the prime requisites of a good chiclero, and only a small proportion of the native labor is capable of bleeding chicle. The chiclero is thus regarded as a skilled worker in the tropical forests and is among the best paid of all native laborers. Since the chicle tapping season is dependent on the rainfall, the chicleros spend the greater part of the rainy season from July to February in the chicle forests. As soon as the tropical rains start in June, the exodus of chicleros from the coast towns and villages into the jungle of Peten, Quintana Roo, Yucatan, Campeche, Chiapas, and British Honduras begins. For the purpose of companionship as well as assistance in certain aspects of the work, they generally go in small groups of from two to five, and may oftentimes take their families with them to form large camps.

While in the chicle forests the chicleros live in temporary camps close to the scene of operation. These camps are generally located on the edge of a lagoon, swamp, or savannah where water is available, since a constant water supply is necessary not only for drinking and cooking but for the molding of cooked chicle as well. As a consequence, the camps are generally situated where mosquitoes and other blood-sucking insects are likely to be most numerous. In figures 4 and 5 is shown a portion of such a chicle camp at the border

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Chicleros tapping Achras zapota for chicle. Photograph by H. M. Hedler.

of a dense cohune palm ridge. Inasmuch as the chicleros may often shift their operations during the same season and rarely return to the same camp in successive years, their huts are but temporary structures of upright poles in the ground roofed over with palm leaves. During prolonged tropical rainstorms these huts afford but little protection from the rain, so that the chicleros are more or less wet for extended periods of time. This constant exposure, together with the presence of disease-carrying insects, often leads to the contraction of malaria and other pernicious tropical diseases. While in the jungles the chiclero's fare is very simple and consists chiefly of rice, frijoles, and tortillas, with occasional meat from wild game which they may kill.

The chicleros are paid in accordance to the amount of gum extracted during the chicle season. A skilled tapper in a virgin forest can sometimes collect as much as 2000 pounds in one season, for which he is paid from 12 to 30 cents per pound, depending on the quality and moisture content of the gum. Since he is frequently able to make more money gathering chicle during the rainy season than for working for wages throughout the entire year, he is preferably idle from February to June. During this period many of them loaf from one village to another doing an occasional job. As a result they may be partially or wholly dependent on some chicle contractor for rations and livelihood during the dry months, and by the time the chicle season arrives they are often in debt for more than the value of the chicle they can extract. In this manner, they often become bound to one contractor from year to year. For these reasons many observers maintain that the chicle industry has done more harm than good to native labor in tropical America. It has been claimed that previous to the advent of chicle the Indian was a fairly industrious and conscientious worker who cultivated his milpa, hunted, and was quite contented to work for small wages rather than remain idle, while the women spun and made their own clothing. Then came the American chicle contractor offering fabulous advances in cash for chicle with the inevitable result that the Indian forsook his milpa to become a chiclero. Finding that he was thus able to more than double his yearly income in a few months gathering chicle, he refused to work at all during the dry season or only for greatly increased wages. As a result the milpa was neglected, and the price of rice, beans, and corn nearly doubled. Moreover, the earning of more money than

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The native machete-spiral method of tapping Achras zapota for chicle.
Photographs by W. D. Durland.

was necessary for food during the chicle season developed extravagant tastes among the women. Where once they had been contented with the simple native costume, they now demanded expensive clothing, etc., from their men. The increased price of food and the efforts to satisfy more extravagant tastes were not commensurate with their increased earnings from bleeding chicle, and as a result they had to turn continually to some chicle contractor for advances. He, in turn, charged impossible rates of interest and paid as little as possible for the chicle. The chiclero, not to be outdone, adulterated the chicle, and often received advances from several contractors without working for any of them. In the last two decades, however, many of these economic factors have changed considerably.

The chicle tapping season is dependent on the rainfall, and is thus concurrent with the rainy season, contrary to the reports of certain authors. If the tropical rains come early it may begin in June and extend to February, but it does not generally get well started until July and August. Tapping commences with the daylight. The chiclero rises while it is yet dark, prepares a light breakfast, and starts out afoot through the dense jungle for the sapodilla trees which he had located on previous days. Arrived at a tree, the chiclero first clears a small area around the tree, and adjusts the skin or canvas bag in which the milk is collected. It is either set on the ground or hung from an incision in the bark (Figs. 1, 2). Directly above the bag a small area of the tree is cleared of its outer hard bark and an upward incision made in the softer cortex with the machete. This makes a flap under which the end of a trimmed palm leaf is inserted to act as a conveyor for the latex from the tree to the bag. Having properly adjusted the bag and inserted the palm leaf, the chiclero begins to tap.

Tapping in the wild chicle "bush" or "chicleria" is done exclusively with a long thin-blade cutlass or machete. Chicleros generally prefer the fairly straight machete, since they are thereby able to remove a wider chip of bark with each stroke. The native method of tapping is essentially a half-spiral system, as is shown in Figures 2 and 3, and consists of successive parallel rows of cuts ascending the bole obliquely. The successive oblique rows of incisions alternate from side to side and lead into the lower preceding ones, so that the latex from the individual rows flows together in a zigzag channel down the tree to the point where the collecting bag is attached. As

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A chiclero's camp in British Honduras.

is at once apparent in Figures 2 and 3, the obliquely ascending rows of cuts are not continuous channels encircling the trunk, but consist or more or less separate partially overlapping incisions. The latex from each cut thus spills over into the lower preceding one. The first oblique rows are usually started a few inches above the point of insertion of the palm-leaf conveyor, at angles of 45° to 70°, depending on the size of the tree and the habits of the chiclero, and the following oblique rows are then made ten to twenty inches apart. In the case of large and old trees, the outer bark is generally too hard and thick for making satisfactory incisions, and as a consequence it is usually removed before each oblique channel is made. This is well shown by the tree in the foreground of Figure 1 and in Figure 2. In the small tree shown in Figure 3, however, removal of the outer bark was not necessary. Chicleros thus frequently carry two machetes, an old one for removing the outer bark and another sharper one for making the oblique incisions.

As soon as the chiclero has tapped as high as he can reach standing on the ground he begins to climb. This is done with the aid of a thick rope passed around the tree and the middle of his body. The looseness of the loop permits the chiclero to steady himself with his feet against the tree, leaving both hands free for tapping, as is illustrated in Figure 1. The trees shown in this figure are being tapped for the second time, and the overlapping of the previous and the new oblique channels accounts for the striking diamond-shaped areas on the bole. Climbing spurs such as those used by telephone linemen are frequently employed as an aid, but the best chicleros spurn such assistance and climb only with bare feet. The chiclero thus climbs higher and higher, swinging from side to side as he makes the alternate rows of cuts until the entire bole has been tapped. In cases where the trunk forks and large erect branches are present, the latter also may be tapped. When one tree is finished the chiclero proceeds to the next, and so on into the early forenoon until relative humidity, sun, wind, and temperature begin to affect the flow of latex. In the dense jungle where only slight winds penetrate relative humidity remains fairly high, so that tapping may continue until middle forenoon. In the more open "bush," however, increased temperature, sun and wind, and loss in humidity make tapping unprofitable after 8 or 9 o'clock in the morning.

The chiclero usually spends the remainder of the forenoon locating trees for the next day's tapping. The first step after finding a virgin tree is to test its flow of latex. Incisions are made in the bark near the base, and if the latex flow is good the tree is marked or staked for tapping; otherwise it is discarded. In an area which has

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Aerating chicle after cooking.

once been tapped, it is not uncommon to find several large, vigorous, and sound trees that are untouched. They all, however, bear the test marks of the chiclero, testimony to the fact that they are poor yielders. By the careful selection thus of only good yielding trees, the amount of chicle per tree in the virgin sapodilla forests may be quite high, but the acreage yield is proportionately low. The yield per individual tree is quite variable, as is to be expected in a wild population. Some trees do not yield sufficient latex to wet the incisions, while others have been reported to yield as much as sixty-one pounds (Hummel, 1925). The report of Sperber that trees in Mexico yield thirty to thirty-five pounds annually is obviously without foundation. Exceptionally large trees may yield that amount at the initial tapping, but certainly not every year. According to the writer's observations, the initial yield per large virgin tree is usually two to ten pounds. As soon as a sufficient number of trees have been located, the chiclero returns to camp with the bags of latex. Frequently the bags are allowed to remain on the trees until the following day if there is no danger of rain. Otherwise they are collected on the same day, since the presence of excess water in the latex makes cooking long, tedious, and difficult.

The latex from the various trees is poured together in empty petrol tins or larger bags and stored until a sufficient amount for cooking has been accumulated. The chicleros generally tap throughout the week and cook the latex on Sundays. Cooking is primarily for the purpose of driving off water and is done in large iron kettles or cauldrons over an open fire, as is illustrated in Figures 4 and 5. The time required for cooking varies with the amount and quality of latex in the pot, but usually one to two hours are sufficient. During the process the latex is stirred continuously with a long stick or paddle in a circular fashion to prevent burning and to throw the water toward the periphery of the mass. After the latex has reached the consistency of soft taffy, the fire is scraped from beneath the kettle or the latter is removed from the open fire. The gum is then further worked and aerated (Fig. 6) with the long paddle until it begins to cool and become firm. It is then lifted out onto a large soaped palm leaf, tarpaulin sheet or sack (Fig. 7) and molded into blocks (Fig. 8). The chicle at this stage is still quite sticky, and an abundance of water and soap are essential for successful handling and molding. Preparatory to taking the chicle out of the cauldron, the chicleros soap their hands and arms thoroughly, and by constant renewal of soap they are able to handle and mold it with a minimum of sticking. In the earlier days of gum collecting the chicle was often heaped together into semi-spherical and rectangular masses and allowed to dry, but the general practice at present is to mold it in

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Molding chicle into blocks.

rectangular frames of uniform size, which allows greater economy of space in storing and shipping. Formerly, the weight of the chicle masses and blocks varied as much as their shape, and blocks weighing as much as a hundred pounds were not uncommon. At present, however, they are usually more uniform in weight, varying from twenty-five to forty pounds. At the time of molding the chicle contains approximately forty to fifty per cent water, but by the time it is shipped to the States, the moisture content varies from twenty-five to thirty-five per cent.

As soon as the chicleros have accumulated a fair number of blocks, the chicle is delivered to the contractors who advanced the money for rations and supplies. In more organized chicle operations the contractors generally send out pack mules periodically to the various chiclero camps to collect the accumulated chicle. It is then concentrated in central camps, baled and transported by mule, boat or aeroplane to storehouses along the coast, and eventually shipped to the United States or Canada.

Attempts have also been made from time to time to extract chicle profitably from the leaves and green fruit, but without much success. It is estimated (Anonymous, 1923) that approximately 3200 leaves are required for a pound of gum, and the cost of production at that rate is in excess of the present price of chicle.

(*To be continued*)

Rare Cladoniae in New Jersey

W. L. Dix

Cladonia squamosa f. *carneopallida* Sandstede. This specimen was collected by the writer a few miles east of Jackson, Camden County. It was first collected in America near Hartford, Connecticut, and reported by Dr. Alexander W. Evans in his third supplement to the Cladoniae of Connecticut.

Cladonia pyxidata var. *neglecta* f. *centralis Schaer.* In this form the cup is centrally proliferate. It was collected near Hopewell in Mercer County. Apparently this is the first account of this form in America.

The second authenticated collection of *Cladonia turgida* in New Jersey was made by the writer along the Appalachian Trail in Warren County last November. The reported collections of Austin from Bergen County, by Eckfelt from Warren County, and by Torrey from Passaic County, all proved to be other species, or are represented by no specimen. Torrey, however, did later find "a small form of the species" in Green Bank State Forest, Atlantic County, in 1936. The specimen collected by the writer consisted of squamules only.

BOOK REVIEWS

The A. B. C. of Insects

Introducing Insects: A Book for Beginners. By James G. Needham. The Jaques Cattell Press, Lancaster, Penna. 1940. Pp. v + 129. $1.50.

Biting into a wormy apple is an unpleasant experience! Unpacking the dress suit after it has been stored for a while only to find that it has a few conspicuous moth holes can be very distressing. If we know nothing about these "pesky bugs" that come to upset us or if we should like to refresh our memories, Professor Needham's little book is an ideal starting point.

Professor Needham has given us a book, written in simple, nontechnical language coupled with an easy style, that will help the layman to understand and to appreciate the insects with which he comes in contact. His introductory chapters, "Why Study Insects" and "How to Study Insects," are followed by discussions of such common insects as butterflies, dragonflies, grasshoppers, leaf bugs, beetles, scale insects, aphids, mosquitoes, and bees. The author next considers such ecological groups as carniverous insects and insects that eat our foods and textiles. The concluding chapters are concerned with the control of insects and the collecting and rearing of insects.

The expositions of life histories, food habits, and habitats preferred by the insects during their developmental stages are interspersed with considerations of the balance in nature, parasitic and predatory insects, beneficial and noxious insects. The importance of careful observation is stressed so that we shall know which insect to swat and which insect to protect: our insect friends should not be needlessly killed.

The line drawing illustrations are well chosen and admirably compliment the various parts of the text. In illustrations of this type, most drawings have to be larger than the actual specimen under consideration to show even a minimum of structure. As the book is especially designed for beginners, it is to be regretted that hairlines, indicating the size of the insects, are not included with all the drawings.

This book can be used with profit in nature study groups or clubs and in biology classes which range in age from the early teens through adults. The suggested points for field observations, tricks for catching some of the insects, the study of live insects, and the simple rearing experiments should certainly provide excellent training and considerable enjoyment. The author appropriately closes his INTRODUCTION by listing a few advanced books to which the inquisitive beginner might turn for more detailed information.

FORDHAM UNIVERSITY — JAMES FORBES

A Nature Study Book

The Flower Family Album. By Helen Field Fischer and Gretchen Harshbarger. 130 pages, 62 full-page plates. The University of Minnesota Press. 1941. $2.50.

When this book first appeared, bound in stiff paper and printed by the off-set process, it was reviewed briefly in Torreya **40:** 212 (1940). It proved so popular that it is now issued by the University of Minnesota Press, bound in attractive cloth covers. The size remains the same, 8½ by 11 inches, with the same attractive illustrations showing 458 common wild and cultivated flowers belonging to some forty plant families. The drawings are all to the same scale, with the height in inches indicated at the side of the page. For each family a sketch of a single blossom or flower cluster is shown to give the family characteristics. Most of these latter are rather generalized, some without enough detail to be of much help. In the introduction there is a series of sketches of flower types with references to the pages where the corresponding types of flowers are found, this making a sort of key so that one can hunt more easily to find an unknown plant's portrait.

Opposite each plate is a description of the family and of the flowers illustrated. These are entirely non-technical, often somewhat whimsical, but clear and accurate. For example the description of the flowers of the legumes reads, "In most of the family they (the flowers) look much like butterflies. One petal enlarges to make a banner to tell the bees that pollen is ready. Two more, called wings, make a roof landing field for the bees. The last two join to make a cradle for the ovary, which is wrapped in a gossamer sheet made from the united stems of the stamens." Of the mints we read "The family is friendly and helpful, seems to love the society of mankind, for around every dooryard may be found plants of MOTHERWORT and CATNIP, which furnish tonic for man and beast." Of the composites, "Cooperative Flowers," "Each disk flower is given the materials to produce a seed, and it all works out as efficiently as the production line in an automobile factory." Of the composites ten pages of plates include such cultivated forms as dahlia, cosmos, chrysanthemum, marigold and zinnia and such wild forms as asters, bidens, dandelion, goldenrod and thistles.

The book will be of little value to the professional botanist, but the beginning student and gardener will find that a knowledge of the characters of the plant families given in this informal way will aid in placing the majority of plants in their proper places while all plant lovers will find the book helpful and attractive.

GEORGE T. HASTINGS

Butterflies of the North-eastern States

Butterflies. A Handbook of the Butterflies of the United States. Complete for the Region North of the Potomac and Ohio Rivers and East of the Dakotas. By Ralph W. Macy and Harold H. Shepard. viii + 248 pages. The University of Minnesota Press. 1941. $3.50.

This attractive book is written for beginners in the study of butterflies as well as for experienced students and collectors. Covering all of the north-eastern United States and adjacent Canada completely it will be useful beyond this area as many, if not most, of the species described extend beyond any artificial boundary. One hundred sixty-two species and twenty-seven races are described, about one-fourth of all the species in North America north of Mexico. The descriptions include not only the adults but also the life histories as fully as known, the food plants of the caterpillars, the ranges throughout the United States and the world—for some, and as the Mourning Cloak and Red Admiral range over most of the northern hemisphere. There are often in addition personal observations on the habits of caterpillars and adults by the authors. Synonomy is complete and for each species there are page references to other works in which it is described or illustrated. The keys to families, genera and species make use of non-technical characters—wing shape, color and pattern, size—as far as possible so that in only a few cases is it necessary to consider the venation of the wings or to use a lens for minute characters. Unfortunately after determining a specimen by use of the keys no page references are found, but one must either hunt through the following pages or turn to the index to find the location of the descriptions.

The book begins with brief accounts of butterflies in folklore, curious facts about butterflies, protective coloration and mimicry, sense organs, hibernation and migration, habitats and ranges, classification and the use of the keys. Half a dozen pages are used in explaining in detail how to collect, kill and mount specimens, with suggestions as to making nets, killing jars and display cases.

Twenty-eight butterflies are beautifully illustrated in the four color plates and there are photographs of thirty-eight others—but again the lack of page references in the descriptions makes the locating of the illustrations a matter of search. The book is bound in green cloth and the press work leaves nothing to be desired.

Both of the authors have been collecting and observing butterflies for twenty-five years or more and each has published numerous technical papers and popular articles. Dr. Shepard is Assistant Professor of Entomology at the University of Minnesota; Dr. Macy, Professor of Biology at the College of St. Thomas at St. Paul, Minnesota.

George T. Hastings

Santa Monica, Calif.

Deam's Flora of Indiana

Flora of Indiana. By Charles C. Deam, M.A., D.Sc., LL.D. With a foreword by Stanley Coulter. 1236 pp., with half-tone frontispiece, 2243 distribution maps and 4 full-page maps in text. Department of Conservation, Indianapolis, June, 1940. $3.50. (Obtainable from the State Forester.)

Several reviews of this splendid volume have already been published, but the whole story of its excellent features has not been told yet. The present review seeks to bring out some of its important points without unduly duplicating what has been said about it already.

This book is doubtless based on more thorough work than any other state flora ever published. The author has lived in Indiana all his life, and has been studying the flora of the state for over forty years, and he began publishing notes on it in 1904. (He has also traveled and collected in several other states, and in Central America.) He had previously published books on the trees, shrubs and grasses of Indiana, some of them in two or more editions; and in a long bibliography at the end of the present volume 34 of the titles, or about 5% of the total, are by him. Good roads and automobiles, although they have expedited the destruction of natural vegetation in recent years, have enabled Mr. Deam to visit every township in the state; something that probably no botanist has done in any other state.

Accuracy in identification has been his constant aim, and the aid of several specialists has been enlisted to that end; but of course there will always be some doubtful cases, on account of intermediate or imperfect specimens, differences of opinion, or even perhaps recent mutations in the plants themselves.

In nomenclature the work is very up-to-date. Apparently all recent revisions involving Indiana plants have been taken advantage of, some as late as 1940 being cited in footnotes. Changes since the latest manuals available have been surprisingly numerous, and a great many of the names used will be unfamiliar to readers who have not kept up with recent developments as closely as Mr. Deam has. Nearly 22% of the species (not counting varieties and forms) in his catalogue bear names different from those used in Robinson & Fernald's Manual of 1908. Some of these innovations are recently discovered or recently introduced species, some are changes in classification due to increasing knowledge, and some are due to differences of opinion as to generic or specific limits, or new nomenclatorial rules. And Mr. Deam has done very little of the changing himself, but has accepted the judgment of other workers if after carefully weighing the evidence he believed it to be valid. A list of new names appearing for the first time in this book (p. 1112) includes only 17 cases, and those mostly varieties. In his treatment of families and genera he has been very conservative, following Robinson & Fernald's Manual pretty closely.

In Indiana, as in most other northeastern states, there are few distinct endemic species as compared with some of the southeastern states. This is due partly to its small size and dearth of unique habitats, and partly to the encroachments of civilization, which may have already wiped out some very local species, and scattered others outside of their original range. The fact that most of the state was covered by glaciers, perhaps only 50,000 years ago, may be another factor tending to reduce the number of endemics. One can pick out from the catalogue forty or fifty species, varieties, etc., that are at present known only from Indiana, or Indiana and one other state, but the great majority of these are hybrids, or recently described and not very distinct varieties and forms, that might easily turn up elsewhere when botanists study them closely enough. Practically none has a well-defined range that stops short of the borders of the state.

In a state with 94.7 inhabitants per square mile (1940 census), and the greater part of the area cultivated at one time or another, and all the forests easily accessible to lumbermen, many unquestionably native plants have adapted themselves to changed conditions and persisted in weedy as well as in undisturbed habitats, while some, less adaptable, or originally confined to sites very subject to economic exploitation, have disappeared entirely, and a horde of more or less undesirable immigrants has come in from Europe and elsewhere to take possession of fields and roadsides.

In Indiana, as in other thickly settled states, practically every species has felt the devastating effects of civilization in some degree, and there are all gradations between delicate plants that are found only in undisturbed habitats, and the weeds of ditches, fields, roadsides, vacant lots, etc.; so that it is hard to draw the line between natives and exotics. A few of the species now confined to unnatural habitats, such as *Phytolacca, Prunus angustifolia, Passiflora incarnata* and *Solanum Carolinense,* may have existed in Indian clearings before the white man came, but it is hard to get evidence on that point now.

Many authors of local floras in the northeastern states, with the veneration for authority characteristic of long-settled regions, have accepted without question the distinction between native and introduced species made in current manuals; and if a species is regarded—rightly or wrongly—as native anywhere in the eastern

United States it becomes *ipso facto,* in their estimation, native in the state or county covered by the flora, even if it is there strictly confined to weedy habitats. Mr. Deam did not go quite to that extreme, but he gave many weeds the benefit of the doubt, and classed them as natives. My acquaintance with Indiana vegetation is chiefly confined to car-window notes in about one-fourth of the counties, between 1911 and 1941, but from what I know of the same species elsewhere, I would judge that his 302 introduced species should be increased to about 500, and the natives correspondingly reduced.

Many valuable features of the book, such as keys and distribution maps for every species, the tabular summary, the descriptions of natural regions, the bibliography of about 700 titles, and the list of Indiana botanists (142 men and 29 women) have been discussed by previous reviewers. It is worth noting here that the 41 botanists who have died lived about 61 years on the average; the later ones a little longer than the earlier ones.

Typographical errors are very few, and mostly easily detected. One minor fault of the book is the use of too many fictitious common names, some of which are longer than the technical names, and not likely ever to come into general use, and thus serve no useful purpose.

Roland M. Harper

University, Ala.

FIELD TRIPS OF THE CLUB

Trip of August 2-3, 1941, to Southern New Jersey

Mr. Hollis Koster of Green Bank, a competent student of pine barrens natural history, showed us many interesting species in that area. Some of the species bring to mind early botanists of the area. Among these were *Rynchospora knieskernii, Lobelia canbyi, Polygala nuttalii,* and *Panicum commonsianum.* The writer was interested in adding *Juncus caesariensis, Smilax walteri,* and *S. laurifolia* to the list of plants occurring at the ghost town, Martha. Mistletoe (*Phoradendron flavescens*) is a plant that many of us had not previously seen on a field trip in New Jersey. In the Bass River State Forest a tree designated as *Quercus imbricaria* brought on some discussion of the possibility of its being *Q. heterophylla.* As no decision was reached this remains ample reason for a return field trip.

Mr. Otway Brown guided us over Cape May County and showed us some of its flora and remarkable plant communities. The lichenologists worked valiantly this day. Conspicuously large specimens of a number of trees were brought to our attention. The climax for most of us was to lay hands on the bald cypress (*Taxodium distichum*). The specimen is several feet in circumference and Stone says in 1910 that "very old residents remember them as being large trees in their youth." The second tree recorded from nearby has long since disappeared. We found knees at a distance of sixty feet or more from the base indicating the extensive root system. Neither fruit nor seedlings were seen but referring to Stone's Plants of Southern New Jersey again we see that at least immature cones have been observed on this tree. The plant is on the upper reaches of Sluice Creek in South Dennis. Its natural or introduced presence is debatable. No lists of species were kept but those collecting found plenty of interest to take. Attendance, seventeen.

John A. Small

Trip of August 10, 1941—Elysian Club (Kaiser Road) to Sunfish Pond via Appalachian Trail

From the Elysian Club there was a walk of about a mile over side trail to the Appalachian Trail. The side trail follows what used to be a road (Kaiser Road) crossing Kittatiny Ridge from Mt. Vernon valley to Dimmick Ferry on the Delaware. After picking up the AT there was a walk of some two miles to Sunfish Pond, travelling to the southwest. The trail followed a dry ridge at the start giving fine views of the Delaware valley and the Poconos beyond. The flora was that of similar portions of Kittatiny Ridge; oak-hickory with admixtures from the coastal plain such as pitch pine, scrub oak, and wild indigo. Broom beard-grass were evident on the exposed outcroppings. Tree species coming into such openings included red cedar, grey birch, poplars, and aspens.

The next mile or so was over richer, more moist terrain, skirting Tock Swamp for some distance. A larger number of species were recorded from this portion. Red maple and sour gum were conspicuous trees while shrubs and ground plants were represented by numerous species. Four northern plants were seen which venture into New Jersey only in these upland areas of the northern counties. Thus New Jersey represents the southern limit of their range except as they follow down the higher ridges of the Appalachians. *Cornus canadensis* is one of these. Neither Britton's Catalog nor Taylor's Flora of the vicinity of New York record this species from Warren County. A specimen in the herbarium of the New York Botanical Garden is labelled, "Green's Pond, Warren County, New Jersey, May 21, 1921. In larch woods, very rare." Green's Pond is now Mountain Lake on the topographical maps. *Rhododendron canadense* is reported in the above manuals from Morris and Sussex Counties only. *Prunus cuneata* is also limited to the northern counties in New Jersey, and *Muhlenbergia racemosa* is credited with a similar distribution. The last three are not recorded from Warren County in the herbarium of the New York Botanical Garden. This trip therefore may have produced three definite extensions of range.

Among the ferns seen, *Aspidium simulatum* and *Woodwardia virginica* are distributed over the state but their occurrence is sufficiently local to make this station of interest. A total of ten ferns and 138 flowering plants were recorded without leaving the trail. The list is filed with the field committee. Attendance, ten. Leader, L. Hardy. Plant lists by L. E. Hand and G. G. Nearing.

John A. Small

Trip of October 4, 1941, to Brooklyn Botanic Garden

This walk was devoted to a study of the pines. The distinguishing characteristics of the white pines and pitch pines were pointed out. The circumboreal distribution of the genus was evident from the walk. American species included our common white pine, *Pinus Strobus,* and the dominant pitchpine of southern New Jersey, *P. rigida*. Going northward on the magic needles we saw the red pine, *P. resinosa,* and the far northern jack pine, *P. Banksiana*. Moving westward via the Allegheny species, *P. pungens,* we noted the western *P. flexilis*. It was observed that two of the western species, *P. ponderosa* and *P. Jeffreyi* do not grow well in the Prospect Park environment. The following European species were seen: *P. nigra* and *P. sylvestris* which are not uncommon in American nurseries, then *P. Heldreichii, P. mugo* and *P. Cembra.* The Himalayan pine, *P. excelsa,* was the largest specimen among Asiatic pines. Other species were *P. Thunbergii,* which might be called silver-bud pine, *P. densiflora, P. parviflora, P. koraiensis* and *P. Bungeana* which grows as a shrub here. The leader stated that the genus Pinus reaches into the southern hemisphere in only one place, the mountains of Java. Has anybody been looking at Java on the map lately? Attendance was 11. Leader: Dr. Alfred Gundersen.

John A. Small

Trip of October 18 to the Brooklyn Botanic Garden

This time the objective was the study of evolution. The Conservatory was visited and we were shown the exhibit of the principal groups of plants. Algae, Ferns and Angiosperms are the three main stages of plant evolution, with many diverging lines within and between. Algae are nearly all water plants. Early stages of land plants are suggested by lichens, by liverworts, by the fossil Rhynia group, and also by clubmosses and horsetails. These have no true leaves, but fronds of ferns are primitive leaves, which are now recognized as fused and flattened branches. Seeds differ from spores somewhat as the large eggs of reptiles differ from the small eggs of amphibians, for seeds and reptile eggs are adaptations to land life. Differences such as open or closed ovary should be considered with the time difference between Gymnosperms (late Devonian) and Angiosperms (Cretaceous). The significant characteristic of flowering plants is insect pollination, although a few of them have reverted to the primitive wind pollination. Deciduous leaves and the herbaceous habit must be thought of as adaptations to a winter season. Various books were seen and discussion closed the meeting. Attendance 17. Leader: Dr. Alfred Gundersen. There will be other visits for somewhat different studies in 1942.

John A. Small

Trip of November 16, 1941. Kaiser Road to Millbrook Road Via Appalachian Trail, Warren County, N. J.

Like the trip of August 10, this walk started from the Elysian Club, following the side trail to the crest of the ridge. Several plants of the stiff stemmed gentian were seen along the trail up the mountain. The AT to the southwest leaves Kaiser Road at the crest of the ridge. The road then leads northward crossing the ridge in an apparent quest of a suitable line of descent. When this point is reached the AT proceeds northeast following the skyline. And a veritable skyline it is: narrow, with occasional high outcroppings that make delightful natural rock gardens. In these one finds Aquilegia, mountain phlox, marginal shield fern, polypody, and a variety of mosses and lichens. The view from these points is excellent, particularly at this season of the year.

At other points the trail follows the top of an escarpment dropping from the narrow summit ridge to the valley below. One sees Andropogon and other grasses in such places, with rock tripes on the stone. Red cedar, sweet fern, and blueberries make up the major portion of the woody flora. The general flora of the ridge is oak, of which eight species were recorded, among them *Q. prinoides* which we note is not credited to Warren County in Britton's survey. Hickories, beech, red maple, black birch, ash, and sour gum made up the other common tree species. Flowering dogwood, azaleas, and laurels indicated the beauty to be seen along this trail at the appropriate season.

About three miles above Kaiser Road the trail descends abruptly to a notch in the ridge where another road, now long abandoned, formerly crossed to the Pahaquarry copper mines. This road is still maintained eastward as an access road to the nearby boy scout camp which owns most of the land over which we had travelled. This makes a suitable point for approaching the trail by car. Several species were added along the brook at the point where we crossed the notch. We then climbed abruptly as the ridge regains its normally rather level crest. Along the trail at this point, a well-fruited sprout growth of Castanea was found. None of the fruits examined appeared viable however.

The vegetation continued as on the south side of the notch. Even more spectacular escarpments were encountered but with more limited views. Time and daylight did not permit us to continue to Millbrook road, so a side trail to the west was taken, bringing us around to Catfish pond. From here we crossed the scout camp and went out over their road. Attendance 11. Leaders, Mr. and Mrs. Louis Anderson. Plant lists by Louis Hand and W. L. Dix. These lists recorded 111 flowering plants, 7 ferns, 8 mosses, 20 lichens, and 3 fungi. The lists for mosses and fungi are only fragmentary since no one well qualified to list these plants was available. One of the lichen species, *Cladonia turgida* was remarkable for being the second collection in the state, the other being from Atlantic County where it was collected in 1936 by the late Raymond H. Torrey.

John A. Small

PROCEEDINGS OF THE CLUB

Minutes of the Meeting on January 6, 1942

The annual meeting of the Torrey Botanical Club was held at the Men's Faculty Club of Columbia University on Tuesday, January 6, 1942. Dinner was served at 6:30 p.m., after which the meeting was called to order by the President, Dr. J. S. Karling. Seventy-seven members and friends were present.

The minutes of the previous meeting were approved as read.

Reports of the officers of the Club were mimeographed and distributed to those present at the annual dinner. The report of Dr. Dodge as delegate to the Fordham University anniversary and to the A. A. A. S. meetings in Dallas, and the report of Dr. Robbins as delegate of the Club to the New York Academy of Science were accepted by the Club.

Dr. Small announced that as a member of the New York-New Jersey Trail Conference, the Club was participating in the Sportsman's Show.

The Club accepted the 1942 budget as approved by the Council.

Dr. Zimmerman moved that the Club reconsider its action of May 16, 1941, dedicating the 1942 volume of the Bulletin to Dr. Harper, and extend the dedication to include the surviving charter member of the Club, Dr. Denslow. Dr. Bold seconded the motion and the Club so voted.

The President announced that the following list of officers had been elected by the Club to serve during 1942:

President: C. Stuart Gager
First Vice-President: John A. Small
Second Vice-President: Clyde Chandler
Corresponding Secretary: H. C. Bold

Recording Secretary: John W. Thomson, Jr.
Treasurer: W. Gordon Whaley
Editor: Harold W. Rickett
Bibliographer: Lazella Schwarten
Business Manager: Michael Levine
Members of the Council: John M. Arthur
Lela V. Barton
Arthur H. Graves
Edwin B. Matzke
Delegate to the Council of the New York Academy of Sciences: W. J. Robbins
Representative on the Board of Managers of the New York Botanical Garden: Henry A. Gleason
Representatives on the Council of the American Association for the Advancement of Science: Albert E. Hitchcock
John S. Karling

Mr. Rutherford Platt then conducted a guessing game with the Kodachrome colored slides of plants for which he is so well known. The botanists present did not prove to be too familiar with the common plants which he showed. First, second and booby prizes were awarded.

The meeting was adjourned at 9:20 P.M.

Respectfully submitted,

John W. Thomson, Jr.,
Recording Secretary

Minutes of the Meeting of January 21, 1942

The meeting was called to order at 3:35 p.m., in the Member's Room of the New York Botanical Garden by the President, Dr. C. Stuart Gager. Thirty-six members and friends were present. In the absence of a Recording Secretary, the Corresponding Secretary read the minutes of the preceding meeting. These were adopted as read. The following were elected unanimously to annual membership in the Club:

Dr. W. B. Baker, Emory University, Atlanta, Georgia
Mr. Stanley D. Wikoff, 91 Easton Avenue, New Brunswick, N. J.
Mr. G. Thomas Robbins, University of Colorado, Boulder, Col.
Mr. Frank G. Lier, 510 West 110th Street, New York City.

The transfer of Mr. W. Herbert Dole, 25 Overlook Avenue, West Orange, N. J., from annual to associate membership was approved. The following resignations were noted with regret:

From annual membership:

Mr. H. H. McKinney, Horticultural Field Station, Beltsville, Md.
Mr. Alan Martin, Glenwood, N. J.
Prof. A. J. Sharp, University of Tennessee, Knoxville, Tenn.
Miss Olga H. Hingsburg, 46 Esplanade, Mt. Vernon, N. Y.

From associate membership:

Mr. Seymour Barrett, 1475 Grand Concourse, N. Y. C.
Dr. George H. Hallett, Jr., 3353 82nd Street, Jackson Heights, N. Y.
Mrs. Ruth D. Hallett, 3353 82nd Street, Jackson Heights, N. Y.
Mr. L. W. Steiger, 835 Summit Avenue, Hackensack, N. J.

The Corresponding Secretary announced that the Council had accepted the resignation of Dr. Thomson as Recording Secretary, and read his letter of resignation to the Club. The President stated that in accordance with the Constitution the Council had elected Miss Honor Margaret Hollinghurst to fill the unexpired term of Recording Secretary.

The President also announced that the Council had sent a telegram of congratulations to Professor R. A. Harper in the name of the Club, this being Dr. Harper's 80th birthday.

The President also announced that through an error in the ballot, a vacancy existed in the Council membership. Dr. Rickett nominated Dr. W. J. Bonisteel for the vacancy, the nomination was seconded by Dr. Robbins, and Dr. Bonisteel was unanimously elected to a term from 1942-1944.

Dr. Small again announced that tickets were available for the Sportsman's Show.

The scientific portion of the program consisted of a report by Dr. L. V. Barton of the Boyce Thompson Institute on "Some Special Problems in Seed Dormancy." The speaker's abstract follows:

Dormancy in relation to seeds is a general term used to indicate the failure of the embryo to resume growth when placed under conditions of temperature, moisture, and oxygen supply which ordinarily bring about germination. The dormant state may be imposed by seed coats, dormant embryos or a combination of seed coat and dormant embryos. Furthermore, there are seeds in which the root is not dormant but the shoot or the bud which forms it is dormant. In the last case it is necessary to treat for a period at a low temperature (1° to 10° C.) in a moist medium after the root has already formed in order to break the epicotyl dormancy so that the first green leaf may develop. Such treatment may be given effectively at any time between the first appearance of the radicle and the maximum development of the root system from the stored food in the seed.

Recent experiments in which seeds of *Convallaria majalis* L. and *Smilacina racemosa* (L.) Desf. were the test material, showed epicotyl dormancy of a different type in that the period at low temperature, in order to be effective, must be given, not merely after root production, but after the seedlings had developed to the stage where their shoots had broken through the first enclosing sheaths. Exposure at earlier developmental stages was without effect in breaking epicotyl dormancy. Three to five months at 5° or 10° C. was found to be necessary for forcing the first green leaves of *Convallaria* and *Smilacina*.

Low-temperature pretreatment of the imbibed seeds increased root production in *Convallaria* and was essential to root formation in *Smilacina* when plantings were made in the soil in the greenhouse.

After considerable discussion, the meeting adjourned at 4:40 p.m., to enjoy tea and other refreshments served by members of the Garden Staff.

Respectfully submitted,

Harold C. Bold,
Acting Re. Sec.

NEWS NOTES

The Torrey Club has undertaken a botanical survey of that portion of the Appalachian Trail that is maintained by the New York-New Jersey Trail Conference, namely, from the Delaware River to the Connecticut state line. Something over twenty miles of trail and alternate trail between the Delaware and Flatbrooksville road were covered last season. Three hundred and sixty-seven species of Spermatophytes, 28 species of Pteridophytes, 24 species of Bryophytes, 105 species of lichens (disregarding forms, modes, and varieties), and 47 species of fungi have been recorded to date. The only alga so far determined is *Microspora stagnorum.* In many of the groups a considerable number of additional species would be recorded if specialists in those plants were available on the trips. The project will be continued this season.

THE TORREY BOTANICAL CLUB

OFFICERS FOR 1942

President: C. Stuart Gager

Vice-Presidents: John A. Small, F. Clyde Chandler

Recording Secretary: Miss Honor M. Hollinghurst

Corresponding Secretary: Harold C. Bold

Treasurer: W. Gordon Whaley

Editor: Harold W. Rickett

Business Manager: Michael Levine

Bibliographer: Mrs. Lazella Schwarten

Delegate to the Council, N. Y. Academy of Sciences: W. J. Robbins

Representatives on the Council of the American Association for the Advancement of Science:

A. E. Hitchcock   J. S. Karling

Representative on the Board of Managers of the N. Y. Botanical Garden:

H. A. Gleason

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Arthur H. Graves
Alfred Gundersen
George T. Hastings
Harold W. Rickett
Edwin B. Matzke
Harold N. Moldenke
John S. Karling
Florence C. Chandler
Michael Levine
William J. Robbins
Henry K. Svenson
John A. Small

Elected members

1939-1941	1940-1942	1941-1943
Gladys P. Anderson	Lela V. Barton	Helen M. Trelease
John M. Arthur	Ralph H. Cheney	Ralph C. Benedict
Harold H. Clum	Robert A. Harper	John H. Barnhart
Percy W. Zimmerman	Edmund W. Sinnott	

Committees for 1940

Endowment Committee

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Caroline C. Haynes
Henry de la Montagne
J. Ashton Allis
Helen M. Trelease

Program Committee

Harold C. Bold, *Chairman* (*e-officio*)
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E. Marcy
P. W. Zimmerman
G. Whaley

Field Committee

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Alfred Gundersen
Inez M. Haring
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Rutherford Platt
Henry K. Svenson
Ellys Butler
Dolores Fay
Eleanor Friend
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Herbert M. Denslow
Dolores Fay
H. Allan Gleason
Hester M. Rusk

Cryptogams

Ferns and Fern Allies: R. C. Benedict, W. Herbert Dole, N. E. Pfeiffer
Mosses: E. B. Bartram
Liverworts: A. W. Evans, E. B. Matzke
Freshwater Algae: H. C. Bold
Marine Algae: J. J. Copeland
Fungi: A. H. Graves, J. S. Karling, W. S. Thomas
Lichens: J. W. Thomson, Jr.
Myxomycetes: R. Hagelstein

Committee on Exchanges

Harold C. Bold
Amy Hepburn
Elizabeth Hall

OTHER PUBLICATIONS

OF THE

TORREY BOTANICAL CLUB

(1) BULLETIN

A journal devoted to general botany, established in 1870 and published monthly, except during July, August, and September. Vol. 68, published in 1941, contained 694 pages of text and 55 full page plates. Price $6.00 per annum. For Europe, $6.25.

In addition to papers giving the results of research, each issue contains the INDEX TO AMERICAN BOTANICAL LITERATURE—a very comprehensive bibliography of current publications in American botany. Many workers find this an extremely valuable feature of the BULLETIN.

Of former volumes, 24-68 can be supplied separately at $6.00 each; certain numbers of other volumes are available, but the entire stock of some numbers has been reserved for the completion of sets. Single copies (75 cents) will be furnished only when not breaking complete volumes.

(2) MEMOIRS

The MEMOIRS, established 1889, are published at irregular intervals. Volumes 1–18 are now completed. Volume 17, containing Proceedings of the Semi-Centennial Anniversary of the Club, 490 pages, was issued in 1918, price $5.00.

Volume 18, no. 1, 108 pages, 1931, price $2.00. Volume 18, no. 2, 220 pages, 1932, price $4.00. Volume 18 complete, price $5.00.

Volume 19, no. 1, 92 pages, 1937, price $1.50. Volume 19, no. 2, 178 pages, 1938, price $2.00.

(3) INDEX TO AMERICAN BOTANICAL LITERATURE

Reprinted monthly on cards, and furnished to subscribers at three cents a card.

Correspondence relating to the above publications should be addressed to

W. GORDON WHALEY,
Barnard College,
Columbia University,
New York, N. Y.

Volume 42 May-June, 1942 Number 3

TORREYA

A Bi-Monthly Journal of Botanical Notes and News

EDITED FOR

THE TORREY BOTANICAL CLUB

BY

WILLIAM J. BONISTEEL

John Torrey, 1796-1873

CONTENTS

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TORREYA

TORREYA, the bi-monthly publication of the **Torrey Botanical Club**, was established in 1901. TORREYA was established as a means of publishing shorter papers and interesting notes on the local flora range of the club. The proceedings of the club, book reviews, field trips and news notes are published from time to time. The pages of TORREYA are open to members of the club and others who may have short articles for publication.

TORREYA is furnished to subscribers in the United States and Canada for one dollar per year (January-December); single copies thirty cents. To subscribers elsewhere, twenty-five cents extra, or the equivalent thereof. Postal or express money orders, drafts, and personal checks are accepted in payment. Subscriptions are received only for full volumes.

Claims for missing numbers should be made within sixty days following their date of mailing. Missing numbers will be supplied free only when they have been lost in the mails. All subscriptions and requests for back numbers should be addressed to the treasurer, Dr. W. Gordon Whaley, Barnard College, Columbia University, New York, N. Y.

Of the annual membership dues of the **Torrey Botanical Club**, $.50 is for a year's subscription to TORREYA.

INSTRUCTIONS TO CONTRIBUTORS

The manuscript should be prepared so that it conforms to the best practice as illustrated by current numbers of TORREYA. Manuscript should be typed double-spaced on one side of standard paper. The editors may accept papers up to eight printed pages in length. Longer papers may be published if the author agrees to bear the cost of the additional pages. Illustrations (including tables and graphs) should not exceed twelve per cent of the text; authors of more copiously illustrated articles may be asked to pay for the excess material. Brief notes will be published with especial promptness.

Drawings and photographs should be mounted on stiff cardboard and the desired reductions plainly indicated. Figures should be so planned that after reduction they will occupy the entire width of a page (4 inches) and any portion of the height (6½ inches). Labels should be parallel to the shorter dimension of the page. It is best to combine illustrations into the smallest possible number of groups. Unmounted material will not be accepted. Legends for figures should be typewritten and included with the manuscript (*not* affixed to the figures). All legends for one group of figures should form a single paragraph. If magnifications are stated, they should apply to the reduced figures.

Contributors may order reprints of their articles when they return galley proof to the editor. A schedule of charges is sent with the proof, and will be supplied to prospective contributors on request.

MEMBERSHIP IN THE TORREY BOTANICAL CLUB

All persons interested in botany are invited to join the club. There are four classes of membership: *Sustaining*, at $15.00 a year; *Life*, at $100; *Annual*, at $5.00 a year and *Associate*, at $2.00 a year. The privileges of members, except *Associate*, are: (a) To attend all meetings of the club and to take part in the business, and (b) to receive its publications. *Associate* members have the privilege of attending meetings, field trips and of receiving the Schedule of the Field Trips and the Bulletin of the New York Academy of Sciences.

Manuscripts for publication, books and papers for review, reports of field trips and miscellaneous news items should be addressed to:

DR. WM. J. BONISTEEL
BIOLOGICAL LABORATORIES, FORDHAM UNIVERSITY
NEW YORK, N. Y.

TORREYA

VOL. 42 — MAY-JUNE — NO. 3

The Torrey Botanical Club
Seventy-fifth Anniversary Celebration
June 22 to June 27, 1942

Monday, June 22.

10:00 a.m. to 12:30 p.m. Registration. Rotunda, Low Memorial Library, Columbia University.—General information about accommodations in Johnson Hall, Livingston Hall, and King's Crown Hotel available at registration.

2:00 to 4:30 p.m. Scientific Program. Room 305 Schermerhorn Hall. Sectional chairman: Dr. Edwin B. Matzke.

"The History of Botany at Columbia University." Dr. John S. Karling.

Symposium on Morphology.

1. "Haphazard as a Factor in the Production of Tetrakaidecahedra." Dr. F. T. Lewis, Harvard Medical School, Cambridge, Mass.
2. "The Evolution and Determination of Sexual Characters in the Angiosperm Sporophyte." Dr. C. E. Allen, University of Wisconsin, Madison, Wis.
3. "The Leaf-Stem Relationship in Vascular Plants." Dr. R. H. Wetmore, Harvard University, Cambridge, Mass.
4. "Problems of Pattern in Plant Development." Dr. E. W. Sinnott, Yale University, New Haven, Conn.

4:30 to 6:00 p.m. Tea and Torrey Exhibit. Rotunda, Low Memorial Library.

7:00 p.m. Anniversary Banquet. Men's Faculty Club, 117th St. and Morningside Drive.

Presentation of President of the Torrey Botanical Club, Dr. C. Stuart Gager............. Dr. John S. Karling

Presentation of officially appointed delegates

Dr. John S. Karling

TORREYA for May-June (Vol. 42, 65–103) was issued June 5, 1942.

Welcome to delegates, members, and guests
Pres. C. Stuart Gager

Response of delegates

Reading of letters of felicitation.........President Gager

Tuesday, June 23.

10:00 a.m. to 12.30 p.m. New York Botanical Garden. Sectional chairman: Dr. Wm. J. Robbins.

"The History of the New York Botanical Garden." Dr. Wm. J. Robbins, Director.

Symposium on Taxonomy.

1. "Contributions of the Torrey Botanical Club to the Development of Taxonomy. Dr. H. A. Gleason. New York Botanical Garden.
2. "Modern Taxonomy and Its Relation to Geography." Dr. H. K. Svenson, Brooklyn Botanic Garden.
3. "Economic Aspects of Taxonomy." Dr. E. D. Merrill, Harvard University.
4. "The Importance of Taxonomic Studies of the Fungi." Dr. F. D. Kern, Pennsylvania State College, State College, Pa.

12:30 to 2:00 p.m. Basket Luncheon in the Rock Garden, 50 cents.

2:00 to 4:30 p.m. Inspection tour of Gardens, Conservatories, Laboratories, and Herbarium, conducted by members of the Staff.

8:30 p.m. Smoker. Men's Faculty Club, Columbia University.

Wednesday, June 24.

10:00 a.m. to 12:30 p.m. Scientific Program. Boyce Thompson Institute for Plant Research, Yonkers, New York. Sectional chairman: Dr. P. W. Zimmerman.

"The History and Organization of the Boyce Thompson Institute. Dr. Wm. J. Crocker, Director.

Symposium on Growth.

1. "Viruses in Relation to the Growth of Plants." Dr. L. O. Kunkel, Rockefeller Institute for Medical Research, Princeton, New Jersey.
2. "Morphogenetic Influences of Plant Hormones." Dr. P. W. Zimmerman, Boyce Thompson Institute.

3. "The Many-sided Effects of Animal Hormones and Their Possible Resemblance to Plant Hormones." Dr. Oscar Riddle, Carnegie Institute of Washington, Cold Spring Harbor, Long Island, New York.

12:30 to 2:00 p.m. Luncheon. Boyce Thompson Institute acting as host.

2:00 to 4:30 p.m. Inspection tours of grounds and laboratories conducted by members of the Staff.

Exhibits by investigators of the Institute.

8:30 p.m. Public Lecture. American Museum of Natural History. "Plants Need Vitamins, Too." Dr. Wm. J. Robbins, New York Botanical Garden.

Thursday, June 25.

10:00 a.m. to 12:30 p.m. Scientific Program. Brooklyn Botanic Garden, 1000 Washington Avenue, Brooklyn, New York.

Sectional chairman: Dr. C. Stuart Gager.

"The History of the Brooklyn Botanic Garden." Dr. C. Stuart Gager, Director.

Symposium on Genetics.

1. "Genetics, the Unifying Science in Biology." Dr. George H. Shull, Princeton University, Princeton, New Jersey.
2. "A Consideration of Criteria of Center of Origin." Dr. Stanley Cain, University of Tennessee, Knoxville, Tennessee.
3. "The Status of Plant Pathology in 1875 and in 1942." Dr. George M. Reed, Brooklyn Botanic Garden.
4. "Technical Applications of Genetics in Plant Breeding in 75 Years." Dr. A. F. Blakeslee, Carnegie Institution of Washington, Cold Spring Harbor, Long Island, New York.

12:30 to 4:30 p.m. Luncheon. Brooklyn Botanic Garden. 50 cents. Inspection tours of gardens and laboratories conducted by members of the Staff.

Friday and Saturday, June 26 and 27.

Two-day field trip to Southern New Jersey. Dr. John A. Small, New Jersey College for Women, Field Chairman.

First day to Seaside Park for beach, salt marsh, and encroaching pine barren vegetation. Overnight accommodations at Toms River.

Second day to the dry barrens, "The Plains," and the bogs.

Chile Tarweed in Quebec

Harold N. Moldenke

Since the publication of my recent note on the occurrence of Chile tarweed east of the Mississippi River (Torreya **41**: 162-164), my good friend, Brother Marie-Victorin, of the Montreal Botanical Garden, has kindly sent me some more material of this species, representing the first known eastern Canadian records. All these specimens appear to be the typical form of *Madia sativa* Molina, rather than the variety, and all except three from the Marie-Victorin herbarium are deposited in the herbarium of the Montreal Botanical Garden.

The first specimen is an undated one, collected by Omer Caron in Lotbiniere County, Quebec. The earliest dated collection is represented by five sheets (two in the Montreal Botanical Garden herbarium and three in the Marie-Victorin herbarium) collected by Brothers Marie-Victorin and Rolland-Germain on August 24, 1927, in uncultivated ground along the road from Longueuil to Gentilly, Chambly County, Quebec (*no. 29062*), where the collectors state that the species was introduced and abundant. On September 16, 1933, the same two collectors found it naturalized in fields at Longueuil (*no. 45645,* two sheets). On August 20, 1935, the same collectors collected it again in an abandoned field at Longueuil (*no. 43637,* two sheets), and on September 14, 1935, Cécile Lanouette collected it along Chemin du Lac at Longueuil, where it seems, therefore, to be very definitely established.

New York Botanical Garden

Collecting Chicle in the American Tropics
(Part 2)

John S. Karling

Identification of Achras Species and Chicle Adulterants

In spite of the economic importance of chicle and the sapodilla tree, there is still some confusion and ignorance among contractors, chicleros, and professional botanists about the sources of chicle and the substitutes commonly used. A large number of species of different families yield gum which is utilized to a limited extent in chewing gum manufacture, but there is little doubt that the best and largest supply of chicle comes from *Achras zapota,* although some taxonomists have denied this. This species as described by Plumier (1703), Linnaeus (1753, 1762), Jacquin (1760, 1763), Brown (1789), Pierre and Urban (1904), Coville (1905), Cook (1913), Pittier (1914, 1919), Hummel (1925), and Standley (1925, 1932) appears to be quite variable, and confusion as to the source of chicle is to be expected, especially when the herbarium material has been collected under different vernacular names from widely separated localities. In 1888 Planchon listed three species of *Achras* as commercially important, and recently (1919) Pittier added two additional latex-yielding species, *A. chicle* and *A. calcicola,* which were formerly included in *A. zapota.* Pierre and Urban (1904) described four varieties of *A. zapota* on the basis of fruit and flower sizes and shapes. Whether or not these latter are valid species is uncertain, but it is not improbable that when the jungles of southern Mexico, Central and South America have been thoroughly combed and the forms carefully studied, additional species and varieties will be segregated.

In British Honduras the native chicleros, according to Hummel (1925), recognize the following types of *A. zapota:*

(1) *"Female Sapodilla"*—by far the best tree for producing chicle. Large edible fruit of good quality. Leaves smaller and closer together than those of any of the other kinds of sapodilla. However, the leaves of saplings are often abnormally large and their size and shape are, therefore, misleading. This tree is more numerous in the north of the Colony than in the south; the Sibun River may, roughly, be taken as the dividing line between good and inferior chicle.

"Female sapodilla" grows well on inferior soil, on so-called "Broken Ridge" soil, but it grows also on the best soil together with mahogany.

(2) *"Crown Sapodilla"*—produces the second best chicle. The general appearance of this tree is so similar to No. (1), "female sapodilla," that even chicleros are not always certain in distinguishing it, unless they can see the fruit, which is much smaller and of a slightly different and more elongated shape from those of the "female sapodilla," and not quite so delicious to eat as the latter.

(3) *"Male"* or *"Bastard Sapodilla"*—produces little chicle, less fluid and of inferior quality. The leaves are considerably larger and further apart than those of Nos. (1) and (2). The fruit is small, inedible and grows in small bunches. This tree does not bear fruit every year. The belief that it does not bear any fruit at all is widespread. The attribute "male" has no botanical significance; it is applied in the native nomenclature quite generally to plants of inferior quality, while the attribute "female" is here usually used for plants of superior quality.

(4) *"Chicle Bull"*—the most useless of the various sapodilla trees. The leaves are smaller than those of the "male sapodilla." It is usually recognized by its fruit, which are the size of grapes and grow in fairly great bunches almost like grapes.

The "male" sapodilla tree or "chicle macho" (Record and Kuylen, 1926) of British Honduras, as reported by Hummel, has been described from Guatemala and Mexico, where Pittier treated it as a new species, *A. chicle*. On the basis of reports which he received from chicleros, Pittier regarded this species as the chief source of chicle, and stated: "The chicle of commerce is not extracted exclusively, if at all, from the latter species, *Achras zapota*." This contention has been severely criticized and is undoubtedly wrong, or at least certainly needs additional proof. Record and Kuylen report that the latex of *A. chicle* is used only to a limited extent for chicle. Hummel's descriptions of "chicle bull" and "male" sapodilla are the same with respect to size and growth of the fruits in bunches. This claim has also proven to be incorrect in most instances, since "chicle bull" in the crown lands of British Honduras is very similar to "female" sapodilla with respect to fruit, etc. However, in 1927 Record reported *A. chicle* from Honduras with large edible fruits, which indicates further the variability of *Achras* species and the difficulty of distinct differentiation.

The confusion about the species of *Achras* which yield the chicle of commerce stems largely from the fact that the Indians and chicleros in various localities and countries have different names for the same plant or the same name for widely different plants; and collectors unfamiliar with these vernacular synonyms may be readily led astray. Use of vernacular names as a criterion of differentiation without excellent herbarium material is worthless and leads at once into difficulties. To illustrate, *Achras chicle* in British Honduras is generally known as "chicle macho" and often as "chicozapote," while in Guatemala, according to Record (1926), it goes under the name of "nispero" or "zapotillo." "Chico zapote" and "zapotillo," however, are two of the vernacular names generally applied to *Achras zapota* in Mexico and other regions. Similarly, "sapodilla" is applied to *A. calcicola* in Panama. Hence, chicle reported to come from "chico zapote," "zapotilla," and sapodilla may involve several species of *Achras* as well as other genera of the Sapotaceae.

Throughout Mexico, Central America, South America, and the West Indies, *Achras zapota* has more than twenty different vernacular names, many of which are also applied to trees of entirely different species and genera. Below is a partial list of names commonly given to *Achras zapota* in different parts of tropical America, according to Pittier (1914), Standley, and others.

West Indies, Venezuela, Colombia, and generally throughout Central America	Nispero zapote
British West Indies and Florida	Naseberry, Sapodilla, neesberry, nisberry
French West Indies	Sapotier, sapotille, sapotillier
Dutch West Indies	Mispel, mispelloom
Guatemala	Chicle zapote, muy, chico zapote, sapodilla, zapote chico, zapotillo
Yucatan	Zapote, ya, zapote de abejas, tzapotl, palo maria, zapotillo, peruetana
Vera Cruz, Oaxaca	Zapote, chico zapote, zapote chico, chico, zapotillo, guendaxina, txicozapotl
Panama	Mamey, zapote
Salvador	Muyozapot
Costa Rica	Korok, zapote, zapotillo
Nicaragua	Zapote, iban, zapotillo, chico

Honduras	Nispero, zapote, zapotillo
Ecuador	Nispero quitense
Brazil	Sapote, sapotilla

The terms "nispero," "zapote," "zapotillo," used generally throughout Central America for *A. zapota,* are often extended to include several genera and species of the Sapotaceae, such as *Sideroxylon amygdalinum, S. Gaumeri, S. Meyeri, Lucuma salicifolia, L. Durlandii, Dipholis Stevensonii, Calocarpum mammosum, C. viride, Chrysophyllum oliviforme,* and others. It is not surprising then that in the early attempts to classify the chicle-yielding trees confusion arose among collectors in separate localities. In recent years, however, more extensive botanical collections have been made in the chicle areas, and the commercially important trees are fairly well known.

Achras zapota itself, as noted before, shows considerable variation in different localities, and a number of local varieties are recognized by the chicleros. In regions south of the Belize River, British Honduras, and in certain localities in Peten, Guatemala, is found the form of *A. zapota* which is generally known as "chicle bull" or "chiquibul." Taxonomically and morphologically, as far as it has been studied, it is reported to be the same as *A. zapota,* but for chewing purposes its gum is very inferior to that of trees growing north of this river. The latex is difficult to coagulate and requires longer boiling, while the resulting gum must be worked and frequently washed before it can be molded and hardened sufficiently for shipment. Since trees yielding "chicle bull" are commonly found on a slightly different type of soil, the difference in quality of the gum has been attributed to this variation. The sapodilla tree appears to flourish best on calcareous marl and disintegrated limestone which predominate in the Yucatecan Peninsula of Mexico, northern British Honduras, and the Peten District of Guatemala; and it is primarily from this contiguous area that the best *A. zapota* chicle comes. South of this region the surface soil is reported to be less limey, and here occur *A. chicle,* "chicle bull," and the so-called "bastard sapodillas" in greater abundance. A soil rich in lime is thus regarded by chicle operators as necessary for good chicle. It is not uncommon, however, in regions where they overlap to find the two kinds of sapodillas growing side by side in the same type of soil, but still showing a marked difference in gum quality. In view of this it is not improbable that "chicle bull" may be a variety or physiologically differentiated race of *A. zapota.*

Within the species *A. zapota,* which yields the best chicle of commerce, most chicleros in British Honduras recognize three forms: *zapote blanco, zapote colorado,* and *zapote morado.* The mauve or morado is said to be the best yielder, with the white next in order. The white and red forms are also recognized in Mexico and Guatemala, but the mauve is not generally distinguished. In those countries the white sapodilla is reported to yield almost twice as much as the red (Anonymous, 1923). Whether or not these three forms also are to be recognized as varieties or physiological races of *A. zapota* remains to be seen. Morphologically they appear the same. Their difference lies chiefly in the color of the bark, and the distinctions may be so fine that they are often unrecognizable except to the practised eye. Taxonomists (Standley, 1932) have so far failed to find any essential morphological differences which would justify recognition of these forms as distinct. Chicleros, however, claim to know the difference as soon as an incision is made in the bark. In the writer's experience there may be almost any degree of transition between the three forms, and frequently expert chicleros have been very doubtful of the type when questioned about the exact identity of certain trees.

In addition to the previously-mentioned forms of sapodilla, there are numerous other laticiferous trees the latex of which is sometimes used as chicle adulterants. Such adulterants, as far as is now known, are derived chiefly from the Apocynaceae, Sapotaceae, Moraceae, and Euphorbiaceae. The best chicle is reported to come from the Mexican states of Quintana Roo, Campeche, and Yucatan, because of their comparative freedom from these adulterants. In Peten, Guatemala, other laticiferous trees occur in great abundance in the chicle areas, and their latices have been used to dilute the increased volume of good chicle. This is also true but to a less degree in British Honduras, when, during one rainy season, the writer collected specimens of more than twenty trees, the latex of which is reported to be used in varying degrees for adulterating good chicle. With the view of bringing these datas together more concisely, the writer has listed in tables 1 and 2 the species names, families, localities of occurrence, and vernacular names of these adulterants. The order in which they are arranged indicates the degree of frequency with

TABLE 1. SHOWING THE SOURCES, LOCALITIES, VERNACULAR NAMES, AND LITERATURE REFERENCES OF CHICLE AND CHICLE ADULTERANTS IN MEXICO AND CENTRAL AMERICA

Species	*Family*	*Localities and Vernacular Names*	*Reference in Literature*
Achras zapota (Chiquibul)	Sapotaceae	British Honduras, Guatemala, Honduras: *zapote, chiquibull, chicle bull, crown gum*	
A. chicle	Sapotaceae	Guatemala, British Honduras, Honduras, Nicaragua, Panama: *chicle macho, zapote macho*	Pittier (1919); Hummel (1925); Record (1930); Standley (1932)
Calocarpum mamosum	Sapotaceae	West Indies: *sapote, mamee sapote, marmalade fruit* (*English*). Martinique, Guadelupe: *zapotte, grosse zapotte, zapote a creme* (French). Cuba: *Mamey, mamee zapote* (Spanish). Mexico: *tzapotl* (Nauhuatl), *tspas Savani* (Zoque). Yucatan: *zapote mamey* (Spanish), *haas, chacal haaz* (Maya). Venezuela, Colombia, Ecuador: *Mamey colorado* (Spanish). Guatemala: *Saltul* (Kekchí), *tul-ul* (*Pokomchí*), *Chul* (Mame), *chul-ul* (Jacalteca). Costa Rica: *bko* (Cabécara), *kurok* (Bribrí), *kómkra* (Brunka), *fin* (Térraba). Panama: *Oa-bo* (Guaymi), *mamey, mamey de tierra.* Philippine Islands: *chico-mamey* (Spanish).	Pittier (1914), (1926); Pierre, (1890), (1904); Sloane (1725); Jacquim (1760, 1763); Linnaeus (1763); Miller (1768); Gaertner (1805, 1807); Radlkofer (1882); Cook (1913); Standley (1925, 1928); Cook and Collins (1903); Popenoe (1920)
Calocarpum viride	Sapotaceae	Guatemala: *ingerto.* Costa Rica: *zapote, zapote blanco* (Spanish). Honduras: *zapotillo calenturiente* (Spanish). Salvador: *zapote ingerto* (Spanish). British Honduras: *red and white faisan.* Nicaragua: *zapote* (Spanish). Honduras: *zapotillo* (Spanish)	Pittier (1914); Standley (1925, 1932)
Dipholis Stevensonii	Sapotaceae	British Honduras: *zapote faisán* (Spanish)	Standley (1927, 1932)
Dipholis salicifolia	Sapotaceae	Guatemala: *ávalo, chaschin, acun, chaxicaste*	Standley (1927)
Bumelia Guatemalensis	Sapotaceae	British Honduras: *Mijico, Cháchiga*	Standley (1932)

TABLE 1. *Continued*

Species	*Family*	*Localities and Vernacular Names*	*Reference in Literature*
Bumelia laurifolia	Sapotaceae	British Honduras and Guatemala: *Silly Young* (English), *Silion, hoja largo*	Standley (1920)
Castilla fallax and *C. elastica*	Moraceae	Guatemala: *Ule, castiloa rubber, castilloa.* Mexico: *arbol de bule, hule, ule, olli, cuauchile, olcaguite, ulcuagulil, ulcahuitl* (Nahuatl). British Honduras: *hule macho, tunu, toonu*	Pittier (1909-1912); Cook (1903)
Brosimum utile	Moraceae	Guatemala and Honduras: *palo de leche.* Colombia and Nicaragua: *palo de vaca, palo de leche, cow tree, arbol de leche, avichuri*	Blake (1922); Pittier (1918, 1926)
Sideroxylon amygdalinum	Sapotaceae	Guatemala and British Honduras: *zapote faisan* (Spanish), *Silly young* (English)	Standley (1925, 1929, 1932)
S. Gaumeri	Sapotaceae	Mexico: *Caracolillo* (Spanish). British Honduras: *Zoy, Dzoi, cream tree*	Standley (1925, 1932); Pittier (1912)
S. Meyeri	Sapotaceae	British Honduras and Mexico: *zapotillo*	Standley (1932)
Lucuma belizensis	Sapotaceae	Guatemala and British Honduras: *Silly Young* (English), *Sillion, hoja largo, zapote* (Spanish)	Standley (1926)
Lucuma Durlandii	Sapotaceae	Guatemala: *Zapotillo* (Spanish)	Standley (1925, 1932)
Lucuma salicifolia	Sapotaceae	Mexico: *zapote amarillo, zapote barracho, zapote de nino* (Spanish), *cozticzapotl, atzapotl* (Aztec and Nauhuatl). Costa Rica: *zapotillo* (Spanish). Guatemala: *aceitunillo*	Standley (1927)
Lucuma Heyderi	Sapotaceae	British Honduras: *Mamee cirulla* (Spanish)	Standley (1927, 1932)
Lucuma campechiana	Sapotaceae	British Honduras: *Mamey cirera, Mamey serilla*	Standley (1925, 1932)
Stemmadenia Donnell-Smithii	Apocynaceae	British Honduras: *cojoton, cojon de mico, cojon de caballo, chaclikin*	Record (1930)
Pseudolmedia oxyphyllaria	Moraceae	Guatemala: *wild cherry, mamba*	
Brosimum alicastrum	Moraceae	British Honduras: *Bread nut, masico, ramon* (Spanish). Guatemala: *ramon, naranjillo.* Mexico: *ramon, ojite* (Spanish)	Record (1925, 1930); Pittier (1918)

Table 1. *Concluded*

Species	*Family*	*Localities and Vernacular Names*	*Reference in Literature*
Chrysophyllum oliviforme	Sapotaceae	British Honduras: *Wild star apple* (English), *chiceh* (Maya), *Chike.* Salvador and Honduras: *Caimito* (Spanish). Salvador: *zapotillo, guayabillo* (Spanish). Yucatan: *chiceh* (Maya)	Standley (1924, 1925, 1932); Record (1930)
Tabernemontana sp.	Apocynaceae	British Honduras: *cojon de pero, cojoton*	
Thevetia nitida	Apocynaceae	British Honduras: *cojoton*	
Ficus lapathifolia	Moraceae	Guatemala and British Honduras: *Kopo, mata palo, strangler fig*	
Ficus glabrata	Moraceae	British Honduras: *wild fig.* Guatemala: *higo.* Salvador: *Amate de hijo grande*	Record (1925); Standley (1917)
Plumeria multiflora	Apocynaceae	British Honduras: *zapilote*	Record (1930)
Cameraria belizensis	Apocynaceae	British Honduras: *Chechem de caballo*	Record (1930)
Couma Guatemalensis	Apocynaceae	Guatemala: *palo de vaca; cow tree*	Record and Kuylen (1926); Karling (1935)

which, according to reports of chicleros in British Honduras, they have been utilized in adulterating the good chicle from *A. zapota.* This varies naturally in the different localities and countries according to the occurrence of laticiferous plants, and there is, of course, no universal agreement among chicleros and contractors in this respect. The arrangement presented is accordingly personal and tentative. *Achras chicle* gum and "chiquibul" are often collected and sold, without mixing with *A. zapota* chicle, under the name of Crown Gum in British Honduras. Contrary to the reports of many chicleros, *A. chicle* or "chicle macho" in the writer's experience yields a goodly amount of latex in this colony, but its chicle is very soft, difficult to mold, and resembles "chiquibul." Chicleros, therefore, generally mix it with the gum of *A. zapota* in the proportion of one to three, making a chicle that will mold and become quite firm. The practice of adulteration in the jungle is not widely practiced at present, since adulterated chicle can be readily recognized by tests.

Table 2. Showing the Sources, Locality, Vernacular Names, and Literature References of Chicle Adulterants and Substitutes in South America and the Far East

Species	*Family*	*Locality and Vernacular Name*	*Literature and References*
Couma utilis	Apocynaceae	Colombia: *lirio*	Vander Laan (1927)
Manilkara sp. (*Mimusops*)	Sapotaceae	Venezuela: *pendare*	Vander Laan (1927); Pittier (1926)
Manilkara sp.	Sapotaceae	British Guiana	Vander Laan (1927)
Dyera Lowii	Apocynaceae	Sarawak, British Borneo, Sumatra, British Malaya: *dead Borneo, pontianak, gutta jelutong*	Vander Laan (1927); Heyne (1914); Corson (1927); Pearson (1918)
D. borneensis	"	"	"
D. Costulata	"	"	"
D. laxifolia	"	"	Heyne (1914); Vander Laan (1927)
Alstonia Scholaris	"	"	"
A. grandiflora	"	"	"
A. eximia	"	"	"
Rauwolfia Spectabilis	"	"	"

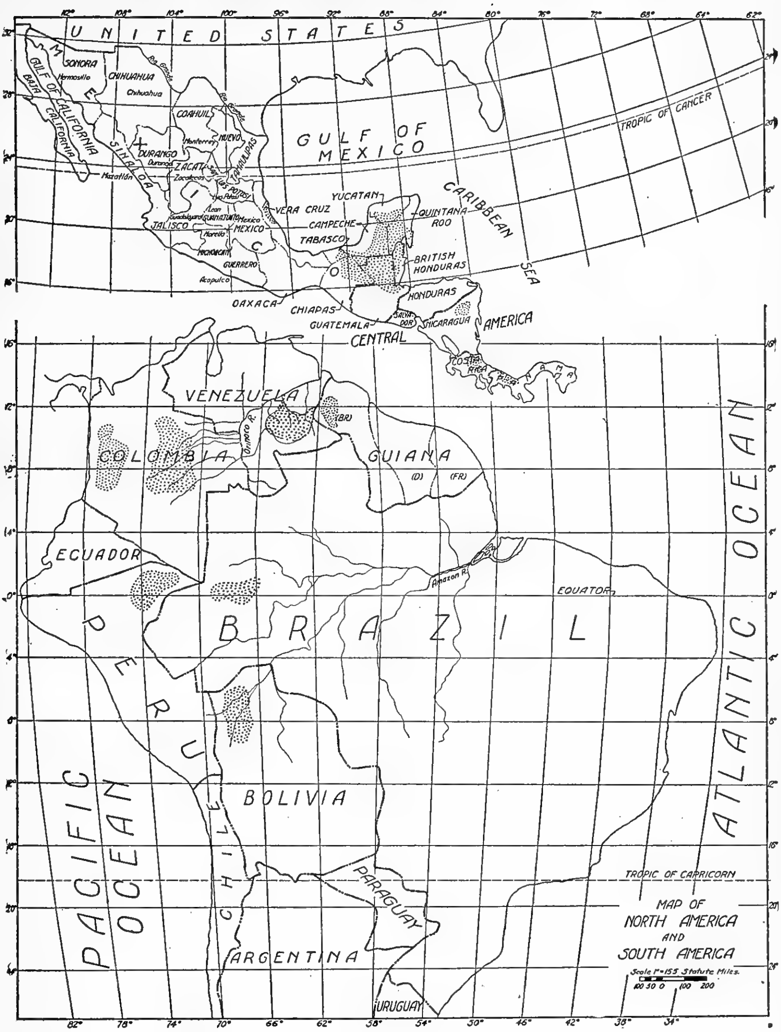
The price of such gum is accordingly reduced, and chicleros soon discovered that adulteration is not profitable.

In these tables are included other laticiferous plants the gum of which is used as substitutes, but which is nonetheless classed as chicle in the countries where it is exported. The source of chicle is less known in northern South America than in Mexico and Central America, and much further study is necessary before definite statements can be made with respect to the species of laticiferous plants. According to Hoar (1924), over three million pounds of chicle were imported from Colombia, Venezuela, Brazil, and British Guiana annually immediately after the close of the last World War. This quantity dropped considerably after political conditions improved in Mexico and Central America, and according to later chicle import data, it is considerably less.

According to Pell (1921), the largest amount and best chicle in Colombia comes from the "zapote" tree, but whether this is *A. zapota* or some other member of the Sapotaceae is uncertain in view of the wide range of trees which bear this vernacular name. Next in amount and quality is "lirio" gum from various "lirio" trees, which is often mixed with balata. The vernacular "lirio" is likewise extensively used in Colombia and applied locally to many widely different plants. *Maloutia* is a genus of laticiferous trees which occurs in the chicle areas of Colombia, and Pell may possibly refer to a member of this group. An anonymous writer (1921) and Vander Laan, however, report *Couma utilis,* another species of the Apocynaceae which is known locally as "lirio," as the principal source of chicle in this country. Pittier (1918) describes *Brosimum utile* as one of the most abundant sources of latex in Colombia, and it may possibly be used as an adulterant. Species of *Manilkara* are also reported to be tapped for chicle. These species are closely related to those which produce the balata of commerce (Chevalier, 1932), and it is not improbable that a considerable amount of latex from the latter, together with that from species of *Sapium, Sideroxylon,* and *Palaquim,* is used in adulteration. Along the north coast of Colombia is gathered an inferior chicle known as "perillo," which was exported to the extent of nearly a half million pounds in 1923. Very little is known, however, of its source, as far as the writer is aware.

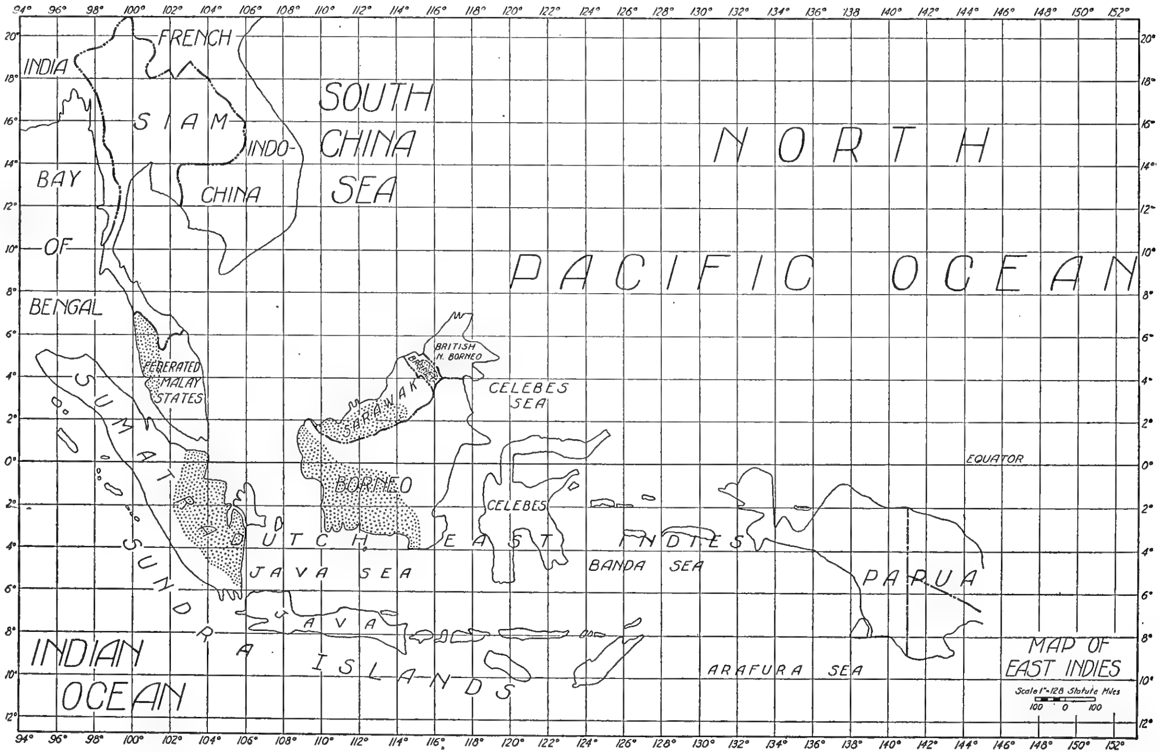
The chicle of Venezuela is known locally as "pendare" and was exported to the amount of over a half million pounds in 1914, 1915, and 1920. According to Fletcher (1927) and Vander Laan, it resembles balata, and probably comes from a species of *Manilkara.* Planchon (1888), however, reported that *A. zapota* is abundant in the forests of Venezuela, but since his studies of the Sapotaceae were made before the chicle industry had become extensively established, he did not describe it as a source of gum. Doubtless, like Pittier (1914), his description deals primarily with the cultivated sapodillas. *Couma sapida* (Pittier, 1926) occurs in the chicle areas of Venezuela and may possibly be tapped for chicle.

Small amounts of chicle have been shipped from Panama, Costa Rica, Nicaragua, and Honduras from time to time, but the exact source of this gum is not certain from the literature. Doubtless, in addition to *A. zapota* as a source, it comes largely from *A. chicle* and the chiquibul form of *A. zapota,* and is adulterated with the latex of other laticiferous species. In 1922 Costa Rica exported considerably more than a hundred thousand pounds. The exports of Honduras probably relate largely to Guatemalan chicle shipped through Honduranian ports.



MAP 1. Areas of Mexico, Central America, and South America in which chicle and chicle substitutes are reported to occur.

Very little is known concerning the source of Peruvian chicle. Vander Laan reports it as coming from a species of the family Apocynaceae. It is probably a mixture of various latices, since balata and other gums occur in abundance in the same regions. Relatively small amounts of chicle have been exported from Bolivia, Brazil,



Map 2. Areas in the East Indies and Malaya in which jelutong is extracted.

British and French Guiana, but the exact sources are not well known. In Brazil occurs a species of the Apocynaceae which yields the chicle known locally as *Tamanqueira leiteira*. Since *Manilkara* and other laticiferous trees occur in great abundance here, this chicle is undoubtedly a mixture. Part of the Brazilian exports probably come from the eastern portion of Peru. In British Guiana a species of *Manilkara* is reported to yield the chicle of commerce.

Another extensively used substitute is jelutong, which comes from several species of the family Apocynaceae in Borneo, Sumatra, and the Federated Malay States. According to Heyne (1914) and Corson (1927), it is the product of various species, principally *Dyera Lowii, D. costulata, D. laxiflora, D. borneensis, Alstonia scholaris, A. grandiflora, A. eximia,* and *Rauwolfia spectabilis.* Jelutong, which was formerly known under the names of "dead Borneo," "pontianak," and "gutta jelutong," is a soft pliable gum with a resin content of seventy-five to eighty per cent and rubber varying from nineteen to twenty-four per cent, according to Eaton and Dennett (1923). It is now being used extensively in the United States for mixing with *Achras zapota* chicle, and according to Vander Laan the total imports in 1910 reached fifty-two million pounds. Since that time, however, it has dropped considerably, and in 1925 slightly more than fifteen million pounds were imported.[2]

The various regions from which chicle, chicle adulterants, and substitutes have been exported are shown in maps 1 and 2. These maps have been made up chiefly from government and consular reports and various articles on chicle, and with the exception of certain parts of Central America do not relate to actual observations in the field by the writer. For this reason these maps will doubtless prove inaccurate in many respects, particularly with reference to the exact regions in which the latex-yielding trees occur, since the ports from which chicle is exported are usually far removed from the source.

(To be concluded)

[2] Since the invasion of Malaya and the Dutch East Indies by Japan the source of jelutong has been almost completely cut off.

More Fungi from the Front Lawn

Laura A. Kolk

Since 1934, I have been recording the different species of fungi which have appeared on the grounds of a small suburban home on Long Island. Twenty-three species were reported in 1935 (Torreya **35**: 31-32, 1935), and since then the number has almost doubled; but it is as interesting to watch each year for the reappearance of the old "perennials" (?) as to welcome newcomers. Previous reference has been made to the two blue spruce trees, approximately thirty years old which dominate a portion of the front lawn. A scarlet oak, a dogwood tree, and a hemlock, all about the same age as the spruce, mark the boundary of the nearby adjoining property. Other gymnosperms are scattered over the lawn, but they offer less favorable cover for the growth of fungi.

Each year Russulas appear during the summer in the vicinity of the oak. Short-stalked specimens are characteristic, so that the purplish-red and grayish-green caps are in many cases scarcely raised above the ground. *Russula variata* seems to be the common species, and it is spreading in the grass beyond the immediate area under the oak. *Xylaria polymorpha,* found in 1934, occurred in abundance in the spring of 1936 in the form of small specimens about an inch and a half tall, but seems to have disappeared. A maple tree, growing too close to the oak, had been removed several years previously and old roots may have been left in the ground, possibly accounting for the appearance of the Xylaria in this location. However, this summer (1941) another specimen appeared, but in an entirely different place.

Amanitopsis vaginata var. plumbea is another species which yearly makes its appearance in an area of approximately ten feet between the scarlet oak and a narrow flower border along the side porch of the house. The volva of this agaric sheathes the base of the stipe much more closely than that of the heavier volva of *Amanitopsis volvata*—a newcomer in the vicinity of the oak during the past two years. The volva of the latter is very thick, and splits at the margin into two or three deep clefts. The sporophore is quite slow in reaching maturity, sometimes requiring two days or more to emerge from the button stage. In July 1941, there appeared within a few feet of the place where I have usually found *A. volvata,* another agaric, with a large, bag-like volva (Fig. 1), deeply buried in the soil, and of somewhat thinner texture. It was very similar to *A. volvata* in its general characteristics, but was almost three times as large as any specimens of that species which had appeared up to date. The white pileus was covered with brownish scales, while the margin was fringed with large loose flakes, similar to the covering

FIGURE 1 (See Text)

of the six-inch stipe, which left a mealy deposit on the hands when touched. Specimens of *A. volvata* showed a striate margin with no indication of this fringe. Kauffman's description[1] of *Amanita Pecki-ana* also fits this fungus in many particulars, but it will be necessary to wait for its reappearance next year before a decision can be reached. The specimen was not kept after photographing.

Laccaria amethystina reappears each year in the grass between the oak and the dogwood tree, whereas the Amanitopsis species tend to appear on nearby patches of bare soil. However, in 1940 another Laccaria, *L. ochropurpurea* appeared on the bare soil, in the form of a few depauperate specimens, but in September 1941, at least ten

[1] Kauffman, C. H. The Agaricaceae of Michigan. Mich. Geol. & Biol. Surv. Pub. 26, Biol. Ser. 5. vols. 1 & 2; 1918.

very well developed specimens appeared in a small area previously occupied by the puff-ball *Scleroderma aurantium.* All these forms are within a radius of 15 feet from the trunk of the oak tree. Typical specimens of this Scleroderma have appeared each year, but several smooth walled specimens were gathered the past summer which fit Coker and Couch's description[2] of *S. cepa,* both as to peridium and spore characters. A third species of Scleroderma has appeared in sunnier situations in another area of the lawn. They are usually much smaller than the specimens of the two already mentioned species, and are replicas of those illustrated by Coker and Couch as *S. lycoperdoides* in their Plate 94. The spores, however, correspond more closely to those of *S. tenerum* on their Plate 120. I have collected this species in the same areas of lawn since 1934.

The Boleti are represented by *Boletus castaneus,* which yearly makes its appearance in the neighborhood of the oak, and by *B. chrysenteron,* which has appeared from time to time in various places on the lawn. A less frequent visitor is *B. granulatus* with its stipe marked by reddish granular dots.

A species of Inocybe with angular, nodulose spores, has appeared in 1940 and 1941 beneath a barberry hedge several feet from the oak. Its cap, about an inch in diameter, shows the typical fibrous markings of an Inocybe; it is umbonate with a dark umbo, and has a tendency to split along the margin. This is the third species of Inocybe to appear on the lawn. Two others, *Inocybe infelix,* and *Inocybe eutheloides* (?) were found in 1934, but only *I. infelix* has been a permanent resident. From spring to early fall this dingy brown little agaric may be found on a barren patch of soil beneath a rhododendron shrub. The spores of all three of these Inocybes differ decidedly.

In a patch of moss (narrow-leaved Catharinea) beneath the dogwood tree, a tiny yellow Clavaria has been found, and also *Pleurotus hypnophilus* and a small white agaric possibly *Omphalia gracillima* (?), but these are only among the occasional visitors.

Of the two blue spruce trees, which occupy a position directly in front of the house, one seems to be much more favorably situated for the growth of fungi than the other. Under the former, *Amanita muscaria* has established itself permanently. Each year dozens of

[2] Coker, W. C. and J. N. Couch. The Gasteromycetes of the Eastern U. S. and Canada. Univ. North Carolina Press. 1928.

specimens appear especially in the late summer and early fall. This dangerous agaric is also found in other areas of the lawn, especially under the hemlock and occasionally under a white pine. Of late these Amanitas have produced caps which are more tan than orange in color, but the volva is typical of *A. muscaria.*

This blue spruce harbors numerous other agarics beneath its branches. The Inocybe with nodulose spores mentioned above, has also been gathered here. *Clitocybe infundibuliformis* appeared in the latter part of June 1936, and was found again in June 1937, and May 1938. It has appeared since then, but no record has been kept. The identification of a small gray Clitocybe has so far been doubtful. Recorded as *Clitocybe pinophila* in 1934, other specimens gathered since then, indicate it may be *C. vilescens.* A species of Psalliota which appeared for the first time in the late summer of 1940, appeared again in September 1941. I am inclined to think this is *P. abruptibulba.* The fallen spruce needles, during a wet period in 1940, developed a conspicuous white mycelium which produced brown sporophores two to three inches tall, with upward tapering stipes, covered especially in the lower half with a dense white tomentum, velvety to the touch, often binding several sporophores together at the base. This is *Collybia* (Marasmius, according to Pennington[3]) *confluens.* The fetid Marasmius (*M. foetidus*) appeared twice on the lawn near the blue spruce; once in 1935, and again in 1937.

In the rear of the house, an apple tree occupies the center of the yard, and for several years troops of *Psilocybe foenescii* were continually in evidence, but these have now disappeared. No other fungi of interest have appeared in this area except a Psathyrella, single specimens of which appeared several years in succession.

The following fungi have appeared only once: an *Entoloma* (species undetermined), *Naucoria semi-orbicularis, Hypholoma incertum,* and *Lycoperdon Wrightii. Mutinus elegans* (incorrectly reported as *M. caninus* in 1935), *Russula foetens, Coprinus micaceus, Hypholoma sublateritium, Guepinia* (sp.) and a Lachnea-like Ascomycete (*Patella albospadicea* ?) all recorded in 1934, have not reappeared. A Hebeloma was found recently near the place where the so-called Pholiota aggericola appeared in 1934.

[3] Pennington, L. H. New York species of Marasmius, N. Y. State Museum Bull. 179; Report of the State Botanist 1914.

The Zygomycetes are represented by *Sporodinia grandis* which attacks the chestnut Boletus and also the Amanitas, and covers them with a bright orange-yellow fuzz.

Even the rusts and smuts are represented in this limited area. Several plants of smooth crab-grass in the back yard were infected with *Ustilago Rabenhorstiana* and some Panicum dichotomiflorum in one of the flower beds harbored the head smut *Sorosporium Syntherismae*. A tiny creeping Euphorbia had its leaves heavily rusted with *Uromyces proëminens* in 1940. A special search for plant pathogens could no doubt have uncovered numerous others, since the weeds above mentioned indicate neither a well-kept garden nor a perfectly groomed lawn. For a mycologist, however, it is ideal.

Brooklyn College,
Brooklyn, N. Y.

BOOK REVIEWS

About Ourselves

About Ourselves. By James G. Needham. The Jaques Cattell Press, 1941. Pp. XII + 276. $3.00.

It seems that a book so thoroughly publicized and by so popular an author needs very little in the way of a review, especially when it comes from a botanist with non-too-critical zoological leaning. However, to those of us of the Torrey Botanical Club whose daily task it is to present the biological aspects of human endeavors to the young, a few words about the impressions made by this book and the reasons why this book has such meaning for them, should be of some interest.

The title "About Ourselves" may have many implications, but since it has been written by a zoologist, one must naturally infer that its discussions treat of the human being. Not only is this true, but man's relation to other animals and other human beings are very much stressed. The book is accordingly divided into two parts. The first deals with man in his biological aspect; the second deals with society in its biological aspects. The first part is replete with topics which should appeal to the teacher in general and the teacher of biology in particular. The language is not technical and is adapted to the reading ability of an average intelligent layman. Behavior, instinct, and learning are the subjects of some of the most interesting chapters in Part 1. The second part is no less interesting for such timely topics as the biological aspects of government, war, and religion are developed. The long list of readers and commentators are high in praise of Needham's efforts. Few readers, however, have attempted to appraise the pedagogical value of this volume. Briefly, as one teacher to another, let me say that the author approaches his subject from the teacher's point of view. His story is told in a vein that makes it simple, interesting, and often amusing. It is these characteristics that make many of the topics models for teaching simple biological concepts to the non-too-willing learner we meet in our schools today. The author chooses from the known and non-technical subjects the facts best suited to illustrate his point. The diagrams of Dr. Sargent are of great simplicity and in two or three cases their purpose is not very clear to the reviewer, except perhaps to heighten the basic nature of the story.

The author at times seems to find it necessary to remind his reader that "About Ourselves" deals with man in his zoological aspects. For in such chapters as "Behavior," and "Learning" little is said about man. The chapter, "Nature and Nurture," is interesting and should serve as a review to all those who teach and find little time for reading or experimenting. Here they will find a slightly different outlook on the problems of heredity. Briefly summarized in the author's inimitable way when he tells the story of germ plasm and body plasm, "Hats change but noses go on forever." In the chapter on the biological aspects of war there is no outpouring of venom against the Axis powers but one finds here an analysis of facts which lead to war and the contention that war will be part of the untamed instincts and evil folkways of *Homo sapiens.*

"About Ourselves" is a book which should interest a wide group of readers, scientists, and especially teachers of biology as well as those who are concerned with our present-day problems of education.

MICHAEL LEVINE

LABORATORY DIVISION
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NEW YORK CITY

The Microbe's Challenge

The Microbe's Challenge. By Frederick Eberson, Ph.D., M.D. 329 pages. The Jaques Cattell Press, 1941. $3.50.

To write a book on a scientific subject that will have appeal for the lay mind as well as for the scientist is a difficult task and yet this is seemingly what Dr. Eberson has achieved in his recent publication, "The Microbe's Challenge."

Microbes are shown to have a way of living. They must grow, eat, reproduce and die. The manner in which they set about this business of living is vividly told. There are both good and bad microbes and these are equally important to man. The microbial parasite is a subject for contempt as are parasites in any walk of life, but must be treated with respect because its parasitism is necessary if it is to go on living. The fight to overcome these disease-producing parasites is a fascinating one and puts to test all of man's ingenuity, as the author plainly shows.

The numerous disease-producing parasites or agents are each described in detail and the means by which invasion is fought and overcome clearly stated. One sees the body-producing poisons to offset those produced by the microbe. Such words as toxin, antitoxin, bacteriophage, etc., are given meaning.

Virus diseases, the yellow fever problem, and many others are set forth in a manner that will arouse enthusiasm for the scientist and respect for the laboratory. The how and the why of epidemics is but one of the problems met with.

Indeed the microbe's challenge is being met with, and though the path is hard and strewn with difficulties, much success has been attained since Louis Pasteur first started out on the journey.

In addition to the above, the author gives a true and accurate account of the history of the development of bacteriology and the men who have made this possible.

RHODA W. BENHAM

Plant Anatomy

Practical Plant Anatomy. By Adriance S. Foster. D. Van Nostrand Company, 1942. Pp. 155. $2.50.

If one approaches Dr. Foster's new book as this reviewer did, by way of the pre-publication announcement, the results are likely to be disappointing. The publisher's notice leads one to expect another *Eames and MacDaniels* with all the recent findings included and laboratory directions added. What one finds is a first rate laboratory guide. The author defines his purpose as the bridging of the gap between theory and practice in the study of plant anatomy. The form of the book is admirably suited to this purpose.

Each chapter consists of a discussion of the pertinent details of modern theory concerning the topic considered and an outline of practical laboratory exercises. The first two chapters have to do with the general characteristics of plant cells. The third chapter is on meristems. Knowing Dr. Foster's excellent work in this field one could wish that this chapter were more complete. The various theories as to the structure of the apex certainly deserve more discussion than they get here. A student doing the proposed collateral reading at this point would easily be confused by the various systems of tissue designation which he would encounter. Chapter IV is a unique and very helpful presentation of the various systems of cell and tissue classification. The charts relating the origin, position, structural characteristics, and functions of different cell types are perhaps the most valuable single feature of the book. In chapters V through XI each of the principal cell types is considered in detail. In chapter XI there is a good discussion of the distinction between sieve-tubes and sieve cells, the neglect of which has led to confusion in some modern papers. The last three chapters cover the stem, leaf, and root as tissue aggregates. There is a very brief appendix detailing certain special laboratory procedures.

As a working laboratory outline this book should prove of great value. The material is well organized and clearly presented. Instructors will appreciate the designation of specific materials which can be used for each exercise.

The principal criticism of this book is one which perhaps can be equally well applied to the teaching of plant anatomy generally. There is too great a tendency toward the purely descriptive aspects. Anatomy is a justifiable study only in that it is a manifestation of development either in the sense that the anatomy of an organism is the ultimate expression of its morphogenetic pattern, or, what is really the same thing, that it is a picture of the physiological differentiation. As there is often a gap between theory and practice in plant anatomy so does the descriptive approach make for a gap between form and function. We should have preferred to see what is really a developmental picture approached with a less static outlook. However, this is merely a personal viewpoint. There is much to be said for learning anatomy by this purer, more Spartan approach. Any student who covers faithfully the material outlined in this excellent book will certainly know plant anatomy, and know it well.

W. Gordon Whaley

Barnard College
Columbia University

General Botany

Fundamentals of Plant Science. By M. Ellen O'Hanlon. F. S. Crofts & Co., 1941. $4.25.

The numerous botanical textbooks of recent years are roughly divisible into two groups: those that are the work of young scientists and, like a spring freshet, have vigor, clarity of outline, and force of presentation; then there are those other texts, the works of botanists who have already won their spurs; and these, like a mature stream, tap deeper reservoirs of knowledge and present the subject set in its whole and proper environment. Happily, "Fundamentals of Plant Science" belongs in the latter group.

The book is divided into two parts. In traditional fashion the first deals with such topics as "The Plant Cell," "Leaves," "The Flower," "Fruits," "Roots," "Stems." In the second half, after a chapter on "Alternation of Generations," the groups of the plant kingdom are considered—the "Algae," "Fungi and Their Allies," "Bryophyta," "Pteridophyta," etc. Following this, a thirty-five page chapter is devoted to "Genetics"; the next eighteen pages deal with "Organic Evolution," and the final chapter takes up "Botanical History." This is followed by a glossary. There is ample botanical nourishment between the covers of this volume for the elementary student of general botany—very probably more than he will assimilate in one year. This is true of all of our good texts and allows for discretion on the part of the instructor as well as of the student. The scope and content are not markedly different from those of other standard works.

Any new textbook of botany, following upon all of those already published, should possess certain distinctive features. In this book they are not hard to find. The author, whose work on the liverworts is well known, has presented an admirable brief account of this group. The Anthocerotales are considered in a rank coordinate with that of the liverworts and mosses and are taken up last in the Bryophyta. In the Pteridophyta the Lycopods are discussed first, where they really belong, and not last, as in most textbooks. In a volume of slightly less than five hundred pages the author has found opportunity to devote a page to apogamy and apospory, another to the Gnetales, another to the embryo sac of the lily and other atypical angiosperms. The chapter on genetics includes a discussion of epistasis and of xenia. Other topics, such as tree rings and their significance, artificial parthenocarpy, and hormones, are not omitted.

Perhaps the most unusual characteristic of this book is to be found in the references at the end of the chapters. The author has had the courage to add to those time-honored and time-worn citations, so familiar in textbooks, selected new ones, many of them readable articles in the current journals. The illustrations are clear and well drawn and, mirabile dictu, practically all original. Throughout the book, as well as in the glossary, the derivation of botanical terms is given.

Conceivably a treatise could be written in clear diagrammatic fashion, presenting facts and little more; but such a one would hardly be worth its ink, like a picture without shading. Any worthwhile book reflects the personality of its author, and this is certainly true of "Fundamentals of Plant Science." The author projects not merely her personality but also her philosophy into her writing. There will be those who disagree with this philosophy, and who will therefore prefer other texts. This volume is appropriately bound in green.

Edwin B. Matzke

Columbia University

Tudor Medicine

An Herbal [1525]. Edited by Sanford V. Larkey and Thomas Pyles. Pp. xxiv + 86. *72 pp. facs.* Scholars' Facsimiles & Reprints, 1941. $3.50.

"Here begynnyth a newe mater the whiche sheweth and treateth of ye vertues & proprytes of herbes the whiche is called an Herball." Just how new the matter was we cannot now say, the author not having revealed himself. It is possible that it was the publisher's own compilation of current beliefs and was not due to the researches of any scholar. In all events, this work, "imprynted by me Rycharde Banckes . . . ye xxv. day of Marche. The yere of our Lorde M. CCCCC. & xxv.", seems to be the first book on herbs printed in English. It was preceded, however, by Bartholomew the Englishman's *De Proprietatibus Rerum,* the seventeenth book of which was devoted to plants and their uses; the English version of this work was printed in 1495.

The medieval herbal was primarily medical. Descriptions of the plants are secondary; in the Banckes herbal there are almost none. It is a collection of information about the physiological properties of plants, in 207 chapters arranged more or less alphabetically. There is intrinsic evidence that it is not the work of one hand. Some plants are introduced twice, their names differently spelled.

In their introduction to the present edition the editors damn it by calling it "quaint, old-fashioned." It is as quaint as our popular medical works will seem 500 years hence and, naturally, as old-fashioned. Perhaps this is only their way of saying that it is a genuine product of the sixteenth century. Its main concern is with the "aching of a man's guts" and the "wicked winds" that trouble them, and other parts and complaints not here mentionable. The hearty (I had almost written lusty) freedom with which these contemporaries of Henry VIII discussed such matters doubtless accounts for the somewhat redundantly anatomical characterization of the work (again by its editors) as "sinewy, muscular." If you wish to read, in modern print and spelling, how our remote forefathers treated their intestinal and other troubles with preparations hot or cold to various "degrees," moist or dry, laxative or "constipulative," here is your opportunity. I refrain from further quotation; the book is easily available. There is little here of purely botanical interest; and none of the imaginative power of vivid description which illuminates old Bartholomew's pages. Nor have we any means of determining whether the work represents the best medical science of its day. To judge from certain remarks of Gerard some years later, many herbals of those times were comparable to our almanacs rather than to our textbooks.

The book was popular in its day, running into many editions during the thirty years after its appearance. In spite of this, copies are excessively rare. It is here presented both in facsimilie and in "modernized" version, with an extensive introduction given largely to bibliographic review. The printer has done a careful job, the pages in facsimile are easily legible, and the small volume is neat if not distinguished.

In the "modernized" version the spelling and punctuation are changed to accord with modern usage, and explanatory notes are added here and there. Although we are told that misprints in the chapters have been corrected, we find "affodil," an obvious misprint for "asfodil"; the characters *f* and *s* being so similar. And it is curious that "Abrotinum" is changed to "Abrotanum" in the text, while other names (e.g., "Aristologia") are not so treated. The most puzzling feature introduced by the editors is the inclusion in brackets after the chapter headings (which are transcribed unchanged) of "corrected forms, as well as alternative forms which might be of use to the modern reader in the identification of some of the herbs." I should have supposed that modern botanical names would be of use here; but "Asfodillus" is changed to *Asphodilus,* "Euforbium" to *Euphorbium,* and "Petrocilium" to *Petrosilium;* "Daucus creticus" is corrected (?) to *criticus;* and what are *Amarusca* and *Centumnodia?* Surely the uninitiated reader is entitled to an explanation of these scholarly mysteries. The work concludes with an "Index of herbs and plants," which is actually an alphabetical list, without page numbers, of all the plant names not used in the chapter headings. No indication is given of which herbs are not plants.

H. W. Rickett

New York Botanical Garden
New York, N. Y.

FIELD TRIPS OF THE CLUB

Trip to Mistaire Laboratories, Millburn, N. J., February 7, 1942

About twenty members and guests of the Club met at Mistaire Laboratories, in spite of a rainy afternoon. They observed the unique laboratory and greenhouse, where an attempt is made to control all factors of plant growth while using natural daylight. Special exhibits were arranged to explain the research and the methods used in raising ferns, orchids, and other plants.

All plants are started with exceedingly careful pure culture technique on nutrient agar of known composition within glass containers. Among the exhibits in the planting room was a vibrator, used to shake the seeds or spores being sterilized. Prothallia were transplanted from one tube to another with a platinum needle over a flame. Flaming stoppers were snuffed out under a copper cone attached to a standard. A practical method for siphoning sterilized solution from a large flask into hundreds of older tubes, in order to adjust acidity and moisture, was shown. The air conditioning system was so regulated that the pressure within the planting room was greater than in the laboratory or outdoors. This kept unwanted germ laden air from entering through cracks.

Growth and development of the plants is governed by automatic controls of humidity, temperature, and light in the greenhouse. A humidistat controls two humidifiers. Vaporized cold water is used because it is more beneficial to living organisms than humidity formed by heating. The temperature in the greenhouse is kept between 70° and 80° F. by means of an electric thermostat. If extremes of 65° and 85° F. occur, an auxilliary thermostat causes a warning bell to ring in the house. The temperature is also controlled by an outer layer of Solex glass which eliminates most of the infra-red or heat rays of the sun, and acts as an additional insulation in winter. Summer heat thermostatically regulates a fine spray of water between the two layers of glass. Automatic recording instruments make permanent graphs of temperature and humidity.

Within the greenhouse, nine photo-electric cells were functioning. One automatically controlled a large shade; the second, the daylight and green fluorescent lights; the third and fourth, the light recording meter; others were for general study of light intensity.

The use of spectroscope to analyze wave lengths was shown. Row upon row of tubes and flasks were seen on trays in the greenhouse. The very young stages were in light positions of low intensity; the older plants were in brighter light, according to their maturity.

Visitors in the laboratory were shown working charts, graphs, and records, as well as a filing system containing the histories of each tube and flask. Three methods for determining the pH of solution were of interest.

In the house, guests could observe under two microscopes and several lenses, such materials as germinating orchid seeds, moss protonema, fern prothallia and young sporophytes, and nodules on clover roots. Displays of living plants in culture tubes and flasks were examined at leisure. The development of ferns was shown from the spores and prothallia to sporophytes of different ages. Great interest was shown in the proliferation of *Polypodium aureum*. Among the native ferns were: walking fern (*Camptosorus rhizophyllus*), climbing fern (*Lygodium palmatum*), purple cliff brake (*Pellaea atropurpurea*), Hart's tongue (*Scolopendrium vulgare*), *Dryopteris Goldiana, Dryopteris marginalis,* and maidenhair spleenwort (*Asplenium trichomanes*). Another series showed the development of various types of orchids. One round flask, containing a hybrid Billbergia or flowering pineapple, had been completely sealed for six years.

In one room an original humidified bay window, enclosed in glass, contained large ferns growing in deep soil and orchids in hanging pots. An outdoor bird feeding shelf was built into the window; below set into recesses, were two aquaria. The window and aquaria were heated by a concealed radiator, and were artistically lighted.

The pleasant afternoon was brought to a close with a television program and refreshments.

Mistaire Laboratories
152 Glen Avenue
Millburn, N. J.

Clara S. Hires

Fig. 1. One Mistaire exhibit—chiefly ferns and orchids. The hybrid Billbergia or flowering pineapple, in the central flask, has been growing for six years, completely sealed.

PROCEEDINGS OF THE CLUB

Minutes of the Meeting of February 3, 1942

The meeting was called to order at 8:15 p.m. at the American Museum of Natural History by the President of the Club, Dr. C. Stuart Gager. Thirty-seven members and friends were present.

The minutes of the previous meeting were adopted as read.

The following were unanimously elected to annual membership:

Miss Marion Johnson, Rutgers University, New Brunswick, New Jersey; Rev. Jos. Wittkoffski, M.M., Maryknoll, New York; Fr. Marie-Victorin, Inst. Botanique, 4101 rue Sherbrooke, Montreal, Canada.

Mrs. R. B. Woodleton of 454 Seventh Street, Brooklyn, New York, was transferred from Annual to Associate membership.

The President called upon the Chairman of the 75th Anniversary Celebration Committee for a report. Dr. Karling reported that the Committee had held three meetings. The celebration will be held the week of June 22. It will open with a banquet on June 22 and will be followed by scientific meetings during the week. Announcements and invitations which had been sent to institutions have already brought thirty-four responses. Seventeen delegates have been appointed.

The report of the Auditing Committee was made by Dr. Trelease to the effect that the books of the Club had been examined and found to be correct.

The Corresponding Secretary, Dr. Bold, reported on the personnel of the Standing Committees of the Club.

The President announced that a vacancy in the Council had been created by the resignation of Dr. Chandler from her term ending in 1943. Dr. Chandler became a member of the Council upon her election as second vice-president of the Club. Dr. Zimmerman was nominated for the position by Dr. Matzke. This was seconded by Dr. Dodge and Dr. Zimmerman was unanimously elected to fill this position on the Council.

The scientific program of the evening was presented by Dr. Norwood C. Thornton who spoke on "The Mystery of the Potato Chip." The speaker's abstract follows:

The potato chip industry had its beginning in the middle of the nineteenth century. Today more than sixty million pounds of potato chips are sold annually requiring approximately four times this quantity of fresh potatoes to provide for this demand. An industry requiring many tons of potatoes per day demands almost unlimited storage facilities to prevent the potatoes from freezing or even being chilled during the winter. One of the primary requirements of potatoes to be used for potato chips is that the tubers contain a low amount of reducing sugar. For it is this type of sugar, and not the total sugar content of the potato, that is responsible for the color of the finished product. Artificial "chips" have been produced by cooking filter paper soaked in dextrose.

As to be expected, reducing sugar accumulates at low temperatures, and at 5° C. we found this to occur quite readily in the twenty-five varieties tested. However, the reducing sugar values of the potatoes stored at 7° C. were about one-third of the values of those stored at 5° C. and the values of those stored at 8.2° C. were about one-sixth of those stored at 5° C. Delaying the start of cool storage after harvest retarded the rate of increase of reducing sugar at 5° C. so that after ninety days a lower sugar value was obtained than with potatoes stored immediately after harvest. Also, storage temperature differing only 1° C. caused differences in the rate of sugar accumulation in the potatoes. Only potatoes of known history (i.e. the variety, the temperature of the soil at harvest, time after harvest storage is started and temperatures held during each period of storage, etc.) should be used in experimental work when attempting to compare different varieties as to their suitability for potato chips.

The varieties of the Rural group were outstanding in maintaining low reducing sugar values and providing chips of good color.

Following the discussion of the scientific program, Dr. Bold read a communication from Dr. Small concerning tickets for the Sportsmen's Show.

The meeting was adjourned at 9:25 p.m.

Respectfully submitted,

Honor M. Hollinghurst,
Recording Secretary.

Minutes of the Meeting of February 18, 1942

The meeting of February 18 was called to order at 3.35 p.m. in the Members' Room of the New York Botanical Garden. Dr. Chandler, the second vice-president, presided. Thirty members and friends were present. The minutes of the preceding meeting were accepted as read.

Mr. Arthur C. Riemer, Box 241, Delmar, N. Y., was unanimously elected to membership in the Club.

The resignations of the following were accepted with regret:

Gladys B. Goddard of 747 Dixie Lane, Plainfield, N. J.
Lora Bond of Wellesley, Mass.
Harley J. Scott of 3720 Avenue Q, Brooklyn, N. Y.

The scientific program of the afternoon consisted of an illustrated talk by Dr. Norma E. Pfeiffer on "Experiments in connection with Lily Breeding." The speaker's abstract follows:

Lilies, which show a great diversity in their interactions, are often self-incompatible and seldom give natural crosses in the field. Seed set with foreign pollen often gives rise to seedlings showing maternal characteristics only. But pollen tubes from foreign pollen have been observed to grow less rapidly than own pollen tubes.

Mechanical stimuli applied to the stigma of regal lilies in the absence of pollen failed to induce seed setting, contrary to a popular idea. However, the stimulus of pollen can be substituted for in capsule production by chemicals, as shown by experiments on the Easter lily in 1937. Chemicals used by different workers showed variable results in different species in inducing formation of bulbs in the leaf axils. Naphthaleneacetic acid (Beale) gave bulbs in a *lingiflorum* variety, but not in the Formosa lily, while colchicine solutions (Emsweller) induced bulb formation in the Formosa lily, but not in *L. longiflorum;* the latter solution gives rise to polyploids. Formation of aerial bulbs was induced accidentally by the speaker in *L. longiflorum* by stoppage of growth of the main stem and through low temperatures.

Kodachrome slides were shown to illustrate a number of lilies with their hybrids.

After the meeting adjourned at 4.30 p.m., tea was served through the courtesy of the New York Botanical Garden.

Respectfully submitted,

Honor Hollinghurst
Recording Secretary

Minutes of the Meeting of March 3, 1942

The meeting was called to order by the First Vice-President, Dr. J. A. Small, at 8.15 p.m. at the American Museum of Natural History. Thirty-eight members and friends were present.

The minutes of the preceding meeting were adopted as read.

The scientific program of the evening consisted of an illustrated talk by Prof. Ralph Stewart on "Collecting Plants in Kashmir." The speaker's abstract follows:

Kashmir is a very irregular bit of territory at the extreme north of India where Afghanistan, Russia and Tibet come in contact with British India. It is a native state, ruled by a Maharajah and extends roughly from 32 to 32 degrees north and 72 to 80 degrees east. It is all mountainous and very rugged and except for the famous Vale of Kashmir is sparsely inhabited.

There are many elements in the flora because of the great altitudinal range. Jumu is only 1,000 ft. above sea level and plants have been collected up to 19,000 ft. north of the main range. In the foot-hill zone there is a sub-tropical element with some plants which range as far as the Philippines. In the Indus Valley there are desert plants ranging to the Mediterranean. There are temperate and alpine plants which are found in various places as far away as the Alps and others which apparently have come in from China. Behind the Great Range the flora becomes like that of Tibet and Central Asia.

Although the flora is most varied, the total number of species is probably not more than 2,500 and in addition there are about one hundred ferns.

Main Zones

I Sub-montane, largely varied types of thorny scrub.
II *Pinus* longifolia zone, 3-6,000 ft.
III *Pinus excelsa* and temperate hardwood zone, 6-8,000 ft.
IV *Abies Webbiana* zone, 8-11,000 ft.
V *Betula Bhojpattra* zone, 11-12,000 ft.
VI Zone of shrubs, rhododendrons, willows, junipers, 12-13,000 ft.
VII Alpine meadows of herbs and grasses and sedges, 13-14,000 ft.
VIII High alpine zone of moraine and rock plants, 14-19,000 ft.

These zones apply to the Indian side of the main range of the Himalayas and the altitudes vary a good deal according to exposure, rainfall, etc.

Behind the crest of the main range the forests disappear and closed formations are not common. Trees and crops have to be irrigated.

The meeting was adjourned at 9.35 p.m.

Respectfully submitted,

Honor M. Hollinghurst
Recording Secretary

Minutes of the Meeting of March 18, 1942

The meeting was called to order at 3.30 p.m. in the Members' Room of the New York Botanical Garden by the Second Vice-President, Dr. Chandler. Forty-seven members and friends were present.

The minutes of the preceding meeting were accepted as read.

No changes in membership were reported.

The scientific program of the afternoon was presented by Dr. Barbara McClintock who spoke on the "Contribution of the Nucleolus to Genetic Investigations." Dr. McClintock illustrated her talk with slides and drawings.

The meeting was adjourned at 4.50 p.m. to enjoy the refreshments provided by the members of the Garden Staff.

Respectfully submitted,

Honor Hollinghurst
Recording Secretary

Minutes of the Meeting of April 7, 1942

The meeting was called to order at 8.20 p.m. by the President, Dr. C. Stuart Gager, at the American Museum of Natural History. Thirty members and friends were present.

The minutes of the preceding meeting were accepted as read.

The following were unanimously elected to annual membership:

Mrs. W. S. Randall, Alamo National Building, San Antonio, Tex.
Mr. Leon Tannenwald, 120 Lee Avenue, Yonkers, N. Y.
Mrs. Florence B. Cornish, Gillette, N. J.
Professor Hempstead, Castle University, New Haven, Conn.

The following were unanimously elected to Associate membership:

Miss Lilly Elkan, 39-89 46th Street, Long Island City, N. Y.
Miss Katherine L. Dudley, 509 West 122nd Street, New York City.
Mr. Zachariah Subarsky, 5450 Netherland Avenue, Riverdale, N. Y.

The resignation of Dr. James S. Wiant of 641 Washington Street, New York City, from Associate membership was accepted with regret.

Dr. Roger Wodehouse reported on the program planned by the 75th Anniversary Celebration Committee. The celebration will open on Monday, June 22, with a scientific program under the chairmanship of Dr. Matzke at Columbia University. This will be followed by a banquet at the Men's Faculty Club. The scientific program of June 23 will be held at the New York Botanical Garden with Dr. Wm. Robbins acting as chairman. On Wednesday, June 24, the program will be under the chairmanship of Dr. Zimmerman at the Boyce Thompson Institute. Dr. C. Stuart Gager will act as chairman of the meeting at the Brooklyn Botanical Garden on Thursday, June 25. Field trips under the guidance of Dr. Small will close the meetings on Friday and Saturday, June 26 and June 27.

Dr. Small announced that the Field Schedule would be in the mails within a short time.

The scientific program of the evening was presented by Dr. D. F. Jones of the Connecticut Agricultural Experiment Station. Dr. Jones gave an illustrated talk on the "Chromosome Relocation and Degeneration in Relation to Growth and Hybrid Vigor." The speaker's abstract follows:

The inherited characters studied by geneticists for the most part have been highly selected to show clear-cut segregation with complete or nearly complete dominance and recessiveness. Small changes in growth rate or physiological efficiency are not easily detected and have been generally overlooked but these play an important part in heterosis and give information concerning growth and development. Spontaneous growth changes are rarely found in maize endosperm but are easily identified and related to chromosomal changes. Some of these give indication that critical regions in the chromosomes are involved.

The meeting was adjourned at 9.45 p.m.

Respectfully submitted,

Honor M. Hollinghurst
Recording Secretary

NEWS NOTES

An extensive list of Institutions, Societies and Research Workers in the pure and applied plant sciences in C. and S. America has been prepared by the Editors of Chronica Botanica, in coöperation with the Div. of Agriculture of the Office of the Coördinator of Inter-American Affairs, Washington, D. C. It has been published in Chronica Botanica Vol. 7, No. 2 and 3 (March and May 1942).

Contributors to TORREYA will please send all manuscripts to Dr. H. W. Rickett, New York Botanical Garden, Fordham Station P. O., New York, New York, until such time as a new editor of TORREYA may be selected.

The current editor has been appointed chief drug specialist with the Office of the Coördinator of Inter-American Affairs with Nelson Rockefeller and associated with the Board of Economic Warfare. Fordham University has extended a leave of absence for the duration of the conflict and it is impossible to carry on the editorial work associated with TORREYA.

I want to express my appreciation to the officers of the Club and to the many members who have coöperated in the publication of TORREYA.

WILLIAM J. BONISTEEL
EDITOR

THE TORREY BOTANICAL CLUB

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OTHER PUBLICATIONS

OF THE

TORREY BOTANICAL CLUB

(1) BULLETIN

A journal devoted to general botany, established in 1870 and published monthly, except during July, August, and September. Vol. 68, published in 1941, contained 694 pages of text and 55 full page plates. Price $6.00 per annum. For Europe, $6.25.

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Volume 18, no. 1, 108 pages, 1931, price $2.00. Volume 18, no. 2, 220 pages, 1932, price $4.00. Volume 18 complete, price $5.00.

Volume 19, no. 1, 92 pages, 1937, price $1.50. Volume 19, no. 2, 178 pages, 1938, price $2.00.

(3) INDEX TO AMERICAN BOTANICAL LITERATURE

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Correspondence relating to the above publications should be addressed to

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Volume 42 July-August, 1942 Number 4

TORREYA

A Bi-Monthly Journal of Botanical Notes and News

EDITED FOR

THE TORREY BOTANICAL CLUB

BY

HAROLD H. CLUM

John Torrey, 1796-1873

CONTENTS

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TORREYA

TORREYA, the bi-monthly publication of the **Torrey Botanical Club**, was established in 1901. TORREYA was established as a means of publishing shorter papers and interesting notes on the local flora range of the club. The proceedings of the club, book reviews, field trips and news notes are published from time to time. The pages of TORREYA are open to members of the club and others who may have short articles for publication.

TORREYA is furnished to subscribers in the United States and Canada for one dollar per year (January-December); single copies thirty cents. To subscribers elsewhere, twenty-five cents extra, or the equivalent thereof. Postal or express money orders, drafts, and personal checks are accepted in payment. Subscriptions are received only for full volumes.

Claims for missing numbers should be made within sixty days following their date of mailing. Missing numbers will be supplied free only when they have been lost in the mails. All subscriptions and requests for back numbers should be addressed to the treasurer, Dr. W. Gordon Whaley, Barnard College, Columbia University, New York, N. Y.

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The manuscript should be prepared so that it conforms to the best practice as illustrated by current numbers of TORREYA. Manuscript should be typed double-spaced on one side of standard paper. The editors may accept papers up to eight printed pages in length. Longer papers may be published if the author agrees to bear the cost of the additional pages. Illustrations (including tables and graphs) should not exceed twelve per cent of the text; authors of more copiously illustrated articles may be asked to pay for the excess material. Brief notes will be published with especial promptness.

Drawings and photographs should be mounted on stiff cardboard and the desired reductions plainly indicated. Figures should be so planned that after reduction they will occupy the entire width of a page (4 inches) and any portion of the height (6½ inches). Labels should be parallel to the shorter dimension of the page. It is best to combine illustrations into the smallest possible number of groups. Unmounted material will not be accepted. Legends for figures should be typewritten and included with the manuscript (*not* affixed to the figures). All legends for one group of figures should form a single paragraph. If magnifications are stated, they should apply to the reduced figures.

Contributors may order reprints of their articles when they return galley proof to the editor. A schedule of charges is sent with the proof, and will be supplied to prospective contributors on request.

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All persons interested in botany are invited to join the club. There are four classes of membership: *Sustaining,* at $15.00 a year; *Life,* at $100; *Annual,* at $5.00 a year and *Associate,* at $2.00 a year. The privileges of members, except *Associate,* are: (a) To attend all meetings of the club and to take part in the business, and (b) to receive its publications. *Associate* members have the privilege of attending meetings, field trips and of receiving the Schedule of the Field Trips and the Bulletin of the New York Academy of Sciences.

Manuscripts for publication, books and papers for review, reports of field trips and miscellaneous news items should be addressed to:

HAROLD H. CLUM

HUNTER COLLEGE, 695 PARK AVENUE

NEW YORK, N. Y.

TORREYA

VOL. 42 | JULY-AUGUST | NO. 4

Collecting Chicle in the American Tropics
(Part 3)

JOHN S. KARLING

EVILS OF THE PRESENT METHODS OF COLLECTING CHICLE

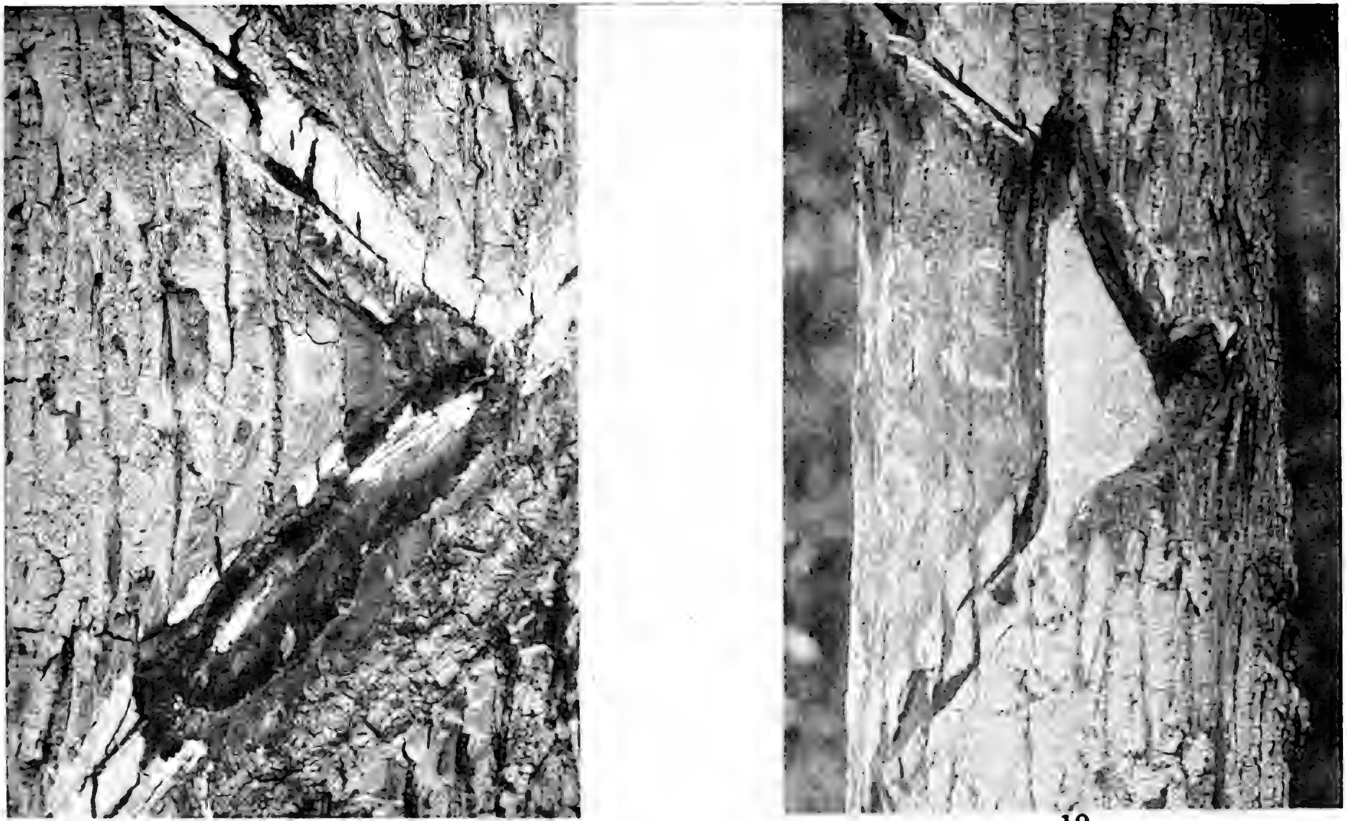
It is quite obvious from the above description that the collection of raw chicle is still in a very crude state. The sapodilla trees are bled in a manner to secure the maximum yield at one time and at a minimum of expense without much attention to conservation. No extensive selection, planting, crossing, and grafting or budding of high-yielding trees have been made, and no systematic production of chicle on a large scale has been attempted. Practically all of the large and important chicle areas in tropical America are controlled by the governments and by large land-owning concerns and allotted to chewing gum companies and individual contractors as concessions. The general policy in the beginning was to grant only short-time leases, and as a consequence the holders attempted to extract as much chicle as possible while the concession was in their possession. The granting of short time leases, the growth habits of the sapodilla tree, and the nature of the countries in which it occurs have hindered development of systematic chicle production in the virgin sapodilla forests and the establishment of permanent centralized coagulating, cooking, and supply camps. Furthermore, the fact that *Achras zapota* can be profitably tapped only once within five to ten years has contributed much to this condition of affairs and often made it undesirable and unprofitable for the small contractors at least to retain their concessions for long periods of time.

In addition, the present basis of remuneration for tapping is a great handicap to conservation and systematic production of chicle. The chicleros are paid on the basis of the amount of gum extracted, and as long as this system is in vogue, it is unlikely that they will tap judiciously. However, experience has shown that this is the most and perhaps the only practical basis of remuneration under the pres-

TORREYA for July-August (Vol. 42, 105–120) was issued November 12, 1942,

ent jungle conditions and type of labor, since supervision in the more or less inaccessible regions is almost impossible and would entail considerable expense. As a result no particular premium is placed on caution and care in tapping, and the only prerequisites of a chiclero under the present system are the ability to climb with the aid of a rope and make incisions which will secure the maximum yield of latex and convey it without loss to the collecting bag at the base of the tree. In their eagerness to secure the maximum amount of chicle during the rainy season, chicleros often overtap the trees and cause serious injury. Little regard is paid by the inexperienced chiclero to depth of tapping and injury to the cambium. According to conservative chicle contractors, approximately fifteen per cent of the tapped trees are eventually killed by the present native machete spiral method of tapping. Hoar (1924) claims that twenty-five per cent are killed. This estimate is based primarily on the number of dead trees which may be seen in the chicle areas and does not, however, represent accurate annual counts and careful observation. To the casual and inexperienced observer it would appear at first sight that the number killed each year is appallingly high, since the chicle forests contain a high number of dead standing trees, many of which bear the tapping scars. This large number, however, represents the accumulation of many years, since the sapodilla tree, because of its hardness, usually remains standing for several years after death and decays very slowly. Furthermore, many trees die a natural death or are killed by wood borers which enter after tapping. Consequently, the number of dead trees in any particular chicle area is not an accurate index of the number that is killed by tapping each year.

Nevertheless, the long machete used in the native system of bleeding is a difficult tool to control with respect to depth of tapping, and the cambium is often completely severed at the point of tangency of the bole and the cut. Quite frequently the cambium is removed with the chip of bark, and the wood is accordingly laid bare. Direct exposure thus of the cambium and xylem to the tropical midday heat often leads to a rapid drying out of the uninjured cambium and cortex immediately adjacent to the exposed region. This drying out may extend as much as an inch or more under the bark all around the injury, forming a dead region many times as large as the original exposed area. This is well illustrated by the trees shown in Figures 9 and 10. Immediately after tapping in October, 1927, the cuts on



9 10

Injury effects of the native system of tapping.

these trees were painted with white lead to prevent drying out as much as possible. Figure 9 shows the condition in June of the following year. In the lower of the two cuts here shown the outer surrounding bark has been removed, and the area of cambium and xylem exposed at the time of tapping is indicated by the two streaks of white paint. The size of this region as compared with surrounding area is obviously several times smaller. Figure 10 shows a portion of a smaller tree photographed a year after tapping when callus formation had apparently just begun. Removal of the hard outer bark showed a large triangular-shaped dead area of exposed wood. Injury and exposure of the cambium obviously involves not only that portion which is immediately injured at the time of tapping but in addition a considerable surrounding area. As a consequence, callus formation must begin a considerable distance back from the border of the original cut underneath the bark, as is shown in Figure 10. If, on the other hand, the chiclero moderates the depth of tapping, and the cambium is not exposed to drying, callus formation begins very shortly in the incisions.

Another destructive result of the machete-spiral method of tapping is that on the side of the tree where the oblique rows of cuts intersect, a panel or zone is formed which is traversed by a zigzag line or channel of cut bark (Figs. 2 and 3). Each oblique row makes an acute angle where it intersects the one below and above, and as a result this panel includes a large number of acute angles. If the cuts are deep and injure and expose the cambium, and if subsequent drying out at the angles is severe, the bark of the entire zone may sometimes slough off, leaving bare an irregular panel running the entire length of the bole, as is shown in Figure 11. Such exposed areas require many years for healing, and in the meantime wood borers and fungi may get in and destroy large regions of xylem and cortex. Figure 12 shows a tree that has been killed by wood borers subsequent to injurious tapping.

The ultimate death or recovery, rate of healing and bark renewal, however, are not dependent entirely on the depth and method of tapping. The age, condition, and reaction of the tree itself play a signficant role. Individual trees which have been carefully tapped may show signs of severe injury and ultimately die, while others which have been bled very severely may readily recover. This is well illustrated in Figures 11 to 13. Although the tree shown in Figure 11

11 12 13

Effects of the native system of tapping on large sapodilla trees.

was severely injured, it is, nevertheless, recovering, as is shown by the well developed callus on both sides of the injured panel. The tree shown in Figure 12 was killed by the combined effects of tapping and wood borers. Figure 13 illustrates a magnificent specimen which has been tapped twice and shows no signs of permanent injury. Shortly after this photograph was taken it was tapped a third time and gave a large quantity of latex. In individual cases it is thus difficult to predict the ultimate effect of tapping and the reaction of the tree to injury.

There is little doubt, however, that the native machete-spiral system of tapping is ruthless compared to the method employed on *Hevea braziliensis* and is gradually killing a large number of trees. This, together with the large amount of gum annually extracted and exported from the chicle areas, and the apparent slow growth of *Achras zapota,* is gradually exhausting the forests of "wild" virgin sapodilla trees. Areas in which supply of chicle seemed almost inexhaustible a quarter of a century ago are thus becoming depleted. On the other hand, there are many contractors who maintain that the present demand and consumption is compensated by the rate of growth and healing of *Achras zapota* and that a sufficient number of young trees come into profitable yield each year to offset to some degree the long interval of time required for a tapped tree to heal. The chief basis for their argument is that certain old chicle concessions or areas have been yielding approximately the same amount of gum for almost twenty-five years and that chicle exports have been increasing steadily. To anyone familier with the conditions in such areas and who has had intimate contact with the chicleros, it is obvious that the task of maintaining the annual demand is becoming more difficult each year. Chicleros must accordingly tap smaller and younger trees each year to meet the demand, and it is not uncommon to find trees as small as eleven inches in circumferences which have been completely tapped. To the writer, who has spent several years of observation and experimentation in tropical America, it is obvious that the demand in normal times is greater than the annual production of latex by the sapodilla trees in southern Mexico and Central America, and that under present tapping methods and lack of conservation a time will eventually be reached when the supply is exhausted. Before this condition arrives, however, greater utilization of favorable adulterants and chicle substitutes by chewing gum manufacturers may doubtless establish an equilibrium between supply and demand of raw chicle and thus indefinitely postpone the time of exhaustion.

Although it has been apparent for a number of years that the present system is gradually depleting the chicle forests, no determined effort has yet been made towards conservation, and it is only within recent years that serious attention has been directed to chicle production on a plantation basis. Since the tropical forests of southern Mexico and Central America contained at first seemingly inexhaustible quantities of chicle that could be extracted at comparatively small expense, this attitude was to be expected, and it was quite natural that no extensive effort was made to cultivate *Achras zapota*. Sporadic small-scale attempts at cultivation have been reported (Anonymous, 1923) from Mexico and the Far East, but until two decades ago no significant efforts were made to cultivate the sapodilla tree. The present status of the sapodilla tree as to methods of tapping, identification and selection of the best-yielding varieties, plantation culture, etc., remind one very much of *Hevea braziliensis* in the early years of the rubber industry. Years of rubber gathering in the wild were necessary before the importance of plantation production was realized, and then followed a long period of experimentation with methods of tapping, propagation, and cultivation, with the result that the present highly specialized methods of rubber culture finally emerged. In relation to plantation production the chicle industry is at present in about the same stage as was the rubber industry at the beginning of the nineteenth century, with the important exception, however, that the sapodilla tree appears much less, if at all, suitable for plantation culture than *Hevea braziliensis*.

Botany Department
Columbia University

Literature Cited

Anonymous. Chicle or sapodilla "gum." Bull. Imp. Inst. **9**:147-148. 1911.

Anonymous. Gathering chicle for the American gum chewers. Sci. Amer. Suppl. **88**:172. Figs. 1-3. 1919.

Anonymous. Chicle cultivation in Mexico and the Far East. India Rubber World **68**:628. Three figs. 1923.

Bell, P. L. Chicle. Colombia. A commercial and industrial handbook. U. S. Dept. Commerce. Sp. Agents Ser. **206**:85-87. 1921.

Blake, S. F. Native names and uses of some plants of eastern Guatemala and Honduras. Contr. U. S. Nat. Herb. **24**:87-100. Pls. 29-33. 1922.

Brown, P. Civil and natural history of Jamaica. London, 1789.

Chevalier, A. Les vrais et les faux Balatas. Rev. Bot. Appliq. d'Agri. Trop. **12**:261-282; 347-358. Pls. 8-11. 1932.

Cook, O. F. The culture of the Central American rubber tree. Bureau Plant Industry Bull. **49**:1-86. Pls. 1-18. 1903.

———. A new generic name for the sapote. Jour. Washington Acad. Sci. **3**:158-160. 1913.

———. Nomenclature of the Sapote and Sapodilla. Contr. U. S. Nat. Herb. **16**:279-282. 1913.

———, and G. N. Collins. Economic plants of Porto Rico. Contr. U. S. Nat. Herb. **8**:1-264. Pls. 13-60. Figs. 12-13. 1903.

Corson, T. Jelutong. Empire Forestry Jour. **6**:47-55. 1927.

Coville, F. V. In W. E. Safford's "The useful plants of the island of Guam." Contr. U. S. Nat. Herb. **9**:369. 1905.

Dannerth, F. The industrial chemistry of chicle and chewing gum. Jour. Ind. Eng. Chem. **9**:679-682. 1917.

Durland, W. D. Chicle—source of chewing gum. Amer. For. & For. Life **33**:228-229. 1927.

Eaton, B. J., and J. H. Dennett. Jelutong. Malayan Agri. Jour. **11**:219-222. 1923.

Fletcher, S. J. In Vander Laan's Production of gutta-percha, balata, chicle, and allied gums. U. S. Dept. Commerce Trade Prom. Ser. 41. 1927.

Gaertner, C. F. Fructibus et seminibus plantarum. **3**:129. Pl. 203. 1805.

Heyder, H. M. Sapodilla tapping in British Honduras. Emp. For. Jour. **9**:107-112. 2 pls. 1930.

Heyne, K. Wild rubber species in the Dutch East Indies. Rubber Recueil. 1914.

Hoar, H. M. Chicle and chewing gum. U. S. Dept. Commerce, Trade Inform. Bull. 197. 1924.

Hummel, C. Report on the forests of British Honduras with suggestions for a far-reaching forestry policy. London, 1925.

Jacquin, J. Enumeratio systematica plantarum. 1760.

———. Selectarum Stirpium Americanarum. 1763.

Karling, J. S. *Couma Guatemalensis* as a possible source of chicle. Am. Jour. Bot. **22**:580-593. 1935.

Linnaeus, C. Species plantarum. 1st ed. 1753.

———. Species plantarum. 2nd ed. 1762.

Melendez, L. E. La explotacion del arbol de perillo en Colombia. 1920.

Miller, P. The gardener's dictionary. 8th ed. London, 1768.

Pearson, H. C. Crude rubber and compounding ingredients. New York, 1918.

Pierre, L., and I. Urban. Sapotaceae. Symb. Antill. **5**:95-176. 1904.

Pittier, H. A preliminary treatment of the genus *Castilla*. Contr. U. S. Nat. Herb. **13**:247-279. Pls. 23-43. Figs. 1-54. 1909-1912.

———. New or noteworthy plants from Colombia and Central America 17. Contr. U. S. Nat. Herb. **20**:95-132. Pl. 7. Figs. 1-62. 1918.

———. On the origin of chicle with descriptions of two new species of *Achras*. Jour. Washington Acad. Sci. **9**:431-438. 1919.

———. Arboles y arbustos nuevos de Venezuela. Cuarta y quinta decadas. Bol. Cient. y Tech. Mus. Com. Venezuela 1. Caracas. 1926.

———. Plantas usuales de Venezuela. Caracas. 1926.

Planchon, L. Étude sur les produits de la famille des Sapotés. Montpellier. 1888.

Plumier, C. Nova plantarum Americanarum. Paris, 1703.

Popenoe, W. Manual of tropical and subtropical fruits. New York, 1920.

Record, S. J. "Cow trees." Trop. Woods no. **7**:29. 1926.

———. Local names of the woody plants of British Honduras. Trop. Woods **24**:15-28. 1930.

———, and H. Kuylen. Trees of the lower Rio Motagua Valley, Guatemala Trop. Wood **7**:10-29. 1926.

Resources of the Empire. Jelutong trade of British Malaya. Rubber, Tea and Cacao Series. London. 1924.

———. Jelutong industry in Borneo. Rubber, Tea and Cacao Series. London. 1924.

Sloane, H. A voyage to the islands of Madeira, Barbados, Nieves, St. Christophers and Jamaica. **2**:124-125. Pl. 218. 1725.

Standley, P. C. The Mexican and Central American species of *Ficus*. Contr. U. S. Nat. Herb. **20**:1-35. 1917.

———. An enumeration of the Sapotaceae of Central America. Trop. Woods **4**:1-11. 1925.

———. New species of trees collected in Guatemala and British Honduras by Samuel J. Record. Trop. Woods **7**:4-8. 1926.

———. Six new trees from British Honduras and Guatemala. Trop. Woods **11**:18-22. 1927.

———. Flora of the Panama Canal Zone. Contr. U. S. Nat. Herb. **27**:1-416. Pls. 1-66. Figs. 1-7. 1928.

———. A second list of trees of Honduras. Trop. Woods **21**: 9-41. 1930.

———. Additions to the Sapotaceae of Central America. Trop. Woods. **31**:38-46. 1931.

Vander Laan, J. W. Production of gutta-percha, balata, chicle, and allied gums. U. S. Dept. Commerce, Trade Prom. Ser. **41**:1-72. 1927.

BOOK REVIEWS

Plants of the Bible

Bible Plants for American Gardens. By Eleanor A. King. The Macmillan Co. 1941. Pp. 203. $2.00.

Probably everyone is familiar with some of the many Biblical references to plants, from the first chapter of Genesis, where on the third day of creation "the earth brought forth grass, and herbs yielding seed after his kind, and the tree yielding fruit" down to New Testament times when Jesus looking out over the mountain side said: "Consider the lilies of the field, how they grow . . . even Solomon in all his glory was not arrayed like one of these." Probably the majority of people reading of the lilies picture to themselves Easter lilies, so it may come as a surprise to read that the lilies referred to were anemonies.

There have been numerous magazine articles on flowers and trees of the Bible. The Journal of the New York Botanical Garden in March, 1941, had an illustrated article on "Plants of the Holy Scripture" by Miss King, and also a check list prepared in connection with the Garden's exhibit at the International Flower Show by Dr. Moldenke of all plants mentioned in the Bible with the scientific names of the plants as they are understood by modern students. But no complete work of a popular nature on the subject has appeared until this book by Miss King. In the front there is a paragraph of appreciation of the help given by the staff of the New York Botanical Garden, especially of that of Harold N. Moldenke. Comparing the book with the scholarly study—Plants of the Bible—distributed in mimeographed form by Dr. Moldenke, it is evident that this work was drawn on to a large extent in the writing of the present volume.

As the title suggests the book is a gardeners' manual with directions for growing the plants, outdoors or in, especially for those interested in plantings or gardens for church grounds. But it is much more, as it identifies the plants mentioned in the Bible, tells something of their characters, uses and meanings to ancient peoples. Merely identifying the species is often difficult, not only because the names used by the English translators were given by men unacquainted with the plants of Palestine, but also because the writers of the Scriptures were not thinking in terms of botany, but used vernacular Hebrew or Greek names that often referred to more than one kind of flower. For example, the rose was some flower with a bulbous root—tulip, narcissus, crocus of amaryllis—probably a general term including all of these; the lily of the field, as already mentioned, was an anemone (*Anemone coronaria*), but possibly included all the wild flowers blooming on the hillsides; apples were apricots, quinces or oranges; the gourd that shaded Jonah may have been a vine of the gourd family, though many students believe it to have been the castor bean. Of course, for many of the plants named there is no doubt as to the species—the Cedar of Lebanon, olive, fig, green bay, palm, and some of the spices and plants used for perfumes or in making incense.

The book will be of great value to those who desire to devote a part of their gardens to these plants of such sacred memories, to all students of the Bible and to plant lovers generally. The dozen full page plates illustrate a few of the plants and give some suggestions for flower arrangements that combine beauty with religious significance.

George T. Hastings

An Individual Botany Text

Work Book in General Botany. By H. C. Sampson. Harper & Brothers, New York, 1941. 242 looseleaf pages. $1.75.

The subtitle of this publication is "A problem approach to plant science through observation and discussion." This, perhaps as well as any single phrase, can be used to describe the method of instruction in the beginning course at Ohio State University under the immediate supervision of Professor Sampson. It is inevitable that many teachers of elementary botany may look with some disfavor on this guide for it can scarcely be said to follow traditional lines. It is therefore necessary that a little of its background be reviewed.

There has been much discussion concerning the method of instruction followed in that institution. In the first place, the beginning student is not assigned a chapter in a book and told to return the next day and "recite his lesson." Also, there is no differentiation between lecture and laboratory sessions, for the students meet in the same room with their instructor one hour a day, five days a week. This provides the necessary continuity of topic and concept so sadly lacking in many courses; it also establishes firm contact between teacher and student. And it is this contact which permits freedom of discussion.

It has been said, and with truth, that the method of instruction at Ohio State is "a discussion in the presence of the material." The lesson, then, begins with a consideration of the problem. This is followed by a study of pertinent material, interspersed with discussion leading to primary conclusions and these, ultimately, to broader biological generalizations. In recording his observations and conclusions, the student thus personally accumulates a basic textbook of botany. It is obvious that many items, especially of a theoretical or extended nature, or requiring too precise experimentation, cannot be observed or discussed during the study period. For these the orthodox text[1] is assigned, as well as supplementary reading. In this way the student is prepared for a further adventure into the general subject of botany; at least he has been given some insight into the methods of scientific reasoning based on experimental procedures. Thus, by seeing, doing, recording and discussing, the student learns the same facts he might otherwise memorize from a book. However, at the same time he also acquires the habit of gathering and evaluating evidence, a mental trait which certainly cannot be cultivated by the other method.

There has been considerable argument that the use of a set of drawings, complete except for the labels, does not cultivate the student's powers of observation. The writer of these notes is able to take issue with this viewpoint for he instructed at Ohio State University during the decade of transition from the old to the new type of instruction and watched the method develop with considerable interest, particularly as it influenced student reaction. In selected classes having paired IQ ratings there was no decrease in effective learning where prepared drawings were used. The advantage is that they eliminate a lot of useless "busy work" which wastes time which might more effectively be spent in examining the material or in discussion. However, the instructor should be cautioned that prepared drawings can never take the place of the actual material and that the student must learn to study the material first, using the diagrams or detailed drawings as a means of recording his observations.

[1] Textbook of Botany. By Transeau, Sampson and Tiffany. Harper & Brothers. New York, 1940.

Therefore, regarding the use of unlabeled drawings such as are an integral part of the Work Book, it should long ago have been obvious that careful observation and accurate recording of scientific information have but little in common with artistic ability. It has been one of the major crimes of our biology teaching that we have continued to penalize the student who is not congenitally an artist. The argument that the professional botanist should be able to draw, and therefore must learn in the beginning course, is certainly a fallacy. Those who advocate this doctrine have somehow forgotten that it is not the function of the introductory course to create professional botanists but to teach botany. It is very doubtful if a group of students—sounding for all the world like woodpeckers on a tin roof as they vainly try to "stipple in the cytoplasm" with hard pencils—are learning very much about the structure of protoplasm.

It would seem that I am defending Sampson's Work Book. This is unnecessary for it can stand on its own merits. But there are some who further object to it on the ground that it contains too much material, that they would not have time to cover all of it in a full year. In general these are the same teachers who admit that they assign a chapter in the text and then "hold the student responsible for every word." It is admitted that the Work Book does contain numerous questions, but it should be obvious that it was not the intention of its author and his collaborators that all of them be answered. Certainly many of them were introduced for the sole purpose of arousing discussion and to indicate the limits of our present knowledge, as well as the need for more research before the question can adequately be answered. It is perhaps a healthy mental attitude to instill in the beginning student; he should early realize that the science of plants is not a closed subject and that much yet needs to be done.

There is also considerable complaint by some that the course does not contain sufficient "morphology." This unquestionably results from the fact that the Work Book is not divided into sections labeled "physiology" and "morphology." There may be some lack of delving into the more obscure of the "life histories" but the course actually contains considerably more real morphology than is at first apparent—probably more than most courses—for it is integrated with the functional activity of plants, as it should be.

There is perhaps one drawback to a wider adoption of the course as outlined in the Work Book. To teach it successfully, it is necessary that the instructor have a fundamentally broad training in the field of botany; he cannot be a beginning graduate student interested primarily in getting his degree, with his teaching a bothersome chore to be sandwiched in at odd hours. He must know that the educator, if he aspires to be worthy of the real meaning of the word, must do more than stand in front of a group of students droning over phrases which he has hastily snatched from a book a few minutes before class time—and from the same text the students were supposed to have "studied" the night before. The philosophical background of the course has led to an organization designed to awaken in the student an intelligent awareness of the nature of living organisms through a study of plants. Under the guidance of a competent and sympathetic instructor, this can be accomplished.

New York Botanical Garden
New York, N. Y.
W. H. Camp

FIELD TRIPS OF THE CLUB

Trip of November 2, 1941, Along the Appalachian Trail

Ten members and guests were present on this trip whose purpose was to continue the botanical survey and census being made by the Club of the New Jersey sections of the Appalachian Trail maintained by the New York-New Jersey Trails Conference. In the morning we covered the Dunfield Creek route from the Delaware River to Sunfish Pond (Section 1a) and in the afternoon the blazed route from Sunfish Pond back to the Delaware River (Section 1), covering slightly over nine miles of trail in all. The weather was intensely cold.

According to the official records in Dr. Small's office there have been identified thus far by Club members in Section 1 166 species and varieties of spermatophytes, 11 pteridophytes, 4 bryophytes, 8 fungi, and 24 lichens. In Section 1a there have been found 159 species and varieties of spermatophytes, 17 pteridophytes, 15 bryophytes, 18 fungi, and 39 lichens. The total number of different species and varieties from both areas taken together is as follows: spermatophytes, 238; pteridophytes, 19; bryophytes, 17; fungi, 22; and lichens, 43.

Among the most interesting plants observed by us on our trip through Section 1a were the American dittany (*Cunila origa-*

noides), pubescent angelica (*Angelica villosa*), bearded short-husk (*Brachyelytrum erectum*), eastern golden-saxifrage (*Chrysosplenium americanum*), beech-drops (*Epifagus virginiana*), large coral-root (*Corallorrhiza maculata*), mockernut hickory (*Carya alba*), bitternut hickory (*C. cordiformis*), and small-fruited hickory (*C. microcarpa*), wild hydrangea (*Hydrangea arborescens*), downy rattlesnake-plantain (*Goodyera pubescens*), ternate grape-fern (*Botrychium obliquum*), cutleaf grape-fern (*B. dissectum*), common Virginia winterberry (*Ilex verticillata*), butternut (*Juglans cinerea*), fringed milkwort (*Polygala paucifolia*), white swamp-honeysuckle (*Azalea viscosa*), purple-flowering raspberry (*Rubacer odoratum*), toothed whitetop aster (*Sericocarpus asteroides*), vernal water-starwort (*Callitriche palustris*), common satin-grass (*Muhlenbergia mexicana*), field basil (*Clinopodium vulgare*), Torrey's wild-liquorice (*Galium lanceolatum*), smooth rock-cress (*Arabis laevigata*), hairy milkweed (*Asclepias pulchra*), deep-green sedge (*Carex tonsa*), purple chokeberry (*Aronia prunifolia*), and sheep-laurel (*Kalmia angustifolia*), all identified by foliar or fruit characters, or, at least, in their post-anthesis stages. The rare maidenhair spleenwort (*Asplenium trichomanes*) and walking-fern (*Camptosorus rhizophyllus*) provided a thrill. Three species were found still in bloom at this late date: the common bluets (*Houstonia coerulea*), American witch-hazel (*Hamamelis virginiana*), and common white wood aster (*Aster divaricatus*). Large quantities of a handsome earth-star (*Astraeus hygrometricus*) were found along the trail and some mountain-laurel bushes were seen to be infested with *Phomopsis kalmiae* or *Phyllosticta kalmicola.*

At Sunfish Pond the most important finds were colonies of the long sedge (*Carex folliculata*), dulichium (*Dulichium arundinaceum*), and sweet gale (*Myrica gale*). In Section 1, near the Delaware River, we found fields filled by practically pure-stand colonies of coralberry (*Symphoricarpos orbiculatus*), giving every evidence of being native, some of the stands covering the major portions of several acres. The European privet (*Ligustrum vulgare*), autumn oleaster (*Elaeagnus umbellata*), common tree-of-heaven (*Ailanthus altissima*), Japanese honeysuckle (*Nintooa japonica*), Japanese barberry (*Berberis thunbergii*), and European barberry (*B. vulgaris*) were found as abundant escapes. Other interesting plants observed were the green ash (*Fraxinus pennsylvanica*), maleberry (*Arsenococcus ligustrinus*), ebony spleenwort (*Asplenium platyneuron*), hooked crowfoot (*Ranunculus recurvatus*), northern wild-comfrey (*Cynoglossum boreale*), mountain-holly (*Nemopanthus mucronata*), common running-pine (*Lycopodium clavatum*), American trailing Christmas-green (*L. flabelliforme*), early meadow-rue (*Thalictrum dioicum*), English blue-grass (*Poa compressa*), pitch pine (*Pinus rigida*), common wild-ginger (*Asarum canadense*), and American pennyroyal (*Hedeoma pulegioides*). Particularly noteworthy were the soft agrimony (*Agrimonia mollis*), white avens (*Geum canadense*), low wild gooseberry (*Grossularia hirtella*), roughleaf bent-grass (*Agrostis hiemalis*), smaller catspaw (*Antennaria neodioica*), and plantainleaf catspaw (*A. plantaginifolia*). The liverwort, *Conocephalum conicum,* was found in extensive mats on a moist cliff. Along the river extensive beds of large-bracted plantain (*Plantago aristata*) caused considerable comment.

H. N. Moldenke

NEWS NOTES

As announced in the last number of Torreya, Dr. William J. Bonisteel is now chief drug specialist with the office of the Coordinator of Inter-American Affairs. We regret that this has necessitated his giving up the editorship of Torreya as he was well qualified by temperament and experience to undertake such a task. His work was well organized, and the issues of Torreya were appearing regularly. He also had a number of ideas, which he had not been able to put into practice, for improvement, and for making Torreya more useful to the members.

The long delay since the last number of Torreya appeared has been due to the fact that there was no one immediately available to take over the editorship in the absence of Dr. Bonisteel. Recently Dr. Harold H. Clum has been asked to undertake this, and hereafter all contributions to Torreya should be addressed to him at Hunter College, 695 Park Avenue, New York, N. Y.

Harold H. Clum
Editor

OTHER PUBLICATIONS

OF THE

TORREY BOTANICAL CLUB

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(1) BULLETIN

A journal devoted to general botany, established in 1870 and published monthly, except during July, August, and September. Vol. 68, published in 1941, contained 694 pages of text and 55 full page plates. Price $6.00 per annum. For Europe, $6.25.

In addition to papers giving the results of research, each issue contains the INDEX TO AMERICAN BOTANICAL LITERATURE—a very comprehensive bibliography of current publications in American botany. Many workers find this an extremely valuable feature of the BULLETIN.

Of former volumes, 24-68 can be supplied separately at $6.00 each; certain numbers of other volumes are available, but the entire stock of some numbers has been reserved for the completion of sets. Single copies (75 cents) will be furnished only when not breaking complete volumes.

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The MEMOIRS, established 1889, are published at irregular intervals. Volumes 1–18 are now completed. Volume 17, containing Proceedings of the Semi-Centennial Anniversary of the Club, 490 pages, was issued in 1918, price $5.00.

Volume 18, no. 1, 108 pages, 1931, price $2.00. Volume 18, no. 2, 220 pages, 1932, price $4.00. Volume 18 complete, price $5.00.

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(3) INDEX TO AMERICAN BOTANICAL LITERATURE

Reprinted monthly on cards, and furnished to subscribers at three cents a card.

Correspondence relating to the above publications should be addressed to

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THE TORREY BOTANICAL CLUB

BY

HAROLD H. CLUM

John Torrey, 1796-1873

CONTENTS

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TORREYA

TORREYA, the bi-monthly publication of the **Torrey Botanical Club**, was established in 1901. TORREYA was established as a means of publishing shorter papers and interesting notes on the local flora range of the club. The proceedings of the club, book reviews, field trips and news notes are published from time to time. The pages of TORREYA are open to members of the club and others who may have short articles for publication.

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Manuscripts for publication, books and papers for review, reports of field trips and miscellaneous news items should be addressed to:

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TORREYA

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Botanizing on Niue Island

T. G. Yuncker

To many, Niue Island has little significance because it is one of the more isolated of the Polynesian islands, has had few European or American visitors, and about which there has been little publicity. Furthermore, it lies in a lonely part of the south Pacific ocean and has little or no strategic or commercial importance. Because of the manner of its geological formation and other features it is, however, a very interesting island especially to the botanist and the geologist. It is situated at 19° S. latitude and 169° 50′ W. longitude with the Samoan, Tongan and Society groups as its closest neighbors but with the nearest islands several hundred miles distant. It has no harbor with safe anchorage during storms. This fact discourages visits from any ships except the regular New Zealand government service boat which, previous to the outbreak of the war, was scheduled to visit the island once a month. For weeks the only vessels one may see are the dugout canoes in which the natives fish off the edge of the reef.

The island is approximately 13 miles long and 11 miles wide and has a native population of about 4,000 which has remained fairly constant for a number of years. The white population, mostly government officials and their families, numbers less than a score. The natives wear European clothing for the most part although a wrap-around, skirt-like garment similar to the Samoan lava-lava is also used. They are in the main a high type, quiet and peaceful people. They do not, however, have the spontaneity of the Samoans, for example, nor do they sing and play with as much enthusiasm. This may be because life is considerably more difficult in Niue than in most of the more fertile volcanic islands nearer the equator.

Torreya for September-October (Vol. **42**, 121 to 152) was issued January 29, 1943.

The first European to see the island appears to have been Captain John Cook who visited it on June 20, 1774. Cook and some of his men, including Forster the botanist, attempted to land at two different places along the western coast of the island, as is recorded in his account of the visit. He was met with strong armed opposition by the natives and consequently was compelled to retire without exploring the island or collecting natural history specimens. Because of the violent resistance offered by the natives, Cook gave it the name of Savage Island and by this name it appears on some maps. The natives, however, do not like the name Cook gave their island but prefer the native name of Niue which is said to have been derived from *niu*, the Polynesian name for the coconut.

Most of the larger habitable islands of Polynesia are volcanic in origin thus offering a diversity of elevation as well as other topographic features including streams, ravines, etc., commonly favorable for abundant plant and animal life. Niue, on the contrary, is unique in that it is of the raised coral type of island. It has been formed by the elevation of an original coral reef which was nearly as large as the present island. The elevation was quite uniform so that the top of the island at present is nearly level or sufficiently so that differences can scarcely be noted without instruments. There is a slight dip toward the center of the island suggesting that the reef was originally of the atoll type. Following the initial uplift a new reef varying from about one hundred to four hundred or more meters in width developed around the raised part of the island. Eventually the entire island experienced an additional elevation with the new reef now forming a shelf or terrace about the original island. The total elevation of the island at present is between 65 and 70 meters at its highest point. The edge of the outer terrace ends at the sea with, for the most part, abrupt and precipitous cliffs often 20 or more meters high. A new coral reef, over which at high tide the waves dash against the rocky cliffs, is now forming about the island. Perhaps the island has experienced other elevations but these two, at least, are apparent to the geologically inexperienced eyes of a botanist. The geological history of Niue should prove of great interest to students of the raised-coral type of island.

During the centuries since the first elevation of the island, the coral has been undergoing decomposition and change. Naturally, the central or older part of the island, shows more disintegration of the rock than does the terrace. With the coming of plant life, humus has formed and soil has gradually accumulated, though soil, in the ordinary sense, at no place exceeds much more than six inches in depth. Beneath this top soil, which lies in pockets and crevices of the rocks and is by no means a continuous layer, lies a layer of decomposed coral limestone, white and powdery, known as *makatea*. This decomposed limestone will not alone support plant life. It is now used to a considerable extent as a top dressing for roads where, when rolled, it forms a compact and fairly permanent hard surface. A red soil is also found in pockets here and there but to a more limited extent. This soil when mixed with the top loam may furnish a basis for plant growth.

The natives have cleared much of the island where the rock has disintegrated sufficiently to permit working, but most of the lower terrace, as well as large scattered areas on the upper level, still remain too rough for the cultivation of crops. In clearing, the felled trees and brush are burned which not only removes the woody debris but also destroys some of the humus in the soil as well as reducing the microfloral content. The government officials are attempting to teach the natives not to burn their clearings and to conserve all of the humus possible and that this is the one great need of the soil. Seeds of *Crotalaria anagyroides* are also supplied for scattering about the island in the hope that this legume, which grows well under Niue conditions, may aid in soil building.

Cultivation aside from simple hoeing is impossible. Taro, bananas, yams, and sweet potatoes are planted in holes which are made in the soil pockets with sharpened sticks. Weeds may be pulled but for the most part the crops develop, if at all, without benefit of mechanical aid. In spite of these handicaps, under normal moisture conditions, fair crops are produced. During periods of drought, when the plantations fail, the natives are compelled to subsist on coconuts, breadfruit, and the fruit, roots, and other edible parts of wild plants of which there are not a great variety providing usable parts. They may, of course, purchase a variety of canned foods in the "bush" stores whenever they are able to secure money through the shipment of produce to the New Zealand markets.

The soil normally contains enough strength to permit only about one season of cropping at a time. A new plantation area must then be located and the old one allowed to revert to nature when it soon becomes covered with a weedy second growth of herbaceous and shrubby plants. After five or six years of such rest the soil may again be cropped for a season. Thus, the soil is only able to produce once out of every six or seven years. This represents a system of rotating the soil rather than that of the crops. The difficulty of cultivating the plantations and the poor quality of the soil with the resulting low crop yield obviously place a limitation upon the population growth. Another feature which adds to the difficulty of living on the island is the lack of any source of fresh water aside from the rains. All water used for drinking purposes must be collected from rains and impounded in reservoirs which, during times of drought, may have to be severely rationed. Before the construction of the reservoirs the natives secured some water by catching drippings from the roofs of caves. They also relied to a considerable extent upon coconuts for drinking purposes.

As seen at a distance from the sea the island appears as though completely forested with medium to large trees. This impression is due to a considerable degree to the large numbers of coconut, breadfruit, mango, and other introduced trees of economic use which have been planted everywhere about the island particularly in the vicinity of villages, all of which are situated on or near the lower terrace.

A considerable proportion of the upper or older part of the island has been cleared and cultivated at some time. Large areas, however, still persist in what appears to be primitive forest. In these areas the coral has resisted the forces of disintegration and remains in exceedingly rough and rugged masses which make walking off the trails exceedingly difficult. In places, deep, rugged crevices and caverns with sharp projecting rock masses still exist. These, now masked in some instances by lianas, ferns and other

FIGURE 1. A forested "island" on the upper level with cleared plantation area in the foreground in early stages of second growth. FIGURE 2. A typical native house in a grove of coconuts, breadfruit, bananas and other food and ornamental plants. FIGURE 3. The cliffs along the western shore near where Captain Cook landed in 1774. The profile of the island in the distance shows the upper level and surrounding secondary terrace.

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growth offer some risk and persons have been injured or killed by falling into them.

In these forested areas which have persisted because they are too rocky to permit clearing and the cultivation of crops, one finds a number of different species of shrubs and trees some with great buttressed trunks and over a hundred feet in height. One also finds several species of ferns and herbaceous plants and vines growing together in great profusion. *Flagellaria gigantea,* a curious grass-like liana, which climbs to the tops of the tallest trees by means of its prehensile-tipped leaves is also found here. Its great clusters of small, white flowers are to be seen above the tops of the highest trees and are collected with considerable difficulty. Among the more abundant of the woody species to be found in the forested areas and in the older thickets may be mentioned the following: *Celtis paniculata, Trema orientalis, Paratrophis anthropophagorum, Ficus* spp., *Laportea Harveyi, Pipturus argenteus; Hernandia Moerenhoutiana, Pittosporum Brackenridgei, Adenanthera pavonina, Inocarpus fagiferus, Micromelum minutum, Acronychia* sp., *Canarium Harveyi, Dysoxylum Richii, Aglaia samoensis, Glochidium ramiflorum, Macaranga Harveyana, Rhus taitensis, Pometia pinnata, Ellatostachys falcata, Dodonaea viscosa, Colubrina asiatica, Alphitonia zizyphoides, Elaeocarpus samoensis, Grewia crenata, Psidium Guajava, Eugenia* spp., *Planchonella samoensis, Diospyros,* spp., *Linociera pauciflora, Fagraea Berteriana, Alyxia stellata, Tarenna sambucina, Psychotria insularum, Morinda citrifolia, Morinda Forsteri,* and *Scaevola frutescens.* The cleared areas on the upper level are either bearing crops or are covered with a mass of second growth of ferns, grass, introduced weeds, and low shrubs.

Along the coast on the exposed rocks or adjacent territory grow a number of interesting native species. A conspicuous shrubby plant which grows at the cliff edge is *Bikkia grandiflora* with its large white tubular flowers up to six inches or more long. Large numbers of *Messerschmidia argentea* trees grow along the rocky cliffs and when in flower are surrounded with great clouds of butterflies. Among other common species found in this region may be cited: *Procris pedunculata, Pipturus argenteus, Hernandia ovigera, Capparis sandwichiana, Leucaena glauca, Erythina variegata* var.

orientalis, Mucuna gigantea, Aleurites moluccana, Triumfetta procumbens, Hibiscus tiliaceus, Thespesia populnea, Calophyllum inophyllum, Pemphis acidula, Barringtonia asiatica, Terminalia Catappa, Planchonella Grayana, Ochrosia parviflora, Cordia subcordata, Heliotropium anomalum, Premna taitensis, Hedyotis foetida, Gardenia taitensis, Guettarda speciosa, and *Timonius polygamus.* Pandanus trees occur everywhere, the leaves of which are much used by the natives for the weaving of large numbers of baskets and other articles.

The government officials who have been stationed on the island during the past forty years, together with the missionaries, have been active in introducing ornamentals and plants of economic worth. The natives themselves have also been responsible for the introduction of a considerable number of species especially those of more ancient introduction such as the coconut, banana, breadfruit, yam, papaya, etc. In all of the villages are large numbers of those ornamentals commonly found through the tropics including species of: *Crinum, Hymenocallis, Hedychium, Antigonon, Bougainvillea, Bauhinia, Clitoria, Acalypha, Euphorbia, Codiaeum, Hibiscus, Polyscias, Plumbago, Jasminum, Allemanda, Plumeria, Nerium, Cestrum, Thunbergia,* etc. *Salvia coccinea* has become a common weed about villages and along roadsides. In January it produces a fine show with a blaze of red and pink flowers. Appropriately, it is known locally as Bon Fire. Recently the Cassia shower trees have been introduced and give promise of becoming an important decorative addition. Occasional Norfolk Island pines and introduced palms add to the landscape. The flame tree, *Delonix regia,* likewise grows well and recently planted trees are flourishing and will soon make a fine show of color during their blossoming season.

The writer was on the island for a number of weeks early in 1940 and attempted to secure as complete a collection of the plants occurring there as possible. To that end I had the very hearty cooperation of Captain William Bell, resident commissioner, and Mr. Joseph McMahon-Box, then Secretary-Treasurer of the island government, as well as a number of the natives. Good roads and trails lead to all parts of the island so that nearly all regions were readily accessible. In order to secure as many of the species as possible, particularly those which might be rare or obscure, the commissioner asked the native officials and older men of each village to prepare a list of all of the plants which they knew. Many of the older natives were known to have a wide knowledge of the plants, particularly those with food or medicinal properties. The natives gathered in groups in the various villages and each person contributed the names of as many plants as he knew while one who could write would list them. In this manner more than a dozen lists, some of which included more than a thousand different native names, were obtained. Naturally, there were innumerable duplications and it was necessary to match lists and combine names when applied to the same species. From the list thus secured it was possible to seek those species not already collected and to locate, with the aid of a competent guide, a number of species which would likely have otherwise been overlooked. Finally, prizes were given to natives who could bring plants which were rare and of which specimens had not already been obtained. Most of those submitted had already been collected but a few interesting additions were secured in that manner. It was interesting to note that in many instances the natives employed a workable form of binomial nomenclature to designate the various species, using descriptive specific terms of color, habitat, leaf characters, etc. One wonders that professional botanists waited until the time of Linnaeus before adopting a similar system.

As might be expected, the endemic species are comparatively few. Practically all of them occur also in Samoa, Tonga, Raratonga or other islands of that general area. The total number of all species collected was found to be less than 500 of which something less than 50 percent are native. Considering the fact that there is little variation in the thin soil, that the topography of the island is flat and low, and that there is no surface water to furnish freshwater habitats of stream or marsh, one should probably not expect a larger number.

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Sedges and Rushes of Hot Springs National Park and Vicinity

Francis J. Scully

While making a collection of grasses of Hot Springs National Park and vicinity a number of plants were collected which proved to be the vegetative stage of many different species of sedges. During the next year a careful survey of this area was made for sedges, attempting to collect them in the fruiting stage so the determinations would be more accurate. The following forty-six species of sedges represent this collection. Included also are twelve species of rushes collected at the same time. The determinations of this collection were made by E. C. Leonard of the Smithsonian Institution and E. J. Alexander of the New York Botanical Garden.

Sedges

Carex blanda Dewey
Carex Bushii Mackenzie
Carex caroliniana Schw.
Carex cephalophora Muhl.
Carex comosa Boot
Carex crinata Lam.
Carex debilis Michx.
Carex festucacea Schkuhr.
Carex Frankii Kunth.
Carex granularis Muhl.
Carex Howeii Mackenzie
Carex hystricina Muhl
Carex intumescens Rudge
Carex laxiflora, Lam.
Carex Leavenworthii Dewey
Carex lurida Wahl.
Carex Meadii Dewey
Carex oxylepis Torr & Hook
Carex retroflexa Muhl.
Carex rosea Schkuhr.
Carex stipata Muhl.
Carex Swanii (Fernald) Mackenzie
Carex tetanica Schkuhr.
Carex triangularis Bock.
Carex tribuloides Wahl.
Carex vulpinoidea Michx.
Cyperus globulosus Aubl.
Cyperus lancastriensis Porter
Cyperus ovularis (Michx.) Torr.
Cyperus pseudovegatus Stend.
Cyperus refractus Engelm.
Cyperus rivularis Kunth.
Cyperus rotundus L.
Cyperus strigosus L.
Cyperus Torreyii Britton
Eleocharis Engelmanii Stend.
Eleocharis lanceolata Fernald.
Eleocharis obtusa (Willd) Schultes
Eleocharis tenuis (Willd) Schultes
Fimbristylis autumnalis (L) R & S
Fimbristylis puberula (Michx) Vail
Kyllinga pumila Michx.
Rynchosphora cymosa Ell.
Rynchospora glomerata (L) Vahl.
Scirpa lineatus Michx.
Schleria oligantha Michx.

Rushes

Juncus acuminatus Michx.
Juncus aristulatus Michx.
Juncus diffusimus Buchl.
Juncus effusa L.

Juncus interior Weigand.
Juncus marginatus Rostk.
Juncus setacens Rostk.
Juncus scirpoides Lam.
Juncus tenuis Willd.
Juncus validus Coville
Juncoides bulbosus (Wood) Small
Juncoides campestre (L) Kuntze

904 Medical Arts Building
Hot Springs, Arkansas

Cornus, A Reply

Oliver A. Farwell

In Torreya Vol. **42**:11-14 (1942) Dr. H. W. Rickett endeavors to maintain as genera the subgenera *Cynoxylon* and *Eukrania* published as such by Rafinesque in Alsog. Am. (1838); the former on p. 58 and the latter on p. 59. If Rafinesque were publishing new genera, he would most certainly have made new combinations or binomials under them. That the names were those of subdivisions is proved by Rafinesque himself, who on p. 63 (l. c.) lists and describes a species of *Cornus* as "281 *Cornus* (Eukrania) *cynanthes* Raf. atl. j. 151." This can in no sense be construed as a genus, *Eukrania* Raf. Aside from this we are not concerned with trying to interpret the ideas or unriddling the intentions of Rafinesque; but we are dealing with an actual fact in cold print. This fact is that Rafinesque was monographing the genus *Cornus* and creating new subdivisions thereunder; proved by the consecutive numbering of the species under Cornus and *not under* the divisional names. A perfect parallel is that of *Chrysopsis* of Nuttall under *Inula* in his *Genera* II 150, 151 (1818).

Many botanists, even Asa Gray, have considered *Chrysopsis* of Nuttall as a well-published genus by him (l. c.), and have credited Nuttall with the authorship of the binomials thereunder. But it is no longer done as Nuttall listed his species under *Inula*. Likewise as Rafinesque named his species under *Cornus* and *not under* the new names, I have no doubt that botanists will treat them as they treat *Chrysopsis*, as subdivisional names.

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Cornus Again

H. W. Rickett

Mr. Farwell's contention really does not concern me, since I am decidedly not endeavoring "to maintain as genera" the groups in question; this must be plain from my article. But Farwell's words prompted me to open yet again the Alsographia and thumb through its pages, with results which the readers of this journal may find as amusing as I did. For the first time I noticed on page 76 the Index of Genera, the sub-title of which says "Subgenera in Italics." Running my eye down this I quickly found *Eukrania* in italic and *Cornus* in Roman, and was ready with chagrin to acknowledge my error. But looking further I found *Kraniopsis,* which on page 58 is distinctly listed as "Subg.," in Roman, the same as *Lentago,* while the sister subgenera *Mesomera* and *Opulus* are in italic. Throughout the work the manner of listing the species is Rafinesque's own. *"Vib. L. rufidulum"* means *Viburnum,* subgenus *Lentago, V. rufidulum.* On page 31 Rafinesque distinguishes *Leptalix* as a new genus to include the American species of *Fraxinus,* and under it lists *"Frax. vel. L. longifolia,"* and *"Frax. L. mixta."* I think the conclusion is clear that one cannot solve the riddle by typography, and I repeat that it is impossible to be sure of the author's intentions, especially since in several places he very clearly implies that he had not completely made up his mind on the status of these items. I am perfectly willing to refrain from being dogmatic about the generic status of *Eukrania* or *Cynoxylon;* but a weighty burden of proof must rest on anyone who recognizes these genera but disregards these names. The work, incidentally, is not a monograph of *Cornus,* but a supplement to Rafinesque's Trees and Shrubs of North America.

New York Botanical Garden
New York, N. Y.

BOOK REVIEWS

Standardized Plant Names

Standardized Plant Names. Edited by Harlan P. Kelsey and William A. Dayton, for American Joint Committee on Horticultural Nomenclature. Second Edition. Pp. 675. Harrisburg, Pa.; J. Horace McFarland Company. 1942. $10.00.

The second edition of *Standardized Plant Names* is nearly twice as large as the first edition, 1923. It was the aim to include in the new edition the names of all plants of any economic or social value to man and this has extended the total to "approximately 90,000 separate entries of plant and plant product names." The new volume is of primary value and interest in regard (1) to the standardization of names and (2) to the "innovations" in the nomenclature, the most important of which recognize the distinctions between (a) true species (b) groups of hybrids (named "polybrids") and (c) clones.

The botanical names of genera and of their species are listed alphabetically and the "approved" scientific names are printed in bold-face type while synonyms or unapproved names are in italics. Common names for species and polybrids are in small captials as are the names of clones. Names of polybrids are distinguished from names of species by a symbol (∞) and the names of clones from common names of species and polybrids by another symbol (¢).

In making decisions on approved scientific names there were numerous collaborators and it is stated that it was the aim to apply these names in accord with International Rules of Botanical Nomenclature. In many cases when there is uncertainty in the application of synonyms the authority is given; but authorities are not cited for the names that are approved.

In any list of species names which is without either descriptions or citation of authorities the identity of the group of plants to which any name applies is not indicated. Hence the person who consults *Standardized Plant Names* in regard to any name must either have a knowledge of what that name applies to or be able to obtain this information from other sources. If one has this knowledge for at least one of the botanical names listed or for the one common name that is given he can learn what the approved scientific name is.

For example, one learns that the generic name *Amaryllis* is preferred to the name *Hippeastrum* and that the species name *Hemerocallis Thunbergii* is approved instead of the name *Hemerocallis serotina*. In respect to the standardization of scientific names the volume should be of value to gardeners and nurserymen.

In recognizing the clone and the polybrid the Editorial Committee of *Standardized Plant Names* renders a somewhat belated service to both botany and horticulture. In the first edition these distinctions were not made. That the rules of botanical nomenclature adopted to date are inadequate in application to cultivated plants has been noted in various publications and also in the deliberations and recommendations of the International Committee for Horticultural Nomenclature.

It has long been recognized that all members of a clone have collectively only the status of an individual. Methods of vegetative propogation, especially for perennial plants, have made the clone an important and very general horticultural unit. The term "clon" was proposed in 1903 but recently most writers have used the spelling "clone." The Editorial Committee of *Standardized Plant Names* wishes to give the spelling that was first proposed preference over that in recent general usage; but does not hesitate to offer many new changes in the spelling and the pronunciation of other terms.

The heterogenic nature of many groups of cultivated plants has been emphasized by genetical studies as well as by the experiences of gardeners. Often this condition arises after hybridization but it is more or less developed in the population of any species. If seed-reproduction is the rule for a group of hybrids, as in *Petunia,* there is usually segregation into true-breeding varieties each of which deserves a distinctive name. But for most perennial plants the polybrid group is soon separated into clones each of which deserves a clonal name. In horticulture a polybrid group is a rather temporary and variable group in comparison to the clone.

The horticultural varieties grown from seed are not listed in *Standardized Plant Names* for certain genera; as, for example, *Petunia* and *Zinnia*. But extensive lists of seed-grown varieties are given for barley, oats, flax, rye, wheat, sorghum, and other agricultural plants.

The Editorial Committee of *Standardized Plant Names* recommends that there be "one standard common name for each plant." In reference to the names of species and true varieties the term "plant" really refers to a group of individuals of successive seed grown generations. When two or more common names are in use for a group of plants only one is approved. Numerous new common names have been improvised. Numerous double names and hyphenated names in common use have been reduced to a single word; as, Lilyofthevalley, Jerusalemartichoke, etc.

There is much information concerning plants available in *Standardized Plant Names.* For any genus of plants one may learn how many species, varieties, polybrids, and clones are listed as important to man. In numerous genera the horticultural clones are segregated and listed by common names and the names of the originators are given (see *Aster, Begonia, Azalea, Hemerocallis,* etc.). There is a list of plant patents with an index of the plants involved. Lists are given of poisonous plants, range plants, state flowers and trees, fiber plants, herb garden plants, and other groups of plants that have special interest. These lists are useful as a basis for obtaining specific information in descriptive literature.

In the designation of species, of clones, and of polybrids in *Standardized Plant Names* there are numerous inaccuracies. Especially are many definitely recognized clones listed as polybrids or even as species; but in most cases this treatment follows that of some manual. This condition is illustrated in the nomenclature suggested for the genus *Populus.* At this time this reviewer wishes to record that the statement made in *Standardized Plant Names* that he collaborated in deciding the nomenclature presented for the genus *Populus* is an error.

Criticism of the volume is to some degree tempered when one reads the following statements in the preface: "*Standardized Plant Names* adopts the rule that species and natural varieties only are entitled to Latin or botanical names and that all hybrids, clones, polybrids, horticultural varieties and the like should receive suitable English or common names. . . . . Time and other serious handicaps make it impossible for the Editors to consistently carry out these principles. Yet reasonable progress has been made and it is hoped a later edition may see all necessary changes made in conformity with this beginning."

New York Botanical Garden A. B. Stout

The Years of John Torrey

John Torrey. A story of North American botany. By Andrew Denny Rodgers, III. 352 pp. Princeton University Press. 1942. $3.75.

The journey of the Astorians during 1811 and 1812 began a notable period in the exploration of western North America;—notable for many reasons, among which we may reckon the presence of two well known naturalists. Subsequent expeditions (mostly under the auspices of the United States Government) likewise included natural history among the fields to be explored; the collection and description of the plants and animals and other products of the country supplemented their purely geographical work. Specimens flowed eastward in an increasing tide for identification and preservation. Fortunately the prolixity of nature and the zeal of collectors met their match in a few great naturalists who stayed at home. Many North American plants went to William Jackson Hooker at Kew; but the bulk of them during many years were classified by John Torrey.

Torrey brought to this work acuity of perception and a talent for organization (without which, indeed, it would not have been brought to him). Though he was not himself a field botanist, though he saw the western plants growing in their native places only after his work was done, he labored to good purpose; his classification has formed an adequate skeleton on which to drape the flesh of later research. His was a purely descriptive science. Inquiries into the physiology of plants, into causes and first principles, even into the Darwinian theories when they appeared, seem to have interested him little. But in the scope of his knowledge, in his mastery of detail, in his grasp of relationships, Torrey is entitled to first rank among the leaders in American botany.

Recognition was not slow in coming to such work, and both labor and glory grew at the geometrical rate of the traditional snowball. In his later years Torrey maintained a large correspondence with botanists all over the world. He was instrumental in the establishment of the United States National Herbarium, and was one of the first "corporators" of the National Academy of Science. From a group of young botanists inspired by his leadership grew the Torrey Botanical Club.

From these remarks it is evident that a biography of John Torrey must indeed be a "story of North American botany." Some readers of the present work may feel, however, that title and subtitle would better fit the contents if they were interchanged. Mr. Rodgers has given us what is essentially a synopsis of the botanical exploration of North America, with biographical details of the principal American (and some foreign) botanists of the nineteenth century;—all against a background of extensive quotations from Torrey's letters. Some will think that a biographer should have made a greater effort to penetrate this mass of detail and to portray the human person within; others will doubtless maintain that the letters tell the story. It is true nevertheless that the work is something of a hodge-podge, the main theme lost in the accompaniment. This is the more to be regretted since, apart from his importance to botany, Torrey was an engaging person; naive, religious, unselfish, modest, shy,—and wholly lovable.

But there is another reason why this reviewer at least thinks that the author should have written with a different emphasis. Mr. Rodgers is not a botanist, and his attempts to evaluate the place of Torrey in the history of botany are not to be taken seriously. He assures us, for instance, that on two separate occasions American systematic botany was "born"; and it is rather astounding to read that Mendel was one of the "great theorists, [who] built on the vast taxonomic data gathered and organized by leaders such as Torrey." We see here a tendency evident in much modern biography: to indulge in an orgy of hero-worship which covers a lack of critical thinking. In the same tradition are the unfortunate attempts at "fine writing." As a substitute for creative literature we are offered perfervid periods.

In spite of such shortcomings, the book has real value, particularly as a reference work for those interested in American systematic botany. The data are copious and accurate, and the student will find useful notes on sources. There is also a "bibliography" of Torrey's works, from which dates of publication and other critical bibliographical materials have unfortunately been omitted.

Style, after all, is a matter of taste; many will disagree with the present reviewer in his strictures. But errors of grammar, punctuation, and syntax are in a different category; they are all too numerous in this work, and contribute not a little to the peculiarity of the style. One could wish that the editor of a University Press could find time to attend to such small matters.

THE NEW YORK BOTANICAL GARDEN H. W. RICKETT

Plant Breeding

Methods of Plant Breeding. By H. K. Hayes and F. R. Immer. McGraw-Hill. 1942. $4.00.

At a time like the present when it behooves every person to examine his own endeavors and ask himself what he is contributing to the nation's war effort and to the cause of humanity this book seems particularly pertinent and useful. It clearly serves the double purpose of being a working guide for investigators in its own field and an excellent review of the accomplishments and possibilities of plant breeding for others.

Methods of Plant Breeding is a long book (well over four hundred pages), but the subject of plant breeding is one of tremendous consequence, and its accomplishments are already notable. The first chapter is a brief statement of the rôle of plant breeding. Chapters II and III cover respectively the genetic and cytogenetic basis of breeding methods and the mode of reproduction in relation to plant breeding. The latter chapter includes a good practical discussion of the heterosis question. In view of recent work of Dobzhansky and others indicating the close association between appearance and degree of hybrid vigor and the method of reproduction this arrangement seems particularly good. Chapter IV gives details of methods for selfing and crossing the principal economic crops. It is chapters like this one and later ones on the handling of data which gives the book its value as a working handbook. Chapters V, VI, and VII cover methods of breeding and Chapter VIII correlates them with practical problems of breeding for disease and insect resistance. Chapter XIII returns to this discussion of breeding for special characters. The intervening chapters are given over to summary discussions of the genetics of wheat, oats, barley, and flax. Chapters XIV and XV deal with breeding methods and the genetics of maize, which is genetically our best known plant and probably the one in which breeding has so far obtained the greatest improvements. Chapters XVI and XVII discuss controlled pollination and seed production methods. The former includes a good section on the part played by incompatibilities and sterilities in breeding problems. The last five chapters deal with the standard methods of treating and analyzing data. A bibliography, glossary of terms, and appendix of statistical tables complete the book.

Methods of Plant Breeding could hardly have appeared at a more opportune time. The plant breeder is to-day faced with what is at once a challenge and a golden opportunity. Regardless of how long or short the "duration" may be this country must for some years to come produce both foodstuffs and other plant materials to supply not only ourselves and our allies but later all those peoples of the world whose lands have been devastated by war. This program will necessitate further improvements in our main crop plants, and the cultivation of many crops new to our agriculture. The endeavor will be a tremendous one and this book should prove a valuable guide to those entrusted with its breeding problems.

Finally it should be pointed out that several times the authors emphasize that progress in the field, and its attendant benefits to mankind, depend to a large extent upon free exchange of ideas and materials among workers at different stations and in different nations. This thought is one which it is to be hoped will permeate fields far greater in scope than that of plant breeding.

Barnard College, Columbia University — W. Gordon Whaley

Apache-state Flora

Flowering Plants and Ferns of Arizona. By T. H. Kearney and R. H. Peebles (and collaborators). Pp. 1,069, illustrated (29 plates and frontispiece) and indexed. U. S. Dept. of Agriculture Misc. Publ. 423. May, 1942. $2.00.

This, the second volume to appear in the last two years that can be truly called a state Flora, takes its place alongside Deam's *Flora of Indiana* as an example for authors of future state Floras to emulate. The differences, other than format and general plan, between these two state Floras are primarily due to the fact that while

Kearney and Peebles have *studied* the Arizona plants, Deam has *lived with* those of Indiana. This statement is in no sense a reflection upon the Arizona authors and their comprehensive survey of their state's vegetation; it is merely a summation of the differences in "flavor" between the two volumes.

Certain of the families and genera of included plants, as in Deam's Flora, have been treated by recognized experts in these groups; in this respect, as well as others, one may justifiably say that the authors approached their problem in the "modern" systematic manner. Well written—that is as well written as any manual, consisting primarily of keys, species-descriptions and records of distribution, can be written—and rather adequately illustrated with definitely good photographs, the Flora also contains an interesting discussion of the mantle of vegetation which, though torn and frayed by climate and topography, covers Arizona. To one who is addicted to maps as an aid to the interpretation of vegetational studies, a detailed map of the state, showing the major floristic areas and accompanying F. Shreve's discussion of vegetation types, is a desideratum which might well have been included. An outline map giving county limits, larger rivers and principal localities is a multiple guidepost to the "visitor" who dips into the book.

Among the more interesting facts presented, at least to one whose inclination is also toward things phytogeographic, is the presence in Arizona of two ferns, *Asplenium exiguum* and *Cetararch dalhousiae*. The isolated Arizona stations listed, together with a few localities for the former in northern Mexico, constitute the known western hemisphere records of these two species whose primary distribution is the Himalaya Mts., elsewhere in eastern Asia, and Abyssinia.

As an indication of the scope and complexity of the flora of Arizona, approximately 3,200 species, representing 128 families, are treated, and the estimate is made that when the state is completely explored the total may well be more than 3,500 species. The diversity of vegetation is due to several factors; among them the altitudinal range and climatic variation, and the resultant complexity of ecological habitats, within the state, as well as the number of primary vegetation-centers from which the components of the Arizona flora have come.

All in all, then, the *Flowering Plants and Ferns of Arizona* is a splendid contribution to North American botany. One can only regret that in so few of these United States has the flora been so thoroughly studied and so precisely depicted; it seems scarcely necessary to say that the total complexities and coherence of the vegetation of our country cannot be grasped so long as the distribution of a majority of its component elements, within so many of the states, is adequately known.

CHARLES L. GILLY

NEW YORK BOTANICAL GARDEN,
NEW YORK, N. Y.

Algae for Undergraduate Students

An Introduction to the Study of Algae. By V. J. Chapman. Pp. 387. The Macmillan Company. 1941. $3.75.

In the present volume the author has attempted to prepare a short and relatively elementary text on phycology for undergraduate students, hitherto available treatises being too unwieldly and comprehensive for such a purpose. The method of presentation, is in general, the "type-method" in which one or more genera are selected to illustrate the characters of each family. The book is divided into fourteen chapters, including general chapters on classification; reproduction, evolution and fossils; physiology, symbiosis and soil algae. Four chapters are devoted to ecology and distribution, and seven deal with the morphology of the type genera, families, orders and classes. References to important original sources are included at the conclusion of each chapter. The logic of including the Conjugales and Charales of the Chlorophyceae in the same chapter with the Xanthophyceae, Bacillariophyceae, Chrysophyceae, Cryptophyceae and Dinophyceae may be challenged in some quarters.

Some curious inaccuracies pervade the book. For example: the plural of flagellum is given as "flagellae" throughout the text. On page 63, the Chaetophorales are referred to as a "family." On page 72 it is implied that the oogonium of *Coleochaete scutata* possesses a trichogyne. It is stated on page 102 that in *Spirogyra* "meiosis takes place when the zygote germinates." *"Elachista"* is written for *"Elachistea* on page 145; the single egg of *Desmarestia* is referred to as "ova" in figure 114. On page 30 species of *Oedogonium* with antheridia and oogonia on different plants are spoken of as "dioecious homothallic" while on page 21 *Phacotus* is described as a "colourless unicell." It is highly doubtful that any motile cells of *Botrydium* have only one flagellum as they are figured in 83b. It is regrettable that Juller's (1937) important work on *Stigeoclonium* is not referred to in the discussion of that genus, nor is it considered in the general discussion of life cycles in the Chlorophyceae.

The last chapters on ecology and geographical distribution of algae represent more or less of an innovation in phycological texts in English, and the author is to be congratulated for having introduced this material as well as a discussion of aspects of algal physiology. Finally, the analysis of the derivation of the generic names of the types described will be a helpful feature to many students.

HAROLD C. BOLD
BARNARD COLLEGE,
COLUMBIA UNIVERSITY

FIELD TRIPS OF THE CLUB

TRIPS OF APRIL 26 TO BUSHKILL FALLS, PENNSYLVANIA

Thirteen members and guests of the Torrey Botanical Club gathered at Bushkill Falls in the soft haze of an unusual morning that in its warmth seemed like midsummer, but in its fragrance and in the delicate green tracery of the new leaves it was definitely a morning of early spring. Only the red maples in the low wet grounds and the oaks on the drier hillsides faintly echoed the final fanfare of the reds of autumn in the color of their expanding buds.

The group was honored this year by the presence and participation of Dr. Fulford, who contributed much to the study of the rich Bryophyte flora of this area.

Many of the liverworts and mosses have been found and recorded on previous Torrey Club trips to this region (TORREYA **40**: 175-177; **41**: 136-137). However, each year additional species are collected, and a thorough search would undoubtedly yield very many more. We had never identified *Frullaria Asagrayana,* with its midrib-like ocelli, before; nor had we ever noticed the common *Chiloscyphus rivularis,* which was growing in great abundance in one of the small tributary streams. Not far away, also flourishing, was *Jubula pennsylvanica,* coating the rocks of dark green. On the sides of the main gorge, we had never seen the tiny *Lejeunea patens,* the only slightly more conspicuous *Leucolejeunea clypeata,* nor *Jungermannia pumila.* Directly opposite the main falls there were miniature forests of *Pellia* sporophytes, their translucent stalks glistening in the sunlight.

Antheridial receptacles of this year were well along on *Marchantia,* but only archegoniophores of last year were in evidence, somewhat the worse for wear.

Coptis trifolia, the Gold-thread, in flower, added its cheerful touch to the dubious marshes, and the Fringed Milkwort was also seen in bloom again.

Ceratodon purpureus, like other birds of passage, was roosting in a burned over, waste spot.

On one of the drier hillsides, close to the path, *Buxbaumia aphylla* was growing more plentifully than we have ever seen it, while in the brook below, the giant water moss, *Fontinalis gigantea,* was still prospering, regardless of priorities.

The drive back through the village of Shawnee and the beautiful valley of the Delaware led past apple and pear trees in full flower and young grain fields in new green. It was still, on this Sunday afternoon, a valley at peace in a world at war.

Edwin B. Matzke

Trip of June 13, 1942, to Englewood Cliffs, N. J.

This Saturday afternoon trip covered a good botanizing region only a half-hour's bus ride from New York. Many of the common plants of late spring and early summer, and numerous trees, shrubs, and ferns were pointed out in relation to their varied habitats of cliffs, open fields, woods, and swamps. Also some notes were made concerning the geology of the region.

Mary Holtzoff

Trip of June 12-13 to Lake Shehawken, Pa.

This trip eventuated under several disturbing circumstances, principally an unusually hot and humid Saturday, followed by a rainy Sunday. The tour on Saturday took the party into Scott Township about four miles north of Lake Shehawken. Among the more interesting northern plants observed were *Lycopodium annotinum, L. tristachyum, Polystichum Braunii* var. *Purshii, Eriophorum callithrix,* and *Cornus canadensis.* A short side excursion was made to see a field blue with blossoms of *Scabiosa arvensis.* Another walk provided an infinite number and variety of *Botrichium matricariaefolium* and *B. lanceolatum* var. *angustisegmentum.* Collections were made of *Polygonum natans* var. *Hartwrightii* (not in flower), *Potentilla palustris* and *Salix lucida.* The locality for *Cetraria islandica* was also visited.

With the help of Mrs. Rodda of Palmerton, Pa., about sixty species of birds were observed, among which were the Black-throated Blue, Black-throated Green, Canadian, Blackburnian, and Magnolia warblers, the Water Thrush, and the Veery and Hermit thrushes. In one field was observed an unusual number of Henslow sparrows, and one in particular which sat and sang (?) from the roadside fence within a few feet of our car till we drove away and left him still singing.

Besides the leader, the party comprised Mr. and Mrs. Rodda and Mr. and Mrs. Hand of Philadelphia, Pa. A return visit under a more favorable star is hoped for at a near opportunity.

W. L. Dix

Trip of June 20, 1942, to Branch Brook Park, Newark, N. J.

Mr. Carl P. Witte, Horticulturist of the Essex County Park Commission, accompanied the group through the Park telling the people something about the plants of the Park and naming some of the trees and shrubs for those interested. Dr. P. P. Pirone, Research Specialist at the N. J. Agricultural Experiment Station, pointed out a number of pathological conditions and gave us much new information about the care and maintenance of shade trees. Those participating were unanimous in declaring it an afternoon spent to a pleasant and profitable advantage. Leader, Dr. Pirone. Attendance, ten from Newark Museum Nature Club and Torrey Botanical Club.

Edward B. Lang

Trip of June 20, 1942, to the Fern Garden of Mr. and Mrs. W. Herbert Dole

The eighty-odd ferns and fern allies in this garden were temporarily marked so that each species could be easily found and identified. Most of the ferns in the garden have been growing here from ten to twenty years and are well established and appear happy in their present positions. A number are of recent introduction and have been tried out for only a year or two. Several southern species were planted only this spring and may prove unsuitable for this latitude. The only way to settle that question seems to be to try growing them.

My ferns all came through the winter in good condition, though some species are always slow to start growth in the spring. Ferns are more liable to damage by wind during the winter than by low temperatures, and it has been found advantageous to protect those in exposed locations with small branches anchored with pegs or stones to prevent dislodgment. All are lightly covered with dry leaves, except of course the larger local ferns which require little attention.

The *Cheilanthes lanosa* on the limestone ledge in an exposed position in full sun most of the day is still in fine condition and shows considerable increase. From one small clump planted about ten years ago there are now five clumps each larger than the original, notwithstanding that a number of these ferns have been given to other fern gardens. *Woodsia ilvensis,* also on the limestone in part shade, after six or seven years is still in a very thrifty condition. The Polystichums, set out in 1940 and given no special winter protection, are still doing well. These include *P. andersoni, P. plumosum compactum, P. aculeatum plumosum* (?) and *P. viviparum* (said to be a West Indian fern). *P. lonchitis,* set out several years ago, survived several winters then disappeared.

The Florida shield fern (*Dryopteris ludoviciana*) appears to be hardy here. It has gone through three winters and shows increase by offsets. *Dryopteris celsa* and *D. chinensis* set out a year ago are growing nicely. The latter fern is especially attractive with its finely cut lacy fronds. Several specimens of Scott's spleenwort (Alabama type) set out last year have developed new fronds and appear in good condition. The same is true of *Asplenium pinnatifidum* planted in a low wall of brown sandstone. *Cystomium falcatum,* the holly fern which I have mentioned several times in previous years, still attracts attention with its shiny bright green fronds and exotic appearance. The alpine lady fern, *Atherium alpestre* var. *americanum,* collected on Mt. Rainier and sent to me several years ago, appears perfectly happy in its new habitat and has increased to several good sized clumps. *Blechnum spicant* (Deer fern) has again developed fertile fronds; last year there were only sterile fronds on this northwestern fern. The small "Mexican deer fern" which was sent to me last year went through the winter without any protection and is now larger than when it was received.

The afternoon provided ideal weather conditions and those who came remained until late afternoon sitting in the shade to discuss ferns and partake of refreshments provided by Mrs. Dole. Attendance 9.

W. Herbert Dole

PROCEEDINGS OF THE CLUB

Minutes of the Meeting of April 15, 1942

The meeting was called to order at 3.30 p.m. by the second vice-president, Dr. Chandler, in the Members' Room of the New York Botanical Garden. Twenty-eight members and friends were present.

The minutes of the preceding meeting were accepted as read.

The first portion of the scientific program was an illustrated report by Mr. Libero Ajello on a New Chytrid Genus, *Polychytrium.* The Speaker's abstract follows.

Polychytrium aggregatum is a new, polycentric, saprophytic species of the family Cladochytriaceae which occurs in the decaying vegetation of bogs in the ridges of Bearfort Mountain, Passaic County, New Jersey. It has a coarse, richly branched rhizomycelium which becomes yellowish-brown at maturity, and lacks spindle organs or intercalary enlargements. The sporangia are smooth or tuberculate and produce spherical, posteriorly uniflagellate zoospores which lack a conspicuous refractive globule but include a prominent opaque lunate body. The sporangia dehisce by the deliquesence of the tip of the exit tube or papilla. Dormant thick-walled resting spores have not been observed, but the irregular tuberculate yellowish-brown sporangia are strikingly similar to the resting spores of many Cladochytriaceous species. However, they produce zoospores directly without going through a dormant period.

The second talk was given by Dr. Edwin Matzke who spoke on The Microscopic Anatomy in the Identification of the Commercial White Pines. This was illustrated with slides and specimens. The speaker's abstract follows:

There are three common commercial species of white pine growing in the the United States: the northern white pine, *Pinus Strobus,* the western or Idaho white pine, *P. monticola* and the sugar pine, *P. Lambertiana.* In general these trees are similar; the northern pine is distinguished from the others by its finer needles, while the sugar pine can be told by its long cones.

The wood of these three species is also much alike in its gross as well as in its microscopic characters. The texture is somewhat coarser in the sugar pine, and the resin ducts are larger and darker in color. Sugar pine also has the largest tracheids, northern white pine the smallest.

The most diagnostic microscopic difference between these three species is the shape of the pits of the ray parenchyma cells. They are large and oblong in *P. Strobus,* small, diagonally elongated and often apiculate or lemon-shaped in *P. Lambertiana,* and intermediate between these two types in *P. monticola.*

In many ways, microscopically as well as macroscopically, the western white pine is intermediate between the other two. This is also true of its distribution. However, other species also undoutbedly enter into this series.

The meeting was adjourned at 4.35 p.m. to be followed by a tea served by friends at the Garden.

Respectfully submitted,

Honor M. Hollinghurst
Recording Secretary

Minutes of the Meeting of May 5, 1942

The meeting was called to order at 8.20 p.m. by the second vice-president, Dr. Chandler, at Schermerhorn Hall, Columbia University. Forty members and friends were present.

The minutes of the preceding meeting were accepted as read.

The following were elected unanimously to annual membership:

Dr. V. E. Brown, Taylor University, Upland, Indiana
Dr. Wayne Manning, 14 Adare Place, Northampton, Mass.
Dr. Ernest Ball, Osborn Botanical Laboratory, New Haven, Conn.

The resignations of the following were accepted with regret.

Dr. D. A. McLarty, Dartmouth College, Hanover, N. H.
Dr. George C. Wood, 4430 Tibbet Avenue, Riverdale, N. Y.
Dr. Walter T. Bedell, West Winding, Poughkeepsie, N. Y.

The scientific speaker of the evening was introduced by Dr. Robbins. Dr. Beaman Douglas spoke on Botanizing in An Art Museum and illustrated his talk with some very fine Kodachrome slides.

The meeting was adjourned at 9.30 p.m. and was followed by a tea served by members of the Columbia University Botany Department.

Respectfully submitted,

Honor M. Hollinghurst
Recording Secretary

Minutes of the Meeting of May 20, 1942

The meeting was called to order at 3.30 p.m. in the Members' Room of the New York Botanical Garden by the second vice-president, Dr. Chandler. The minutes of the preceding meeting were accepted as read.

The following were elected unanimously to annual membership:

William E. H. Schneider, Jr., 90 Engle Street, Englewood, N. J.
Prof. Seville Flowers, University of Utah, Salt Lake City, Utah
T. Monroe Kildow, Box 520, Tiffin, Ohio

The following was unanimously elected associate member:

Eleanor Ruth Witkus, 61-19 Grand Avenue, Maspeth, N. Y.

The resignations of the following were accepted with regret:

Don. E. Eyles, Memphis, Tenn.
Clifford S. Leonard, 31 Cliff Street, Burlington, Vt.

In response to the question raised regarding the progress of the committee on the per capita cost of membership in the Club, Dr. Dodge stated that he was awaiting a report from the Treasurer.

Dr. Bold moved that the Treasurer be instructed to pay for the 75th Anniversary Celebration Banquet dinners of the officially appointed delegates and speakers from outside the metropolitan area. This was seconded by Dr. Karling and passed by the Club.

The chairman of the 75th Anniversary Committee, Dr. Karling, announced that 97 institutions had appointed delegates to the meetings.

The scientific speaker of the afternoon was Dr. W. H. Camp who spoke on "The Genetic Structure of Populations and the Delimitation of Species."

Following the discussion of the talk, tea was served by friends at the Garden.

Respectfully submitted,

HONOR M. HOLLINGHURST
RECORDING SECRETARY

MINUTES OF THE MEETING OF OCTOBER 6, 1942

The meeting was called to order at 8.40 p.m. at the Brooklyn Botanic Garden by the President, Dr. C. Stuart Gager. Thirty friends and members were present. The minutes of the preceding meeting were accepted as read.

The following was unanimously elected a sustaining member:

Thomas C. Desmond, 94 Broadway, Newburgh, N. Y.

The following were elected unanimously to annual membership:

Gladys Boughton, 448 Washington Street, Brooklyn, N. Y.
Margaret S. Rogers, 20 Haslet Avenue, Princeton, N. J.
Dr. F. L. Wynd, University of Illinois, Urbana, Ill.
Dr. Arnold Rocha, Rua Angelo Agostino, 18, Rio de Janeiro, Brazil
Dr. Selman A. Waksman, N. J. Agric. Exper. Sta., New Brunswick, N. J.
Dr. Joseph Austin Miller, 364 Prospect Street, South Orange, N. J.
Dr. John N. Martin, 507 Welch Avenue, Ames, Iowa
Nettie M. Sadler, 503 Allen Street, Syracuse, N. Y.
Dr. William A. Beck, University of Dayton, Dayton, Ohio
Clarence R. Hanes, Schoolcraft, Mich.
Dr. Thomas S. Stewart, 18th and Rittenhouse Square, Phila., Pa.
Francoise A. Kelz, 31 Dobbs Terrace, Scarsdale, N. Y.
Joseph Ravizza, 312 Stanley Street, New Britain, Conn.
Arthur M. Scott, 7035 Chestnut Street, New Orleans, La.
Rev. F. J. Mahoney, S.J., Regis College, Denver, Col.
Mrs. George H. Sinden, Vassar College, Poughkeepsie, N. Y.

Transfer from annual to associate membership was approved for:

Dr. Alexander V. Tolstoouhov, 24 Arden Street, New York City

The following resignations were accepted with regret:

Fred. A. Barkley, Montana State University, Missoula, Mont.
Helen Berdan, London, Ont.
Mrs. Herbert Richards, 370 Riverside Drive, N. Y.
Walter J. Harmer, 100 West 80th Street, N. Y.
Anna E. Lofgren, 575 West 172nd St., N. Y. C.
Mrs. R. A. Wetzel, 218 Tecumseh Avenue, Mt. Vernon, N. Y.

Gretchen D. Taylor, 127 Prospect Place, South Orange, N. J.
Mrs. Fitz-Henry Paine, Abington, Conn.

A brief report on the success of the 75th Anniversary Celebration was given by the chairman of the Celebration Committee, Dr. Karling, who thanked the members of the institution in the metropolitan area for their assistance and cooperation in making the Celebration a success. It was moved by Dr. Rickett that the chairman might include this report in a foreword to the issue of TORREYA covering the Celebration. This was seconded by Dr. Dodge and passed.

With reference to the members of the Club who are now in the armed forces, Dr. Whaley moved that the Club suspend or impose a moratorium on their dues so that these members might remain in good standing for the duration. This was seconded and passed.

The scientific program of the evening then proceeded with reports by several members on their activities during the past summer.

The meeting was adjourned at 9.40 p.m. The Club then enjoyed refreshments served by members at the Garden.

Respectfully submitted,

HONOR M. HOLLINGHURST
RECORDING SECRETARY

MINUTES OF THE MEETING OF OCTOBER 21, 1942

The meeting was called to order at 3.30 p.m. by the second vice-president, Dr. Clyde Chandler, in the Members' Room of the Museum Building of the New York Botanical Garden. Twenty-nine members and friends were present.

The minutes of the preceding meeting were accepted as read.

The following was unanimously elected an associate member:

Rev. James J. Hanlon, 328 West 14th Street, New York City

The scientific program of the afternoon was presented by Dr. B. O. Dodge who gave an illustrated talk on "Hybrid Vigor or Heterocaryotic Vigor in the Fungi." The speaker's abstract follows:

Continuation of the work on heterocaryotic vigor has been made possible by a grant in aid by the American Philosophical Society and by assistance provided by Dr. W. J. Robbins from private funds advanced for researches on growth substances. It has been previously reported that certain dwarf races of *Neurospora tetrasperma* which grow very slowly by themselves seem to act in a complementary manner to stimulate growth in other rather slow-growing races, and vice-versa, so that the heterocaryotic mycelia, or races, grow up to two or three times as rapidly as does either of the individual components. A rather slow growing race C4, was crossed with a dwarf race, No. 16, and many ascopores had been isolated at random. Cultures from these individual ascopores showed that the factors for heterocaryotic vigor seemed to be heritable. Certain questions arose, however, which indicated that random selections from dispersed ascospores was not the most desirable method of procedure. The present work has consisted in the isolation of the four spores from individual asci, or isolation of the full complement of spores whenever other than four spores were delimited. All the spores from 131 asci were isolated and grown in culture separately. Of these 118 asci contained four spores, except two or three which contained five spores. Ten asci contained two normal sized spores and one larger spore. Two asci contained two abnormally large spores and one contained a single giant spore. In addition, three of the four spores of 39 asci were also isolated and grown in culture. It was found that 35 of the 118 asci which had four spores showed that all four spores developed similar cultures which grew vigorously and all had perithecia. Thirty-five others showed a two and two pattern in which two grew vigorously and produced perithecia, while the other two grew vigorously but very few, if any, perithecia matured. Forty asci showed a two and two distribution, two cultures growing vigorously, producing an abundance of ascocarps, while two were dwarfs. These were called double dwarfs because so far as tested they have shown that two nuclei of both sexes were present because they fruited with both of the tester strains. The other asci from which the components were grown showed various sorts of irregularities which have not as yet been analyzed. In some cases all the spores were clearly unisexual, as shown by tests.

The advantage in using races of *Neurospora tetrasperma* for this work over an obligately heterothallic species such as *N. crassa* or *N. sitophila* is that in the latter forms the nuclei of the opposite sex tend to remain apart even in mixed cultures so that it is difficult to obtain a heterocaryotic race by growing two individual unisexual races together in a culture; with *N. tetrasperma* one has no difficulty at all in obtaining heterocaryotic races by growing two individual races together. In this way it is possible to compare not only the morphological characters exhibited by unisexual or component races as compared with a heterocaryotic race composed of the same two individual races, but also their comparative growth rates can be accurately measured.

In order to secure fairly accurate growth rates of a large number of individual races a modification of what we are calling the Beadle and Tatum tubes are used.

The individual components of 80 bisexual races representing the full inheritance of 20 asci have been obtained by plating out conidia, hyphal fragments, or in the case of the double dwarfs, minute colonies. The growth rates of a number of bisexual races and of their individual components have been measured. While this work is only partially completed, there is evidence that the growth rates are probably not determined by single pairs of factors, although it is clear that such factors exist and that they are inherited in a Mendelian fashion. Individual homocaryotic races have been obtained which show a higher growth rate.

Following the talk, Dr. Mary Schmidt showed some of the experimental material. The meeting was adjourned at 4:35 p.m. Tea was then served by friends at the Garden.

Respectfully submitted,

Honor M. Hollinghurst
Recording Secretary

NEWS NOTES

The Council of the Torrey Botanical Club has decided to publish the papers presented at the Seventy-fifth Anniversary Celebration in the 1943 volume of Torreya. This volume will consist exclusively of these papers and of the Proceedings of the Club.

In furtherance of the effort to conserve quinine and seek for supplies of cinchona bark from Tropical America, Norman Taylor, the director of Cinchona Products Institute, of New York, is leaving soon for a survey of plantations and wild sources of bark. The trip, which includes the region from southern Mexico to Bolivia, has been authorized by the Board of Commissioners for the Netherlands East Indies. The chief object is to cooperate in the war effort both with governmental agencies and manufacturers so that adequate supplies of cinchona bark may be available.

A $1,000.00 fellowship for 1943-1944 is offered by Sigma Delta Epsilon, the Graduate Women's Scientific Fraternity. Applications and reference statements, both in triplicate, should be submitted before March 1, 1943, to the Fellowship Board.

Women with the equivalent of a Master's degree, conducting research in the mathematical, physical or biological sciences, who need financial assistance to complete their work for the doctorate, and give evidence of high ability and promise are eligible. During the term of her appointment the appointee must devote the major part of her time to the approved research project, and not engage in other work for remuneration (unless such work shall have received the written approval of the Board before the awarding of the fellowship or in any later emergency before any new work shall be undertaken).

Application blanks may be secured from Dr. Eloise Gerry (mark envelope "Personal"), care of U. S. Forest Products Laboratory, Madison, Wisconsin. Announcement of the award will be made early in April.

THE TORREY BOTANICAL CLUB

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John A. Small	W. Gordon Whaley	

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Cryptogams

Ferns and Fern Allies: R. C. Benedict, W. Herbert Dole, N. E. Pfeiffer
Mosses: E. B. Bartram
Liverworts: A. W. Evans, E. B. Matzke
Freshwater Algae: H. C. Bold
Marine Algae: J. J. Copeland
Fungi: A. H. Graves, J. S. Karling.
Lichens: J. W. Thomson, Jr.
Myxomycetes: R. Hagelstein

PUBLICATIONS EXCHANGE COMMITTEE

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OTHER PUBLICATIONS

OF THE

TORREY BOTANICAL CLUB

(1) BULLETIN

A journal devoted to general botany, established in 1870 and published monthly, except during July, August, and September. Vol. 68, published in 1941, contained 694 pages of text and 55 full page plates. Price $6.00 per annum. For Europe, $6.25.

In addition to papers giving the results of research, each issue contains the INDEX TO AMERICAN BOTANICAL LITERATURE—a very comprehensive bibliography of current publications in American botany. Many workers find this an extremely valuable feature of the BULLETIN.

Of former volumes, 24-68 can be supplied separately at $6.00 each; certain numbers of other volumes are available, but the entire stock of some numbers has been reserved for the completion of sets. Single copies (75 cents) will be furnished only when not breaking complete volumes.

(2) MEMOIRS

The MEMOIRS, established 1889, are published at irregular intervals. Volumes 1–18 are now completed. Volume 17, containing Proceedings of the Semi-Centennial Anniversary of the Club, 490 pages, was issued in 1918, price $5.00.

Volume 18, no. 1, 108 pages, 1931, price $2.00. Volume 18, no. 2, 220 pages, 1932, price $4.00. Volume 18 complete, price $5.00.

Volume 19, no. 1, 92 pages, 1937, price $1.50. Volume 19, no. 2, 178 pages, 1938, price $2.00.

(3) INDEX TO AMERICAN BOTANICAL LITERATURE

Reprinted monthly on cards, and furnished to subscribers at three cents a card.

Correspondence relating to the above publications should be addressed to

W. GORDON WHALEY,
Barnard College,
Columbia University,
New York, N. Y.

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EDITED FOR

THE TORREY BOTANICAL CLUB

BY

HAROLD H. CLUM

John Torrey, 1796-1873

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THE TORREY BOTANICAL CLUB

OFFICERS FOR 1943

MEMBERSHIP IN THE TORREY BOTANICAL CLUB

All persons interested in botany are invited to join the club. There are four classes of membership: *Sustaining,* at $15.00 a year; *Life,* at $100; *Annual,* at $5.00 a year and *Associate,* at $2.00 a year. The privileges of members, except *Associate,* are: (a) To attend all meetings of the club and to take part in the business, and (b) to receive its publications. *Associate* members have the privilege of attending meetings, field trips and of receiving the Schedule of the Field Trips and the Bulletin of the New York Academy of Sciences.

TORREYA

TORREYA was established in 1901 as a bi-monthly publication of the **Torrey Botanical Club** for shorter papers and interesting notes on the local flora range of the Club. It also contains the proceedings of the Club, reports of field trips, and some book reviews and news notes. The Council of the **Torrey Botanical Club** has decided to devote volume 43 of TORREYA, 1943, to the publication of the papers presented in June 1942 at the 75th Anniversary Celebration of the Club, and to the Proceedings of the Club. This volume will be published in two numbers instead of the usual six.

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Some Local Names of Plants—VIII *

W. L. McAtee

Correspondents have kindly continued to send local names of plants, and the writer has been able to glean many in the course of bibliographic research on birds. Noteworthy accumulations since the last report are here systematically recorded and alphabetically indexed. A short list of Literature Cited and suggestions toward a bibliography of plant vernaculars also are given. The order of the terms is chiefly that of Heller's "Catalogue of North American Plants," 2nd edit., 1900, and the nomenclature principally that of Britton and Brown's "Illustrated Flora," 2nd edit., 1936.

It may interest readers of Torreya that in 1881, W. R. Gerard, one of the editors of the Torrey Bulletin, announced an undertaking to collect and arrange the common names of United States plants (Amer. Nat. **15**:1000).

Literature Cited

Emory, W. H. 1848. Notes of a military reconnoissance from Fort Leavenworth, in Missouri to San Diego, in California. 30th Congress, 1st Session, Senate Document Ex. 7, 416 pp.

Contains chapters by John Torrey, pp. 135-156, and J. W. Abert, pp. 386-405, the few unusual names in which are here indexed.

Hearne, Samuel. 1911. A journey from Prince of Wales's Fort in Hudson's Bay to the Northern Ocean in the years 1769, 1770, 1771, and 1772 Champlain Society. Toronto, xv+437 pp., illus.

* All of this series have been published in Torreya, No. 1, in Vol. **13**: 225-236, 1913; No. 2, **16**:235-242, 1916; No. 3, **20**:17-27, 1920; No. 4, **26**:1-10, 1926; No. 5, **33**:81-86, 1933; No. 6, **37**:91-103, 1937; and No. 7, **41**:43-55, 1941.

Torreya for November-December (Vol. **42**, 153 to 201) was issued April 24, 1943.

Relatively few plant names, of which those for four species are cited in the present glossary.

Lynch, John J. 1942. Louisiana's state waterfowl refuges. 46 pp. Copies are on file with the Louisiana Department of Conservation and the U. S. Fish and Wildlife Service, Washington, D. C.

Contains many local names, both French and English, which for convenience are repeated in a 4-page terminal glossary. Terms not previously recorded in this series nor in the two standard sources mentioned are included in the present paper. They are annotated simply as "Louisiana, Lynch." Names not in this compilation, but received in correspondence from Lynch also are recorded.

Massey, A. B., and R. D. Hatch. 1942. Poisonous plants x x x of Virginia x x x. Va. Polytechnic Institute, 38 pp. mimeographed.

Richardson, John. 1851. Arctic Searching Expedition: a journal of a boat-voyage through Ruperts' Land and the Arctic Sea, etc. 2 vols. London.

Contains names of all plants observed and vernacular names for most of them: Indian, Eskimo, French, and English. Many of the latter are close to or the same as the modern standard names. Hence only a few of the most peculiar or interesting terms are cited in the following glossary.

Wied, Maxmilian, Prinz zu. 1839-41. Reise in das innere Nord-America in den Jahren 1832 bis 1834. Coblenz, 2 vols.

Many German and English and some French and Indian names for plants. A good proportion are scarcely identifiable. The names here quoted from this work are noted as, "Weid, Reise, Vol. ——, p. ——."

As a contribution toward a bibliography of publications dealing significantly with plant names, the following titles may be cited in addition to those given in previous installments.

Bibliography

Ashe, Thomas. 1808. Travels in America, performed in 1806, etc. Contains lists of medicinal, esculent, ornamental, and useful plants, giving both Linnean and popular names.

Barton, B. S. 1798. Collections for an essay towards a materia medica of the United States. Philadelphia.

Bellrose, Frank C. 1941. Duck food plants of the Illinois River Valley. Ill. Nat. Hist. Survey, Bul. **21**(8) Aug.: 235-280, illus. An appendix (p. 280) lists numerous local names of marsh and aquatic plants.

Boucher, Pierre. 1882. Histoire veritable et naturelle des Moeurs et Productions du Pays de la Nouvelle—France. Montreal, ii+164 pp. This reprint of a work first published in 1663, contains chapters on the woody plants and on plants cultivated in New France.

Brown, Thomas. 1835. Illustrations of the American Ornithology of Alexander Wilson x x x with x x x representations of the whole sylva of North

America. Quarto. London, iii, pp., 124 col. pls. Mtehodical disposition of the North American sylva, p. iii, has both scientific and vernacular names, some of the latter unusual.

Carlson, G. G., and V. H. Jones. 1939 (1940). Some notes on the uses of plants by the Comanche Indians. Papers Mich. Acad. Sci., Arts, and Letters, **25**:517-542. Includes vernacular English and Comanche names.

Carver, J. 1779. Travels through the interior parts of North America in the years 1766, 1767, and 1768. Chapter 19, pp. 494-526, devoted to trees, shrubs, roots, herbs, etc., names numerous kinds and recognizably describes most of them.

Catesby, Mark. 1771. The natural history of Carolina, Florida, and the Bahama Islands, etc. 2 vols., 220 col. pls. This is a cornerstone of American natural history. It treats plants as numerously as animals. Many of the vernacular names it employs are still in use and a high proportion of all are identifiable as the plants are for the most part adequately illustrated.

Cooper, J. G. 1859. On the distribution of the forests and trees of North America, with notes on its physical geography. Ann. Rep. Smithsonian Inst. for 1858, pp. 246-280. A catalogue in tabular form (pp. 250-266) includes vernacular names, some of which are not noted in Sudworth's "Check List," 1927.

Coxe, John Redman. 1814. The American dispensatory, etc. 3rd edit. Philadelphia.

Eisenberger, N. F., and G. Lichtensteger. 1750. Piscium, serpentium, insectorum x x x quas Marcus Catesby in x x x Carolinae, Floridae x x x tradidit, etc. 102 pp., 100 col. pls. This volume treats the Catesby material in the Latin and German languages.

Fernald, M. L. 1910. Notes on the plants of Wineland the Good. Rhodora **12**:17-38. Digest of early literature of which numerous titles are cited.

Ganong, W. F. 1910. The identity of the animals and plants mentioned by the early voyagers to Eastern Canada and Newfoundland. Proc. & Trans. Roy. Soc. Canada, Ser. 3(3), 1909, Sect. II, pp. 197-242. Assembles information from about two dozen earlier authors and editors.

Henry, Samuel. 1814. A new and complete American Medical Family Herbal, etc. New York.

Hitchcock, Edward. 1833. Catalogue of plants growing without cultivation. Rep. on the Geol., etc., of Massachusetts, pp. 599-651. Contains many vernacular names, some exceptional.

Jefferson, Thomas. 1854. Notes on Virginia. The writings of ———, edited by H. A. Washington. Vol. 8, pp. 281-285. Any of numerous editions of this work would serve.

Lamb, Wm. H. 1937. Virginia trees. I.—The conifers. Manassas, 112 pp., 82 figs.

Macoun, John. 1882. Manitoba and the great North-west, etc. Guelph, xxii+687 pp., illus. Some of the names, particularly of grasses and sedges, are probably here printed for the first time.

McAtee, W. L. 1941. Some local names of Plants—VII. Torreya, **41** (March-April):43-55. Preceding installment of the present series.

————. 1941. Names of American plants in books on Kalm's travels. Torreya, **41** (Sept.-Oct.):151-160. References to 8 source books, and systematic list of names in several languages.

Medsger, O. P. 1939. Edible wild plants. xv+323 pp., 19 pls., 80 figs.

Nehrling, Heinrich. 1891. Die nordamerikanische Vogelvelt. xxx+638 pp., 36 col. pls., 10 figs. Contains German vernaculars for numerous American plants, scientific names for which are given in footnotes.

du Pratz, Le Page. 1758. Histoire de la Louisiane, etc. Paris, 3 vols. The native plants are chiefly treated in Vol. 2, pp. 1-65 with descriptions and illustrations sufficient for identification of most of them.

Provancher, L. A. 1862. Flore canadienne; ou description de toutes les plantes x x x du Canada, etc. Quebec. 2 vols.

Read, Wm. A. 1931. Louisiana-French. Louisiana State University Studies, No. 5, xxiv+253 pp. Contains numerous French and Indian plant names and some of other derivations; has a full bibliography and index.

Russell, John L. 1862. [Plants mentioned in Josselyn's New England's Rarities discovered, etc.]. Proc. Essex Inst., **2**: 95-115. Identified so far as practicable.

Saunders, C. F. 1920. Useful wild plants of the United States and Canada. viii+275 pp., 69 figs., 20 pls.

Schmitt, Joseph. 1904. Monographie de l'Ile d'Anticosti (Golfe Saint-Laurent). Botanique, pp. 129-234. Records numerous French names, some of them provincial.

Seligmann, J. M. and M. Houttuyn. 1772-81. Verzameling van uitlandsche en zeldzame Vogeln x x x beschreven x x x door G. Edwards en M. Catesby. Amsterdam, 5 vols. The first volume containing all of the Catesby material has names of American plants in both "Hoog-" and "Neder-duitsch."

Zimmerman, E. A. W. (Transl. & Editor). 1793. William Bartram's Reisen durch Nord- und Sud-Karolina, Georgien, Ost- und West-Florida, etc. Berlin, xxvi+469 pp., 7 pls. The hundreds of plant names in this work will have to be taken into consideration in any compilation of names of American plants that aims at completeness.

Glossary

Laminariaceae. 1. *Laminaria* spp.—Devil's-apron, C. W. Townsend (Captain Cartwright and his Labrador Journal, 1911, p. 257).

Salviniaceae. 2. *Azolla caroliniana* Willdenow.—Water-velvet, Louisiana, C. Cottam.

Equisetaceae. 3. *Equisetum hyemale* L.—Schachtelhalm (Wied, Reise, **1**: 261).

Pinaceae. 4. *Pinus banksiana* Lambert.—Cyprès of the French voyagers (Richardson, Arctic Searchings Exp. **2**:315, 1851) and of the halfbreeds, Canada (Frank Russell, Explorations in the far North, 1898, p. 103).

5. *Pinus virginiana* Miller.—Yellow pine, John Burroughs (Winter Sunshine, 1895 edit., p. 20).
6. *Larix laricina* Du Roi.—Epinette rouge (French voyagers); wagginagan (tree that bends; Crees) (Richardson, Arctic Searching Exp. **2**:318, 1851); "commonly called juniper in Hudson's Bay." (Hearne, Journey, 1911 edit., p. 64).
7. *Picea canadensis* Miller.—Epinette blanche (French voyagers); minahik (Crees) (Richardson, Arctic Searching Exp. **2**:316, 1851).
8. *Tsuga canadensis* L.—Canadian fir, Cambria County, Pa., R. M. S. Jackson (The Mountain, 1860, p. 224).
9. *Thuja occidentalis* L.—Lebensbaum (Wied, Reise, **2**:401).
10. *Chamaecyparis thyoides* L.—Sweet cedar (Richardson, Arctic Searching Exp. **1**:68, 1851).
11. *Juniperus horizontalis* Moench. ("repens").—Kriechende Wacholder (Wied, Reise, **1**:389).
12. *Juniperus sibirica* Burgsdorff.—Caw-caw-cue-minick (crowberry) (Hearne, Journey, 1911 edit., p. 413).
13. *Juniperus virginiana* L.—Rothe Ceder (Wied, Reise, **1**:220).

TYPHACEAE. 14. *Typha latifolia* L.—Cat's-tail; queue de renard, Eugéne Bazin (Scenes de la nature dans les Etats-Unis, 1857, 2, p. 144).

15. *Typha* spp.—Queue de chat, flat rush, jonc plat, jonc matelas, Louisiana, Lynch.

ZOSTERACEAE. 16. *Zostera marina* L.—Herbe à l'anguille, Eugéne Bazin (Scenes de la nature dans les Etats-Unis, 1857, 2, p. 393); herbe à outarde, Joseph Schmitt (Monographie de l'Ile d'Anticosti, 1904, p. 298).

ZANNICHELLIACEAE. 17. *Potamogeton foliosus* Rafinesque.—Gray-duck grass, herbe canard-gris, Louisiana, Lynch.

18. *Potamogeton pectinatus* L.—Herbe fine, Louisiana, Lynch.

ALISMACEAE. 19. *Sagittaria lancifolia* L.—Bull-tongue, langue du boeuf, Louisiana, Lynch.

20. *Sagittaria* spp.—White bull-tongue, Louisiana, C. Cottam.

VALLISNERIACEAE. 21. *Vallisneria spiralis* L.—Herbe aux canards, Eugéne Bazin (Scenes de la nature dans les Etats-Unis, 1857, 2, p. 383).

GRAMINEAE. 22. *Paspalum distichum* L.—Lake grass, Louisiana, Lynch.

23. *Panicum dichotomiflorum* Michaux.—Sour grass, Allen County, Kansas, Philip F. Allan.
24. *Panicum hemitomon* Schultes.—Little cane, canouche, Louisiana, Lynch.
25. *Panicum repens* L.—Dogtooth grass, dent du chien, Louisiana, Lynch.
26. *Panicum virgatum* L.—Yellow grass, paille jaune, Louisiana, Lynch.
27. *Echinochloa walteri* Pursh.—Riz de l'âne, riz farouche, riz sauvage, Louisiana, Lynch.
28. *Zizaniopsis miliacea* Michaux.—Jonc coupant, Louisiana, Lynch; knife flag, southeastern Missouri, A. F. Satterthwait (Ecology **2**:201, 1921).

29. Zizania aquatica L.—Black rice, among a dozen names listed by Chas. E. Chambliss (Journ. Washington Acad. Sci., **30**(5): May 1940) is additional to those usually recorded; wilde Reiss (Wied, Reise, **2**:83).

30. *Spartina alterniflora* Loiseleur-Deslongechamps.—Salt-marsh, coastal South Carolina, C. Cottam; sea cane, canne du mer, coastal Louisiana, Lynch.

31. *Spartina cynosuroides* L.—Cane-marsh, coastal South Carolina, C. Cottam.; hog cane, canne au cochon, quill cane, coastal Louisiana, Lynch.

32. *Spartina patens* Aiton.—Wildcat grass, paille chat-tigre, wire grass, coastal Louisiana, Lynch.

33. *Spartina spartinae* Trinius.—Sacahuista, Louisiana, C. Cottam.

34. *Bulbilis dactyloides* Nuttall.—Prairie hay, northern Great Plains, A. A. Taché (Sketch of n. w. America, 1870, p. 10).

35. *Phragmites phragmites* L.—Roseau cane, coastal Louisiana, Lynch.

36. *Distichlis spicata* L.—Paille salé, Louisiana, Lynch.

CYPERACEAE. 37. *Scirpus acutus* Muhlenberg.—Moses weed, New Mexico, C. Cottam.

38. *Scirpus californicus* Meyer.—Blue grass, Louisiana, C. Cottam; bull-whip, fouet, jonc rond, round rush, Louisiana, Lynch.

39. *Scirpus olneyi* A. Gray.—Paille d'oie, jonc au trois quarts, Louisiana, Lynch.

40. *Scirpus robustus* Pursh.—Coco, coco grass, Louisiana, C. Cottam, Lynch; leafy three-square, three-cornered grass, Louisiana; turks-head, coastal South Carolina, C. Cottam.

41. *Cladium jamaicense* Crantz.—Redtop, jonc coupant, Louisiana, Lynch.

ARACEAE. 42. *Arisaema triphyllum* L.—Plant-of-peace, N. N. Puckett (Folk beliefs of the southern negro, 1926, p. 245).

43. *Peltandra glauca* Elliott.—Cruel man-of-the-woods, N. N. Puckett (Folk beliefs of the southern negro, 1926, p. 245).

PONTEDERIACEAE. 44. *Pontederia cordata* L.—Bull-tongue, langue du boeuf. Louisiana, Lynch; blue bull-tongue, Louisiana, C. Cottam.

JUNCACEAE. 45. *Juncus roemerianus* Scheele.—Jonc negre, jonc piquant, fouet, whip, Louisiana, Lynch; needle grass, salt rush, coastal South Carolina, C. Cottam.

LILIACEAE. 46. *Lilium canadense* L.—Bitter-root; tra-chin (of the Carrier Indians), J. K. Lord (The naturalist in x x x British Columbia, 1866, 2, p. 228).

47. *Erythronium americanum* Ker.—Easter lily, Allen County, Kansas, Philip F. Allan; "fawn lily would be better than adder's tongue. Still better is the name 'trout-lily,' which has recently been proposed," John Burroughs (Riverby, 1895 edit., p. 25); common fawn lily, Robert B. Troxel (Pennsylvania Game News **13**(1):26, April 1942.

CONVALLARIACEAE. 48. *Clintonia borealis* Aiton.—Bear's corn, Maine, John Burroughs (Signs and Seasons, 1895 edit., p. 125); Canada may-flower, Richard L. Weaver (New Hampshire Troubador **10**(6):8 Sept. 1940.

TRILLIACEAE. 49. *Trillium erectum* L.—Red death, P. H. Gosse (Canadian Naturalist (book), 1840, p. 160).

50. *Trillium ovatum* Pursh.—Herb Paris, Oregon (Richardson, Arctic Searching Exp. **2**:229, 1851.

51. *Trillium undulatum* Willdenow.—White death, P. H. Gosse (Canadian Naturalist (book), 1840, p. 160).

JUGLANDACEAE. 52. *Juglans nigra* L.—Schwarz Wallnussbaum (Wied, Reise, **1**:122).

MYRICACEAE. 53. *Myrica cerifera* L.—Wachsbaum (Wied, Reise, **1**:171).

SALICACEAE. 54. *Salix lucida* Muhlenberg.—Schmalblättrige Weide (Wied, Reise, **1**:81).

55. *Salix purpurea* L.—Rothe Weide (Wied, Reise, **1**:191).

BETULACEAE. 56. *Betula papyrifera* Marsh.—Papier-Birke (Wied, Reise, **2**:81).

FAGACEAE. 57. *Fagus grandifolia* Earhart.—White, red, mountain, and water beech, for assumed varieties, Cambria County, Pa., R. M. S. Jackson (The Mountain, 1860, p. 221).

58. *Quercus phellos* L.—Weideneiche, weiden-blätterige Eiche (Wied, Reise, **2**:377, **1**:145).

59. *Quercus prinus* L.—Kastanien-Eiche (Wied, Reise, **1**:56).

60. *Quercus stellata* Wangenheim.—Spalt oak, Geo. H. Cook (Geology of Cape May, N. J., 1867, p. 75).

ULMACEAE. 61. *Ulmus thomasi* Sargent ("suberosa").—Wahu-Ulme (Wied, Reise, **1**:309).

MORACEAE. 62. *Papyrius papyrifera* L.—Papier-Maulbeerbaum (Wied, Reise, **1**:40).

ARISTOLOCHIACEAE. 63. *Aristolochia serpentaria* L.—Schlangenwurzel (Wied, Reise, **1**:75).

POLYGONACEAE. 64. *Polygonum* spp.—Curage, Louisiana, Lynch.

CHENOPODIACEAE. 65. *Salicornia* spp.—Baloney-grass, salt-grass, San Luis Obispo, California, C. Cottam; sea-fennel, Thos. F. De Voe (The Market Assistant, 1867, p. 365).

66. *Salsola kali* L.—Tumbleweed, Texas, V. W. Lehmann (Wildlife Review **22**:41, 1939).

AMARANTHACEAE. 67. *Acnida alabamensis* Standley.—Chou gras, Louisiana, Lynch.

PHYTOLACCACEAE. 68. *Phytolacca decandra* L.—Crow-berry, chou gras, red-ink berry, Doris M. Cochran (Nature Mag. **35**(2):74, Feb. 1942; Kermesbeere (Wied, Reise, **1**:33).

NYCTAGINACEAE. 69. *Allionia nyctaginea* Michaux.—Snotweed, Allen County, Kansas, Philip F. Allan.

NELUMBONACEAE. 70. *Nelumbo lutea* Willdenow.—Big bonnet, Mississippi, C. Cottam; lily-nut, Maurice Thompson (Byways and Bird Notes, 1885, p. 103).

CABOMBACEAE. 71. *Brasenia schreberi* Gmelin.—Small bonnet, Mississippi, C. Cottam.

NYMPHAEACEAE. 72. *Castalia elegans* Hooker.—Pagayeur, Louisiana, Lynch.

73. *Castalia flava* Leitner.—Herbe au coeur, Louisiana, Lynch.

74. *Castalia odorata* Dryander.—Beaver root, J. G. Millais (Newfoundland and its untrodden ways, 1907, p. 236); pagayeur, Louisiana, Lynch.

75. *Nymphaea advena* Solander.—Can-dock, splatter-dock, Philadelphia, Pa., B. S. Barton (A discourse on x x x Nat. Hist., 1807, p. 48).

MAGNOLIACEAE. 76. *Magnolia virginiana* L.—Spoonwood, Geo. H. Cook (Geology of Cape May, N. J., 1867, p. 76).

77. *Liriodendron tulipifera* L.—Tulpenbaum (Wied, Reise, **1**:48; wild poplar, Cambria County, Pa., R. M. S. Jackson (The Mountain, 1860, p. 227).

78. *Illicium floridanum* Ellis.—Aniseed tree, H. B. Croom (Amer. Journ. Sci. & Arts **26**:319, 1834).

ANNONACEAE. 79. *Asimina triloba* L.—Hoosier banana, Indiana.

RANUNCULACEAE. 80. *Actaea alba* L.—Racine d'ours (French Canadians); musqua-mitsu-in (bear's food, Crees) (Richardson, Arctic Searching Exp. **1**:82, 1851).

81. *Aconitum napellus* L.—Queen's fettle, Great St. Lawrence, Nfd., J. G. Millais (Newfoundland and its untrodden ways, 1907, p. 144).

82. *Hepatica hepatica* L.—Red coon-root, N. N. Puckett (Folk beliefs of the southern negro, 1926, p. 375).

83. *Pulsatilla patens* L.—Rothe Kalbsblume (translation of an Indian name meaning red calf-flower) (Wied, Reise, **2**:314).

LAURACEAE. 84. *Benzoin aestivale* L.—Gewurzholz (Wied, Reise, **1**:223).

FUMARIACEAE. 85. *Bicuculla cucullaria* L.—Staggerweed, Virginia (Massey and Hatch, 1942, p. 6). The authors record this name as being applied also to *Bicuculla canadensis* Goldie, *Capnoides flavulum* Rafinesque, and *Delphinium tricorne* Michaux.

CRUCIFERAE. 86. *Draba caroliniana* Walter.—Shad-blossom, Philadelphia, Pa., B. S. Barton (A discourse on x x x Nat. Hist., 1807, p. 28).

HYDRANGEACEAE. 87. *Hydrangea quercifolia* Bartram.—Swamp snow-ball, B. L. C. Wailes (Rep. Agr. Geol. Miss., 1854, p. 344).

ALTINGIACEAE. 88. *Liquidambar styraciflua* L.—Storaxbaum (Wied, Reise, **1**:31).

HAMAMELIDACEAE. 89. *Hamamelis virginiana* L.—Zauberhaselnuss (Wied, Reise, **2**:343).

PLATANACEAE. 90. *Platanus occidentalis* L.—Wasser-Ahorn, Wasser-Buche, Germans in Pennsylvania (Wied, Reise, **1**:72).

ROSACEAE. 91. *Spiraea latifolia* Aiton.—Wiedenblätterige Spierstande (Wied, Reise, **1**:81).

92. *Rubus chamaemorus* L.—Bethago-tominick (Crees); dewater berry (Hearne, Journey, 1911 edit., p. 411).

93. *Rubus deliciosus* James.—False raspberry (Colorado Agr. Exp. Sta. Bul. 445:35, 1938). Commenting on the book name *Boulder* rasp-

berry, the late Francis Ramaley wrote me (Feb. 21, 1941), "I have lived in Boulder for forty years and never heard this bush called anything but 'Thimbleberry'—never the word 'Boulder' attached to it."

94. *Rubus lasiococcus* Gray.—Fuzzy mountain-dewberry, Oregon, Helen M. Gilkey.

95. *Rubus nivalis* Douglas.—Small mountain-blackberry, Oregon, Helen M. Gilkey.

96. *Rubus pedatus* Smith.—Red mountain-dewberry, Oregon, Helen M. Gilkey.

MALACEAE. 97. *Malus fusca* Rafinesque ("rivularis").—Powitch tree (Richardson, Arctic Searching Exp. **2**:294, 1851). This is from the Chinook, pauitsh.

98. *Amelanchier canadensis* L.—Bois de flèche, French voyagers (Richardson, Arctic Searching Exp. **2**:294, 1851).

AMYGDALACEAE. 99. *Laurocerasus caroliniana* Miller.—Lauria mundi, B. L. C. Wailes (Rep. Agr. Geol. Miss., 1854, p. 342).

100. *Padus virginiana* L.—Traubenkirsch (Wied, Reise, **1**:291).

MIMOSACEAE. 101. *Morongia uncinata* Willdenow.—Saw-brier, Thomas Nuttall (Travels into the Arkansa Territory, 1821, p. 180).

CAESALPINACEAE. 102. *Cercis canadensis* L.—Shad-Blossom, Philadelphia, Pa., B. S. Barton (A discourse on x x x Nat. Hist., 1807, p. 28).

103. *Gymnocladus dioica* L.—Bonduc, Edwin James (Long's Exp. Rocky Mts., Thwaites edit., 1905, Pt. 1, p. 213).

104. *Hoffmannseggia* sp.—Chufa (from the root nodules), mesquite weed, Hansford County, Texas, Philip F. Allan.

FABACEAE. 105. *Baptisia leucantha* Torrey and Gray.—Prairie indigo, J. W. Abert (in Emory, W. H., Military Reconnaissance, 1848, p. 399).

106. *Psorolea esculenta* Pursh.—Wild turnip (Wied, Reise, **1**:321).

107. *Amorpha fruticosa* L.—Pride-of-Barbadoes, B. L. C. Wailes (Rep. Agr. Geol. Miss., 1854, p. 343).

108. *Parosela dalea L.*—Woods clover, Allen County, Kansas, Philip F. Allan.

109. *Sesban macrocarpa* Muhlenberg.—Indigo, acacie, Louisiana, Lynch.

110. *Daubentonia drummondii* Rydberg.—Coffee bean, Louisiana, Lynch. This term and coffee weed are applied in various parts of the South to almost any conspicuous wild legume.

111. *Astragalus emoryanus* Rydberg.—Red-stemmed peavine, Texas, Frank P. Matthews (Journ. Amer. Veterinary Med. Assoc. **97**:125, 1940).

112. *Meibomia* sp.—Wood sage, Allen County, Kansas, Philip F. Allan.

113. *Alysicarpus vaginalis* L.—Alice clover, Herbert L. Stoddard (6th Ann. Rep. Cooperative Quail Study Assoc., 1938, p. 10).

114. *Lespedeza striata* Thunberg.—Buffalo, Carolina, China, Georgia, and oldfield, clover, southeastern States, J. W. Kistler (N. C. Wildlife Conservation 4(12):5, Dec. 1940).

115. *Vicia angustifolia* L.—Augusta vetch, Herbert L. Stoddard (7th Ann. Rep. Cooperative Quail Study Assoc., 1939, p. 16).

116. *Lathyrus hirsutus* L.—Wild winter-pea, Herbert L. Stoddard (7th Ann. Rep. Cooperative Quail Study Assoc., 1939, p. 18).

ZYGOPHYLLACEAE. 117. *Covillea tridentata* De Candolle.—Iodeodondo of the Mexicans, John Torrey (in Emory W. H., Military Reconnoissance, 1848, p. 138).

MELIACEAE. 118. *Melia azedarach* L.—Bead tree, John Latham (Gen. Hist. Birds, 5, 1822, p. 145).

EUPHORBIACEAE. 119. *Croton capitatus* Michaux.—Bighead doveweed, Oklahoma, Verne Davison (Wildlife Review **22**:38, 1939); billy-goat weed, hogwort, Herbert L. Stoddard (3rd Ann. Rep. Cooperative Quail Study Assoc., 1936, p. 14).

120. *Croton texensis* Klotzsch.—Texas doveweed, Verne Davison (Wildlife Review **22**:38, 1939).

121. *Euphorbia lathyrus* L.—Sassy Jack, mountains of Virginia (Massey and Hatch, 1942, p. 5).

EMPETRACEAE. 122. *Empetrum nigrum* L.—Black-berried heath, John Latham (Gen. Hist. Birds, 10, 1824, p. 261); black crake-berry, G. G. Macdougall, Transl. (Graah, W. A., Narrative of an Expedition to the east coast of Greenland, 1837, p. 135); nischa-minnick (Gray-goose berry, Crees), Hearne (Journey, 1911, p. 411).

123. *Ceratiola ericoides* Michaux.—Sand hill rosemary, H. B. Croom (Amer. Journ. Sci. & Arts **26**:315, 1834).

ANACARDIACEAE. 124. *Schinus terebinthifolius* Raddi.—Brazilian or Mexican pepper-tree, Florida holly, Vero Beach, Florida.

125. *Rhus hirta* L.—Hirschkolbenbaum (Wied, Reise, **2**:18).

126. *Rhus trilobata* Nuttall.—Squaw berry, southern Utah, C. Cottam.

CYRILLACEAE. 127. *Cliftonia monophylla* Lamarck.—Buck-wheat tree, H. B. Croom (Amer. Journ. Sci. & Arts **26**:319, 1834).

ILACACEAE. 128. *Ilex cassine* L.—Yapa shrub, John Latham (Gen. Hist. Birds, 5, 1822, p. 142).

129. *Ilex decidua Walter*.—Swamp spice, B. L. C. Wailes (Rep. Agr. Geol. Miss., 1854, p. 344).

STAPHYLEACEAE. 130. *Staphylea trifolia* L.—Dreiblätterige Pimpernuss (Wied, Reise, **1**:294).

ACERACEAE. 131. *Acer negundo* L.—Manitoba maple, Ottawa, Canada.

VITACEAE. 132. *Vitis cordifolia* Michaux.—Choke grape, B. L. C. Wailes (Rep. Agr. Geol. Miss., 1854, p. 346).

TILIACEAE. 133. *Tilia heterophylla* Ventenat ("grandifolia").—Grossblätterige Linde (Wied, Reise, **1**:145).

MALVACEAE. 134. *Hibiscus grandiflorus* Michaux.—Cotton rose, B. L. C. Wailes (Rep. Agr. Geol. Miss., 1854, p. 346).

TAMARICACEAE. 135. *Tamarix gallica* L.—Salt cedar, coastal Louisiana, Lynch.

136. *Fouquiera splendens* Engelmann.—Boojum tree, Superior, Arizona, H. K. Gloyd (Chicago Naturalist **3**(3):73, Oct., 1940).

PASSIFLORACEAE. 137. *Passiflora incarnata* L.—Apricot, the fruit or maypop, Margaret W. Morley (The Carolina Mountains, 1913, p. 68).

CACTACEAE. 138. *Opuntia bigelovii* Engelmann.—Teddy-bear cholla, Superior, Arizona, H. K. Gloyd (Chicago Naturalist **3**(3): 71, Oct., 1940).

139. *Opuntia fulgida* Engelmann.—Jumping cholla, Superior, Arizona, H. K. Gloyd (Chicago Naturalist **3**(3):71, Oct., 1940).

140. *Opuntia polyacantha* Haworth ("glomerata").—Crapaud vert, French voyagers (Richardson, Arctic Searching Exp. **2**:279, 1851).

ELAEAGNACEAE. 141. *Elaeagnus argenta* Pursh.—Stinking willow (fur traders); Tàp-pah (gray berry, Chepewyans) (Richardson, Arctic Searching Exp. **1**:145, 1851); silvery oleaster (ibid. p. 199); napowmuskwaniman (white bear-berry, Crees) (Op. cit. **2**:307, 1851).

142. *Lepargyraea argentea* Nuttall.—Wied (Reise, **2**:80) wrote "Graines de boeuf," considering "graisse de boeuf" an error; he was mistaken, however, as the name "beef-suet tree" indicates.

ONAGRACEAE. 143. *Chamaenerion latifolium* L.—Indian wickup, P. H. Gosse (Canadian Naturalist (book), 1840, p. 298).

ARALIACEAE. 144. *Aralia racemosa* L.—King-of-the-woods, N. N. Puckett (Folk beliefs of the southern negro, 1926, p. 246).

145. *Aralia spinosa* L.—Devil's-club, Cambria County, Pa., R. M. S. Jackson (The Mountain, 1860, p. 237).

AMMIACEAE. 146. *Hydrocotyle ranunculoides* L. f.—Water parsley, parasol, Louisiana, Lynch.

147. *Cicuta maculata* L.—California fern, Virginia (Massey and Hatch, 1942, p. 18); carrotte de Moreau (after a man who died from eating the root), manito-skatask, Crees (Richardson, Arctic Searching Exp. **1**:95, 1851).

148. *Sium cicutaefolium* Schrank.—Queue de rat, French Canadians; uskotask, Crees (Richardson, Arctic Searching Exp. **1**:95, 1851).

149. *Heracleum lanatum* Michaux.—Alexander, C. W. Townsend (Captain Cartwright and his Laborador Journal, 1911, p. 82).

CORNACEAE. 150. *Cornus amomum* Miller.—Hartriegel (Wied, Reise, **1**:326).

151. *Cornus stolonifera* Michaux.—Osier rouge (Richardson, Arctic Searching Exp. **2**:273, 1851).

ERICACEAE. 152. *Dendrium buxifolium* Berg.—Heather, Margaret W. Morley (The Carolina Mountains, 1913, p. 253).

153. *Ledum groenlandicum* Oeder.—Indian tea, P. H. Gosse (Canadian Naturalist (book), 1840, p. 300).

154. *Kalmia latifolia L.*—Ivy, Margaret W. Morley (The Carolina Mountains, 1913, p. 56).

155. *Xolisma ligustrina* L.—Male berry, staggerbush, Virginia (Massey and Hatch, 1942, p. 15). The authors note that the second name is used also for *Leucothoë catesbaei* Walter.

156. *Gaultheria humifusa* Graham.—Mountain wintergreen, Oregon, Helen M. Gilkey.

157. *Gaultheria procumbens* L.—Pine ivy, Thos. F. De Voe (The Market Assistant, 1867, p. 394).

158. *Uva-ursi uva-ursi L.*—Graine d'ours (bear-berry), sac a commis, Bear Lake, Canada, George Keith (in Masson, L. R., Les Bourgeois de la Compagnie du Nord-Ouest, 2, 1890, p. 102); sakakomi, Sakkakomi-Pflanze (Wied, Reise, **2**:81, and **1**:445).

159. *Vaccinium ovalifolium* Smith.—Tall blue huckleberry, Oregon, Helen M. Gilkey.

160. *Vaccinium ovatum* Pursh.—Evergreen huckle-berry, Oregon, Helen M. Gilkey.

161. *Vaccinium parvifolium* Smith.—Peacock berry. W. L. Dawson (Birds of Washington, 2, 1909, p. 577); red huckleberry, Oregon, Helen M. Gilkey.

162. *Vaccinium uliginosum* L.—Ground whortle (old name), whorts (new name), C. W. Townsend (Captain Cartwright and his Labrador Journal, 1911, p. 34).

Sapotaceae. 163. *Bumelia tenax* L.—Sloe berry, coastal Georgia, C. Cottam.

Ebenaceae. 164. *Diospyros virginiana* L.—American medlar, Thos. F. De Voe (The Market Assistant, 1867, p. 386).

Oleaceae. 165. *Forsythia* sp.—" 'Sunshine bush,' it deserves to be called," Bradford Torrey (Clerk of the Woods, 1903, p. 2).

166. *Forestiera neo-mexicana* A. Gray.—Wild olive, New Mexico, A. E. Borell.

Gentianaceae. 167. *Frasera carolinensis* Walter ("waltheri").—Falsche Colombo-wurzel (Wied, Reise, **1**:170).

Apocynaceae. 168. *Apocynum androsaemifolium* L.—Angel's turnip, N. N. Puckett (Folk beliefs of the southern negro,* 1926, p. 245); herb à la puce (from its irritating effects); this name applied also to *A. sibiricum* Jacquin (*hypericifolium* Aiton) (Richardson, Arctic Searching Exp. **1**:121, 1851).

Convolvulaceae. 169. *Convolvulus arvensis* L.—Possession vine, Texas Panhandle, Philip F. Allan; tie vine, B. L. C. Wailes (Rep. Agr. Geol. Miss., 1854, p. 344).

Labiatae. 170. *Mentha spicata* L.—Green mint, Thos. F. De Voe (The Market Assistant, 1867, p. 364).

Solanceae. 171. *Solanum carolinense* L.—Tread saft, N. N. Puckett (Folk beliefs of the southern negro, 1926, p. 246).

172. *Lycopersicon lycopersicon* L.—Liebesapfel (Wied, Reise, **1**:191).

173. *Datura stramonium* L.—Stechapfel (Wied, Reise, **1**:33).

174. *Nicotiana quadrivalvis* Pursh.—Mánascha (Mandan Indians), Tabacks-pflanze (Wied, Reise, **2**:90 and 122).

Bignoniaceae. 175. *Catalpa catalpa* L.—Petalfra ("which as well as catalpa, the received appellation, may be a corruption from Catawba, the name of the tribe by whom x x x the tree may have been intro-

* Some obvious misidentifications in this book have been excluded, and possibly the records under Nos. 43 and 168 also should have been rejected.

duced"), Smithland, Kentucky. Edwin James (in Long's Exp. to Rocky Mts., Thwaits edit., 1905, Part I, p. 84).

MARTYNIACEAE. 176. *Martynia louisiana* Miller.—Cuckold's horns, Edwin James (in Long's Exp. to the Rocky Mts., Thwaites edit., 1905, Part 2, p. 44).

CAPRIFOLIACEAE. 177. *Viburnum lentago* L.—Partridge berry, Thos. F. De Voe (The Market Assistant, 1867, p. 384).

178. *Viburnum opulus* L.—Mongsö-a mina (moose-berry, Crees); dunnè-ki-e (Indian berry, Dog-rib and Hare Indians) (Richardson, Arctic Searching Exp. **1**:120 and **2**:298, 1851).

179. *Viburnum pauciflorum* Pylaie.—Pembina, French voyagers; nipi-minan (water-berry, Crees) (Richardson, Arctic Searching Exp. **1**:120, 1851, and **2**:298). This allocation of the term pembina, is more probably correct than that quoted from Clapin under No. 157 in the preceding installment.

CUCURBITACEAE. 180. *Pepo foetidissima* Humbolt, Bonpland, and Kunth.—Prairie gourd, J. W. Abert (in Emory, W. H., Military Reconnoissance, 1848, p. 398).

CICHORIACEAE. 181. *Nabalus albus* L. ("rubicunda").—Löwenherz (Wied, Reise, **1**:75).

182. *Nabalus serpentarius* Pursh.—Gall-of-the-earth, B. L. C. Wailes (Rep. Agr. Geol. Miss., p. 346).

AMBROSIACEAE. 183. *Ambrosia elatior* L.—Short ragweed, Oklahoma, Verne Davison (Wildlife Review **22**:38, 1939); Georgia, Herbert L. Stoddard (op. cit. p. 43).

184. *Xanthium* sp.—Cuckold bur, Thomas Nuttall (Travels into the Arkansa Territory, 1821, p. 58).

COMPOSITAE, 185. *Laciniaria pycnostachya* Michaux.—Kansas gayfeather, Allen County, Kansas, Philip F. Allan; pinette de prairie, J. W. Albert (in Emory, W. H., Military Reconnoissance, 1848, p. 398). Should be epinette.

186. *Gutierrezia* spp.—Fireweed, lightning-brush, Utah, C. Cottam.

187. *Grindelia squamosa* Pursh.—Epinette de prairie (Wied, Reise, p. 517). See 185; while these authorities differ, both may have correctly recorded usage.

188. *Heterotheca grandiflora* Nuttall.—Telegraph weed, Santa Cruz County, Calif., A. C. Hawbecker (Journ. Mammalogy **21**(4):389, 1940).

189. *Heterotheca subaxillaris* Lamarck.—Camphor-weed, Texas, V. W. Lehmann (Wildlife Review **22**:41, 1939).

190. *Baccharis halimifolia* L.—Manglier; mung, Louisiana, Lynch. These terms are reminiscent of names applied to *Iva*. (See this series, 1, 1913, No. 102.) Evidently there is popular confusion of the two genera. Sand myrtle, coastal South Carolina, C. Cottam.

191. *Acanthospermum hispidum* De Candolle.—Texas spur, star bur (News Letter, Cooperative Quail Study Assoc., Thomasville, Ga., 3, Dec., 1942, p. 6).

192. *Silphium perfoliatum* De Candolle.—Pitcher-plant, Allen County, Kansas, Philip F. Allan.
193. *Echinacea purpurea* L.—Rattlesnake weed, J. W. Abert (in Emory, W. H., Military Reconnoissance, 1848, p. 387).
194. *Borrichia frutescens* L.—Button weed, coastal South Carolina, C. Cottam.
195. *Gaillardia* sp.—Indian-blanket flower, Texas Panhandle, Philip F. Allan.
196. *Artemisia gnaphalodes* Nuttall.—Wermuth (Wied, Reise, 1:556).
197. *Erechtites hieracifolia* L.—Crenate milkweed, P. H. Gosse (Canadian Naturalist (book), 1840, p. 288).
198. *Synosma suaveolens* L.—Vinella (doubtless a corruption of vanilla), B. L. C. Wailes (Rep. Agr. Geol. Miss., 1854, p. 342).

INDEX

U. S. Fish and Wildlife Service
Chicago, Illinois

Polypetalous Forms of Vaccinium

W. H. Camp and C. L. Gilly

During the course of the last decade one of the authors of this brief paper has been giving some consideration to the Ericales. In this study abnormalities of several types have been noted in various groups. Among these is the polypetalous condition in *Vaccinium.*

In the genus *Vaccinium* the corollas are normally gamopetalous, yet the polypetalous condition is closely approached in two groups: namely, the circumpolar subgenus *Oxycoccus,* and the subgenus *Oxycoccoides* (= *Hugeria* Small), the latter found in southeastern North America and eastern Asia. In these two groups the corollas are not strictly polypetalous; instead, the corolla segments are deeply divided. It is to be noted that in *Befaria,* apparently one of the more primitive of the living ericalean genera, the corolla is always polypetalous and that this condition is correlated with an unstable number of parts of various of the floral organs.[1] Whether the deeply divided condition of the corolla in the subgenera *Oxycoccus* and *Oxycoccoides* of *Vaccinium* is a primitive character, or of more recent origin, is outside the present discussion. We are here concerned solely with the phenomenon of polypetaly in the subgenus *Cyanococcus*—the true blueberries—of eastern North America.

The usual gamopetalous corolla of *Vaccinium* indicates its derivation from a polypetalous type by the marked apical lobing and the folds which, in some species, lead from the sinuses toward the base (figure 1g). It is therefore not surprising that, on occasion, the normal gamopetalous corolla splits into its fundamentally component parts. This situation was recorded in the literature a few years ago by Weatherby. The description of this material indicates that the polypetalous condition was not completely stable, for various types of segmentation were present on the same plant.[2]

For the last several years the present authors have watched an abnormal clone which grows naturally in the woodland of the New York Botanical Garden on the hillside just south of the Arch Bridge, and which in consecutive years has produced polypetalous flowers (figures la-f). It is a low-growing form apparently derived from *Vaccinium torreyanum,* which is common in the area.[3]

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[1] Camp, W. H. Studies in the Ericales. A discussion of the genus *Befaria* in North America. Bull. Torrey Club **68**:100-111. 1941.

[2] Weatherby, C. A. A teratological form of *Vaccinium pennsylvanicum.* Rhodora **29**:237, 238. 1927.

[3] *V. torreyanum* is part of the complex which, in the manuals, has been called *V. vacillans.* The "vacillans-complex," spreading over much of eastern North America, contains the following: the southern and central Appalachian *V. pallidum* Ait. (not *V. pallidum* of the manuals), a somewhat coarse shrub with yellowish branches, sometimes ascending to two or even three feet; the more northern, northeasterly and Outer Piedmont *V. torreyanum* Camp with its delicate, mostly greenish-barked branches rarely rising to more than eighteen inches; the broad- and veiny-leafed *V. subcordatum* (Small) Uphof, a plant apparently confined to the Cumberland Plateau and several of its outliers; and *V. viride* Ashe and *V. missouriense* Ashe, both of which have their primary centers somewhere in the Ozark Plateaus. These last two are distinguished from the others by their puberulent leaves, the coarser *V. viride* apparently bearing much the same relation to *V. missouriense* that *V. pallidum* does to *V. torreyanum.* Whether it will be advisable in the future to keep these as nomenclaturally separate species, or to recognize them as parts of a widespread and regionally variable species, will be decided *only*

There is little need to give any detailed description of this plant except to call attention to the fact that the five corolla segments of each of the flowers examined were separate to the base. This condition was obvious even in the bud (figure 1b). As in the case of the plant noted by Weatherby (loc. cit.), the anthers apparently were abortive (figures 1d, e). Whether the sterility extended to the egg-apparatus has not been determined, although it is our observation that this plant does not set fruit. Furthermore, attempts to produce fruit through the medium of artificial pollination have been unsuccessful. However, this last is not a final conclusion, the attempts so far having been attended by conditions which admittedly were not ideal. In brief, we are not as yet convinced that this clone is incapable of setting fruit.

In addition to the polypetalous condition, one other abnormality should be noted. In sectioning the hypanthium of a series of the flowers of this clone it was found that the ovary of each had but four carpels (figure 1f), instead of the five carpels normal for *V. torreyanum* and its close relatives (figure 1j). This, however, is by no means unusual in the genus *Vaccinium*. It is quite common in certain species and is, in fact, a standard character of others. Nevertheless, this does indicate that the disturbance resulting in the polypetalous condition can also influence the number of carpels in the ovary. In this connection, it is of interest to note that various of the nearly polypetalous members of the subgenera *Oxycoccus* and *Oxycoccoides* are tetramerous, with the pentamerous condition being the abnormal form. Whether this condition is merely coin-

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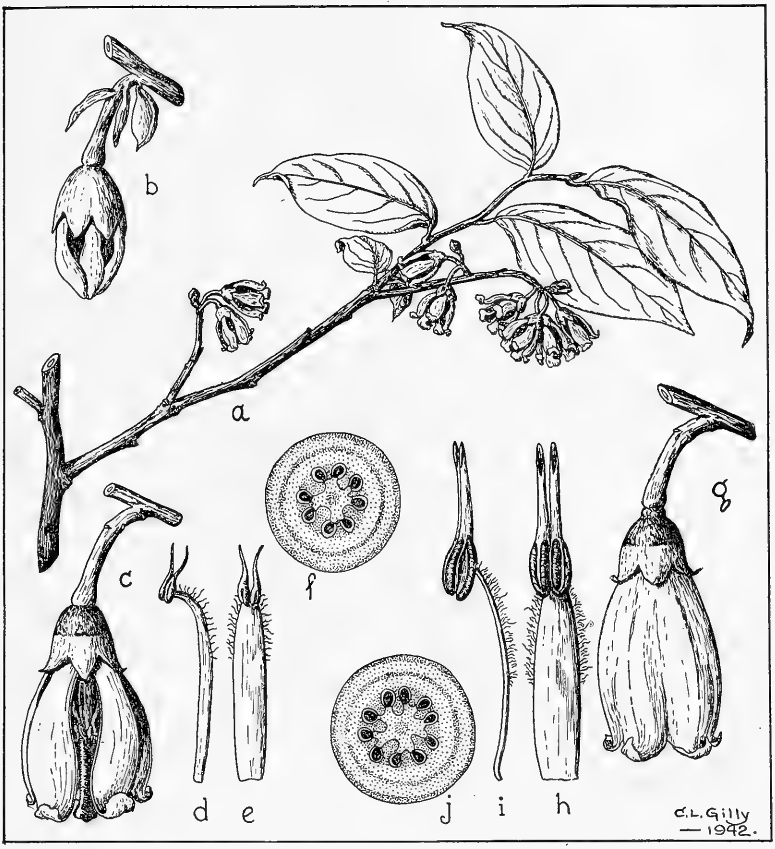
after further and much needed cytological studies of these entities have been made throughout their entire distributions. In addition to the foregoing, the "vacillans-complex" contains *V. tallapusae* (Cov.) Uphof, a derived tetraploid of the southern Appalachians which is best developed in Georgia; *V. altomontanum* Ashe of the southern Appalachians may also be a derivative of this group. *V. vacillans* var. *crinitum* Fernald, with which *V. missouriense* and *V. viride* have been confused, appears to be a series of hybrids and ecologically selected segregates from crosses between the markedly different *V. torreyanum* and *V. atrococcum,* both of which are diploid ($n = 12$) and known to be interfertile. The "high-bush" diploid *V. atrococcum* (A.Gr.) Heller apparently does not enter the ranges of *V. missouriense* and *V. viride,* being primarily an east-coast species; westward, it has been confused with *V. arkansanum* Ashe, and with the "arkansanoid" members of the tetraploid *V. corymbosum* L.



FIGURES 1a-f: Material from a clone of *Vaccinium torreyanum* growing naturally in the woodland of The New York Botanical Garden which, over a period of years, has borne polypetalous corollas. FIGURE 1a: Habit sketch of one branch, natural size. FIGURE 1b: Indicating the position of the petals in the bud, ×4. FIGURE 1c: The fully opened flower, ×4. FIGURES 1d, e: Two views of a stamen showing the abortive anther, ×8. FIGURE 1f: Diagrammatic cross-section of the hypanthium showing the four-carpeled ovary. FIGURES 1g-j: The flower from a normal clone of *V. torreyanum* growing near the former. FIGURE 1g: External view of the flower at anthesis, ×4. FIGURE 1h, i: Two views of a stamen showing the normal anther, ×8. FIGURE 1j: Diagrammatic cross-section of the hypanthium showing the normal five-carpeled ovary. As is common in *Vaccinium,* the "false partitions," coupled with the elongated placentae, give the appearance of a ten-carpeled ovary; the vascular structure (not included in the diagram) indicates its true nature.

cidental, or of fundamental evolutionary significance, is not known.

In addition to the clone here under consideration, one of the authors of this note has found much the same condition in other species. A collection of *V. atrococcum* from central New Jersey has been seen where the corollas were still gamopetalous, but with the segments so poorly united that even a slight pressure would cause them to fall apart. It was also found in a clone of *V. brittonii* Porter on High Point in the Kittatinny Mountains of extreme northern New Jersey. In *V. brittonii* the condition was variable, much as in the material mentioned in Weatherby's discussion. Incipient polypetaly has also been observed in other species of the genus but seldom in so complete a condition as the material figured in this paper.

It is therefore obvious that the individual plant in the genus *Vaccinium,* through some disturbance, may produce polypetalous corollas. The genetics of the situation so far has not been studied, for anther deficiencies often accompany the condition. There is also some slight but not conclusive evidence that the plants may also be sterile to viable pollen.

The nomenclature of such forms should be considered. Similar plants with at least deeply divided gamopetalous corollas have been the basis of such entities as *Rhododendron linearifolium* Sieb. & Zucc. (in which there is also some disturbance of the leaf form), *Kalmia latifolia* var. *polypetala* Nichols, and *Rhododendron atlanticum* forma *tomolobum* Fernald. There is evidence that the precise application of these epithets requires that they be used to refer only to single clones. Since this is the case—and essentially the same manifestation is the basis of a species, a variety and a form —it would seem only logical that some other category be selected to designate the polypetalous condition in the genus *Vaccinium,* and thus complete the nomenclatural cycle.

The foregoing is said less in jest than may at first appear to be the case. It is not the primary purpose of this paper to discuss the proper nomenclatural disposition of such obviously aberrant material. However, it would seem that nomenclature should at least be functional; that its purpose is not only the listing of differentiable entities, but also that it should in some way indicate their proper relationships. Therefore, it is our opinion that, where there is need, an organism should have a name but that the category to which it is assigned should have some biological significance in a system of nomenclature. This is equally true of horticultural material and of organisms growing naturally under feral conditions. In this instance, it is doubted whether a single aberrant clone—as *Rhododendron linearifolium*—deserves specific rank, particularly when the normal form has to take nomenclaturally subsidiary rank under it as a variety.[4]

Were the polypetalous individuals of *Vaccinium* to be brought into cultivation—and if propagated by asexual means—they would deserve no more than the category of "lusus" as originally defined by DeCandolle. Yet it is admitted that this material is of little or no importance either as a horticulturally or otherwise useful plant-type. It is therefore thought best not to further encumber the literature of the group with a series of subspecific names which, for the present, would seem to serve no practical purpose. The polypetalous condition in *Vaccinium* is perhaps of some interest from the botanical standpoint and it is for this reason that this paper has been prepared. Further study of the phenomenon may lead to other work on the origin of somewhat similar forms and thus perhaps shed light on one phase of the general evolution of the group. Some future worker dealing with these matters may find it desirable to give names to such individuals, if only to particularize and expedite his discussions; for the present—to us at least—they are only items of general biological interest and therefore scarcely worthy of nomenclatural recognition.

The New York Botanical Garden
New York, New York

[4] Rehder (Man. Cult. Trees and Shrubs, 1940) begins the description of *Rhododendron linearifolium* as follows: "A garden form of the following . . . ." The following entity is *R. linearifolium* var. *macrosepalum* (Maxim.) Mak. One wonders how the apparently basic, normal material can be considered a variation of an obviously derived and abnormal, vegetatively propagated clone (and therefore, biologically, an individual) except where nomenclature is an end in itself rather than a means by which information can be better organized. The writers of this note bow to the accusation that they hold to the principle that nomenclature, as such, should be a tool in the science of systematics, rather than the view that systematics is a mental diversion appended to the science of nomenclature.

Carex aestivalis and Carex lurida var. gracilis on the Glaciated Allegheny Plateau

Robert T. Clausen

Alma Hill, in Allegany County, is one of the highest hills (elev. 775 m.) in western New York. The flora and fauna both are strongly characteristic of the Canadian Life Zone. Birds such as the Olive-backed Thrush, Winter Wren, Blue-headed Vireo, and Junco seem to be common breeding species there. *Lycopodium annotinum* var. *integrifolium, Dryopteris Phegopteris, Schizachne purpurascens,* and *Milium effusum* further suggest the northern character of the region. On the wooded slopes, *Carex radiata,* a species which is rare in central New York, is frequent. *Carex aestivalis,* even rarer in central New York, occurs in dry rocky woods near the western base of the hill. Along a brook, also on the west side of the hill, at an elevation of 580 m., *Carex lurida* var. *gracilis* occurs.

Data at hand indicate that both *Carex aestivalis* and *C. lurida* var. *gracilis* are infrequent and local on the Glaciated Allegheny Plateau. In the herbarium of Cornell University, neither sedge is represented from this plateau in Pennsylvania or Ohio. Mackenzie (1931–35) did not mention having seen specimens of either from Ohio, although it is possible that both may eventually be discovered in the northeastern part of that state.

House (1924) recorded the range of *C. aestivalis* in New York as "Dutchess county, the Catskill mountains and Otsego county, southward." The two localities in Otsego County, Worcester and East Worcester, are both on the Glaciated Allegheny Plateau. To these may be added the following localities from which specimens are available in the herbarium of Cornell University: woods, 4 Town Schoolhouse, Sempronius, 3 miles east of Moravia, Cayuga County, July 11, 1882, herbarium Charles Atwood; Dresserville Gulf, town of Sempronius, Cayuga County, September 12, 1896, herbarium Atwood; dry steep, shaded, sandy-clay bank, "The Narrows" Slaterville to Caroline Center, Caroline, Tompkins County, July 13, 1919, *A. J. Eames, K. M. Wiegand, & L. F. Randolph 11594;* roadside slope, wooded ravine just east of Bald Hill, Caroline, Tompkins County, July 2, 1936, *M. W. Allen 19329;* dry rocky woods near base of western slope of Alma Hill, Allegany

County, June 18, 1939, *R. T. C. 3917;* and wooded bluff by creek, Sinclairville, June 24, 1924, *K. M. Wiegand 15286.* A further locality, reported by Zenkert (1934), is South Wales in Erie County. Hamburg, also cited by Zenkert, is on the Great Lakes Plain. From just south of the terminal moraine, in the Allegany State Park, House and Alexander (1927) reported *C. aestivalis* as frequent.

House (1924) reported *Carex Baileyi* (*C. lurida* var. *gracilis*) southward to Greene and Herkimer Counties, also from Campville, Tioga County. House and Alexander (1927) reported this same variety as common in the Allegany State Park, an unglaciated area. On the Glaciated Allegheny Plateau, where typical *Carex lurida* is common, the var. *gracilis* seems to be rare. Records are available only from Allegany, Chemung, and Tioga Counties. The following two collections are in the herbarium of Cornell University: open swaly clearing in white oak woods, Comfort Hill, Chemung County, June 29, 1938, *S. J. Smith & Harvey Scudder 933;* and woods along brook on west side of Alma Hill, Allegany County, June 18, 1939, *R. T. C. 3920.* In this herbarium there are several specimens intermediate between *Carex lurida* var. *typica* and var. *gracilis.* These are from Rutland County, Vermont; Norfolk County, Massachusetts; Hartford County, Connecticut; Albany and Fulton Counties, New York; and Haywood County, North Carolina. These support Wahl's (1940) statement that "*Carex Baileyi* (*C. lurida* var. *gracilis* [Boott] Bailey) is very closely related to *C. lurida.*" In counting chromosomes of *Carex lurida,* Wahl found haploid numbers of 32 and 33 for three plants of the typical variety. A plant of var. *gracilis* was $n = 34$. Wahl's data for various *Carices* reveal that plants which are morphologically similar and which certainly belong to the same taxonomic species may differ in having one or two chromosomes more or less. Accordingly, the number 34, mentioned above, does not strengthen the case for treating var. *gracilis* as a species, since typical *C. lurida* already is known to be either $n = 32$ or 33. Though found primarily in the northern part of the range of the species and usually at higher altitudes, the var. *gracilis* can not be regarded as a strongly geographical entity, since its distribution lies entirely within the area of typical *C. lurida.*

Literature Cited

House, H. D. 1924. Annotated list of the ferns and flowering plants of New York State. N. Y. State Museum Bull. 254. p. 1–759.
House, H. D. and Alexander, W. P. 1927. Flora of the Allegany State Park Region. New York State Museum Handbook 2. p. 1–225. illus.
Mackenzie, K. K. 1931–35. Cyperaceae-Cariceae. N. Am. Flora **18**: 1–478.
Wahl, Herbert A. 1940. Chromosome numbers and meiosis in the genus *Carex*. Am. Jour. Bot. **27**: 458–470. t. 1–2.
Zenkert, C. A. 1934. The flora of the Niagara Frontier Region. Bull. Buffalo Soc. Nat. Sci. **16**: 1–328.

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Papers on the Flora of Alaska—I. The Genus Cicuta

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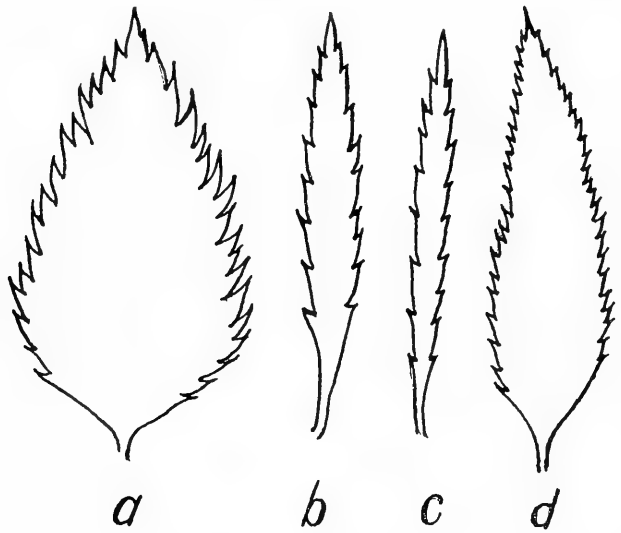
The species of *Cicuta* are of great importance on account of their very poisonous properties. Losses of cattle directly attributed to poisoning by *C. douglasii* (DC.) Coult. & Rose have occurred in southeastern Alaska. There have been rumors of losses elsewhere.

In a recent study, Mathias and Constance (1) have reduced the American species of the genus to seven. Of these, three occur in Alaska. The following key covers these three species:

Fruit longer than wide, leaflets 2–4 times as long as wide. *C. maculata*
Fruit shorter than wide, leaflets 5–10 times as long as wide. *C. mackenzieana*
Fruit about equal in length and width, leaflets 1¾–2½ times as long as wide. *C. douglasii*

This is probably the first report of *C. maculata* L. from Alaska, although *C. virosa* L. reported by Porsild (2) from Hot Springs on the Tanana River undoubtedly was this species. The author first collected it at Knik on Knik Arm of Cook Inlet in 1931 (*1382*). In 1935 it was collected at Circle Hot Springs (*2616*), as again in 1941 (*7560*). A collection at Hyder in 1939 (*5501*) is rather immature but seems to be this species. A visit to Manly Hot Springs (also known as Tanana Hot Springs) in 1941 revealed its presence there (*7075*). It is to be noted that the most northerly stations are at hot springs where other more southerly species of plants also occur.

Cicuta mackenzieana Raup is the most widely distributed member of the genus in the territory. The author first collected it at Matanuska in 1922. The following collections have since been made: Matanuska (*1103*); College, near Fairbanks (*1258*); Circle, on Yukon River (*2595*); mile 312, Richardson Highway (*2686*); Willow Creek, mile 92, Richardson Highway; Valdez (*2888*); Unalakleet (*5106*); Eklutna (*6940*); Takotna (*7352*); Talkeetna (*7580*). An immature specimen collected at Hope (*6695*) seems to belong here.



a. Leaflet of *C. douglasii.* b and c. Leaflets of *C. mackenzieana.* d. Leaflet of *C. maculata.* All drawn by Dr. Ada Hayden.

Cicuta douglasii (DC.) Coult. & Rose seems to be confined to southeastern Alaska. Collections were made at Lemon Creek (*784*) and at Mendenhall (*783*), both near Juneau; Haines (*1570*); Skagway (*1733*); and Echo Cove, Lynn Canal (*6034*).

All specimens cited were collected by the author and are in his herbarium now deposited in Iowa State College at Ames.

So far as their occurrence in Alaska is concerned, the species are very distinct and can be readily separated by vegetative characters alone. *Cicuta douglasii* and *Cicuta maculata* grow up to 2 meters tall and *Cicuta mackenzieana* up to 1½ meters. All have bipinnate leaves which often appear to be ternate-pinnate. In *C. douglasii* the leaflets are lanceolate, 1–5 cm. wide × 2½–9 cm. long, serrate to doubly serrate or even incised and with sharp teeth. In *C. maculata* the leaflets are more narrowly lanceolate, .8–3 cm. × 3–9 cm., rather evenly serrate with sharp, mostly outward pointed teeth. The leaflets of *C. mackenzieana* are narrowly lanceolate to linear, .2–2 cm. × 2–10 cm., with rather remote, sharp, forward-pointing teeth, these being rather small on the more narrow leaflets. Fruits of *C. douglasii* are deeply grooved, about 2¾ mm. long and wide. *C. mackenzieana* also has deeply grooved fruits which are about 2¼ mm. wide × 2 mm. long. In *C. maculata* the fruit is not grooved, the space being filled by thick corky ribs. The fruit measures about 2¾ mm. wide × 3¼ mm. long. All the species are found growing in shallow water, sometimes ascending into mud, but never in well drained situations. This habitat is quite different from that of other tall growing members of the same family, which are always found on better drained soils.

Literature Cited

Mathias, Mildred E. & Lincoln Constance. 1942. A synopsis of the American species of *Cicuta*. Madrono **6**: 145–151. *Pl. 14*.

Porsild, A. E. 1939. Contributions to the flora of Alaska. Rhodora **41**: 266.

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Some New Forms from the Middle West

NORMAN C. FASSETT

NAPAEA DIOICA L., f. **stellata,** n.f., foliorum setis stellatis, ramis 0.2-0.5 mm. longis, rare simplicis 1.0 mm. longis.—Along a railroad 3.8 miles west of Cross Plains, Wisconsin, August 16, 1942, *N. C. Fassett,* no. 22057 (TYPE in Herb. Univ. of Wis.).

N. dioica occurs with two quite distinct types of pubescence. In some plants the lower leaf-surfaces have straight appressed simple hairs a millimeter long, with only occasionally a stellate trichome. In others these simple hairs are nearly or quite lacking except on the larger veins, and are replaced by close stellate hairs with short branches. The first type is represented in the Herbarium of the New York Botanical Garden by a sheet from Pennsylvania, one each from Cincinnati and Peoria, and by two cultivated plants. The second is represented by collections from Ohio, Indiana, Illinois, Wisconsin and Iowa. In the Herbarium of the University of Wisconsin there are from this state 3 sheets with simple pubescence, and 17 with stellate trichomes predominating. It is therefore evident that both forms occur in the Middle West (where, despite

Leaf of *Napaea dioica,* ×¼.

the statement in Gray's Manual, the plant is by no means rare). Linnaeus did not mention the type of pubescence, and most subsequent authors merely specify "scabrous" or "roughish." Sprengel, Syst. Veg. **3**:122, describes *Sida dioica* as "S. herbacea hirsuta" perhaps implying simple hairs. Since the simple-haired plant is certainly present in the east it is taken as the typical form, and the other here described as f. *stellata.*

Two Mass Collections have been made, with upper and lower leaves from a single plant in each clone. One from Cross Plains, Wisconsin, consists of 12 pistillate plants and 2 staminate plants; the other, from near Black Earth, shows 8 pistillate and 3 staminate plants. These 25 individuals are all f. *stellata,* but this observation does not imply that the two forms may not grow together in some regions.

The figure in Britton & Brown's illustrated Flora purporting to illustrate *Napaea* will look strange to anybody who is familiar with the deeply 7-lobed leaf of that plant. Perusal of the material in the New York Botanical Garden brought to light a specimen which closely matched the drawing, and was obviously the original; it is *Sida hermaphroditica.* Since there seems to be no readily available illustration of the very characteristic leaf of *Napaea dioica,* one is here presented.

Asarum canadense L., var. acuminatum Ashe, f. **Prattii,** n.f., calycibus viridibus non purpureis.—Wooded bank, Green Lake, Wisconsin, May 20, 1938, *C. H. Pratt & N. C. Fassett,* no. 22001 (Type in Herb. Univ. of Wis.). This clone of Wild Ginger with green flowers has been under observation by Mr. Pratt for several years. It seems to be quite analagous to *A. caudatum* f. *chloroleucum* Palmer in St. John, Proc. Biol. Soc. Wash. **41**:193. 1928.

Lathyrus japonicus Willd., var. glaber (Ser.) Fernald, f. **spectabilis** n.f., corollis coccineis.—Cobblestone beach of Lake Superior, 12 miles east of Grand Marais, Minnesota, July 12, 1938, *N. C. Fassett & J. T. Curtis,* no. 22000 (Type in Herb. Univ. of Wis.). The deep crimson flowers of this plant were conspicuous among the ordinary purple-flowered individuals of Beach Pea. When pressed, they became a very deep blue.

Zanthoxylum americanum Mill., f. **impuniens,** n.f., ramulis inermis.—Three miles north of Wisconsin Dells, Juneau County, Wisconsin, September 13, 1938, *N. C. Fassett & J. W. Thomson, Jr.*, no. 21822 (TYPE in Herb. of Wis.). Of the 58 sheets of Prickly Ash from Wisconsin. 4 lack the sharp prickles usually characteristic of this shrub.

MIMULUS RINGENS L., f. **roseus,** n.f., corollis roseis.—Sandy shore of the St. Croix River, Evergreen, St. Croix County, Wisconsin, July 31, 1934, *N. C. Fassett,* no. 21821 (TYPE in Herb. Univ. of Wis.).

DEPARTMENT OF BOTANY
UNIVERSITY OF WISCONSIN

Clarence J. Elting and his Herbarium

HOMER D. HOUSE

The New York State Museum has recently acquired as a gift from Mrs. Elting, the herbarium of the late Clarence J. Elting of Highland, Ulster County, New York. The collection is noteworthy among small local herbaria because of the careful preparation, preservation and correct identification of the material according to the current floras of his day. Most of the specimens exhibit both flowering and fruiting specimens, pressed and mounted with a skill rarely seen in such collections, with fairly accurate data as to locality and date. Over 90 percent of the specimens were collected in eastern Ulster County, New York. The remainder are from Mohonk, Minnewaska and Denning in Ulster County, with a few from across the Hudson River in Dutchess County. Important as a contribution to the local flora of New York City and vicinity it calls for some mention of the principal items among the 1075 specimens.

Clarence J. Elting was born October 13, 1860, at Highland, Ulster County, New York, where he spent most of his life until his death on May 28, 1942. His interests were mainly amateur photography, botany, genealogy and local history. He was a member of the local historical societies and well known locally as an authority upon such matters. The *New Paltz Independent* of Thursday, June 4, 1942, contains additional information regarding his life and activities.

Some details are necessary in connection with the localities where most of his plants were collected. Bailey's Gap is the highest point on Route 55, between Highland and Clintondale, and is 3 miles west of the Hudson River. Saxton's Pond is in the township of Lloyd and is now designated on topographic maps as "Lily Lake." Pine Hole is an extensive swamp and bog area on the headwaters of the Swartekill about 2 miles south of Ohioville, a hamlet about 2 miles east of New Paltz. Butterville is a hamlet about 2 miles west of New Paltz. Dashville Falls is near Dashville on the Wallkill River. Black Pond is in the northern part of Lloyd township. Bull Run is in the township of Denning, about 3 miles north of the Sullivan County line. Claryville, Libertyville, Lloyd, Mohonk, Minnewaska, New Paltz, Clintondale, Marlboro and Milton are all in Ulster County and easily located on most maps. Fallsburgh is in northern Sullivan County and Millburn is a hamlet in Wallkill township, Orange County.

Most of the specimens are numbered apparently according to their sequence in his Gray's Manual. The herbarium was started in 1892 and active collection was continued until 1903, with fewer collections in 1907 and some scattered ones as late as 1923 and 1925.

The following species are selected from Mr. Elting's herbarium as most worthy of permanent record:

ANCHISTEA VIRGINICA (L.) Presl. Swamp near Mohonk, *3584,* August 10, 1896

ASPLENIUM MONTANUM Willd. Near Mohonk, *3540,* September 5, 1901

POLYSTICHIUM BRAUNII (Spenner) Fee. Mountain woods near Shokan, *3521,* May 15, 1903

WOODSIA OBTUSA (Spreng.) Torr. Rocky woods, Highland, *3580,* July 8, 1893

BOTRYCHIUM LANCEOLATUM (Gmel.) Angstr., var. ANGUSTISEGMENTUM Pease & Moore. Woods near Highland, August 7, 1900

BOTRYCHIUM MULTIFIDUM (Gmel.) Rupr., var. SILAIFOLIUM (Presl.) Broun (Ind. N. Am. Ferns 41, 1938). Woods near Highland, *3592,* August 29, 1898

PICEA MARIANA (Mill.) B. S. P. "Pine Hole" swamp, 2 miles south of Ohioville, *2515,* May 20, 1897

SPARGANIUM AMERICANUM Nutt. Shallow water near Highland, *2772,* July 10, 1893

POTAMOGETON PECTINATUS L. Shallow water, Libertyville, *2851,* July 24, 1898

SAGITTARIA SUBULATA (L.) Buchenau. Borders of Hudson River near Highland, *2808,* August 20, 1892

SAGITTARIA LATIFOLIA Willd., f. DIVERSIFOLIA (Engelm.) Robinson. Hudson River near Highland, *2810,* August 8, 1892

ANACHARIS OCCIDENTALIS (Pursh) Marie-Victorin. Tidal marsh on Hudson River near Highland, *2531,* July 28, 1894

PANICUM ASHEI Pearson. Woods near Highland, *3411,* June 19, 1901

MUHLENBERGIA RACEMOSA (Michx.) B. S. P. Borders of Saxton's Pond, Lloyd, *3395,* September 14, 1896

CALAMAGROSTIS CINNOIDES (Muhl.) Barton. Minnewaska, *3302,* August 25, 1896

ELEUSINE INDICA Gaertn. Waste ground, Highland, *3328,* August 13, 1895

TRIODIA FLAVA (L.) Hitchc. Near Esopus, *3493,* October 10, 1899

GLYCERIA FLUITANS (L.) R. Br. Shallow water near Highland, *3364,* June 8, 1899. Well marked by the large spikelets and long lemmas.

BROMUS HORDACEUS L. Roadside near Highland, July 10, 1907

ELYMUS WIEGANDII Fernald (Rhodora **35**: 192, 1933). River shore near Highland, *3329,* July 29, 1894

HYSTRIX PATULA Moench. Woods near Highland, *3274,* July 12, 1894

ELEOCHARIS CAPITATA (L.) R. Br. (*E. tenuis* of N. Y. Reports). Wet soil, Highland, *3144,* June 24, 1896

STENOPHYLLUS CAPILLARIS (L.) Britt. Dry soil, Highland, *3170,* August 21, 1896

SCIRPUS HUDSONIANUS (Michx.) Fernald (*Erioprorum alpinum* L.) "Pine Hole" swamp, 2 miles south of Ohioville, *3159,* June 3, 1896

ERIOPHORUM VIRIDI-CARINATUM (Engelm.) Fernald. "Pine Hole" swamp, 2 miles south of Ohioville, *3164,* June 3, 1896

RYNCHOSPORA ALBA (L.) Vahl. Borders of Saxton's Pond, Lloyd, *3180,* August 16, 1895

MARISCUS MARISCOIDES (Muhl.) Kuntze. Saxton's Pond, Lloyd, *3102,* August 6, 1895

CAREX EXILIS Dewey. "Pine Hole" swamp, 2 miles south of Ohioville, *2924,* May 20, 1897

CAREX CEPHALANTHA (Bailey) Bicknell. Borders of Saxton's Pond, Lloyd, *2921,* June 5, 1897

CAREX TORTA Boott. Along stream, Bull Run, Denning, *3065,* May 15, 1903

CAREX DAVISII Schw. & Torr. Meadow, Hackensack road, southeast of Poughkeepsie, Dutchess County, *2908,* June 1, 1899

CAREX PLANTAGINEA Lam. Woods near Bull Run, Denning, *3004,* May 12, 1903

CAREX GRISEA Wahl. Moist woods, Libertyville, *2967,* June 17, 1899

CAREX CRYPTOLEPIS Mackenzie. Wet soil near Highland, *2930,* June 14, 1899

CAREX LASIOCARPA Ehrh. Borders of Saxton's Pond, Lloyd, *2927,* June 5, 1897

CAREX SQUARROSA L. Woods near Highland, *3078,* August 29, 1905

CAREX GRAYII Carey. Wet woods, New Paltz, *2946,* June 23, 1902

ARISAEMA PUSILLUM (Peck) Nash. Wet woods, Highland, *2779,* July 10, 1893

Peck (N. Y. State Mus. Bul. **67**: *20*, 1903) reports specimens contributed to the State Herbarium by Mr. Elting, collected in June, 1902. The type was collected at Millbrook, Dutchess County, by Fred. Thorne of New Paltz (51st Ann. Rep't N. Y. State Mus. *275*, *297*), but the herbarium specimen is mistakenly labelled as having been collected by "F. Thomas." Other New York collections in the State Herbarium are: Bedford Park, Bronx, *Nash*, May 26, 1899; Sandlake, Rensselaer County, *Peck;* Hewlett, Nassau County, *Taylor* (Torreya **9**: 260, 1909).

ARISAEMA DRACONTIUM L. Wet soil, Libertyville, *2778,* May 31, 1898

ORONTIUM AQUATICUM L. Saxton's Pond, Lloyd, *2781,* May 31, 1894

ERIOCAULON SEPTANGULARE With. Saxton's Pond, Lloyd, *2870,* July 5, 1895

XYRIS FLEXUOSA Muhl. Borders of Saxton's Pond, Lloyd, *2709,* August 6, 1895

COMMELINA COMMUNIS L. Waste places, Highland, *2712,* August 22, 1905

ZOSTERELLA DUBIA (Jacq.) Small. Shallow water, Libertyville, *2702,* July 23, 1896

CYPRIPEDIUM REGINAE Walt. Swamp near Highland, *2548,* June 11, 1893

HABENARIA BRACTEATA (Willd.) R. Br. Woods near Highland, *2555,* May 22, 1893

HABENARIA FLAVA (L.) Gray. Woods near Highland, *2572,* July 1, 1893

HABENARIA BLEPHARIGLOTTIS (Willd.) Torr. Minnewaska, *2553,* July 28, 1896

ARETHUSA BULBOSA L. Borders of Saxton's Pond, Lloyd, *2536,* May 13, 1896

POGONIA OPHIOGLOSSOIDES (L.) Ker. Marsh near Highland, *2585,* June 28, 1893

LIMODORUM TUBEROSUM L. Borders of Saxton's Pond, Lloyd, *2537,* June 20, 1895

SPIRANTHES PLANTAGINEA (Raf.) Torr. (*S. lucida* Ames). Wet soil, Lloyd, *2590,* June 13, 1901

GOODYERA PUBESCENS (Willd.) R. Br. Woods near Highland, *2551,* July 17, 1894

CORALLORRHIZA ODONTORHIZA Nutt. Woods near Highland, *2541,* September 3, 1892

LIPARIS LILLIFOLIA (L.) L. C. Rich. Woods near Highland, *2574,* June 6, 1903

APLECTRUM HYEMALE (Muhl.) Torr. Woods near Highland, *2535,* May 26, 1895

MYRICA PENNSYLVANICA Loisleur (*M. carolinensis* of N. Y. Reports, see Fernald, Rhodora **37**: 423, 1935; **40**: 410, 1938). "Pine Hole" swamp, 2 miles south of Ohioville, *2416,* June 8, 1897

CARYA ALBA (L.) K. Koch. Woods near Highland, *2412,* May 24, 1893

CORYLUS CORNUTA Marsh. Thickets near Highland, *2435,* April 6 and June 20, 1893

BETULA NIGRA L. Along stream near Libertyville, *2426,* April 15 and July 10, 1893

× QUERCUS SCHUETTEI Trelease (*Q. bicolor* × *macrocarpa*). Woods near Highland, August 20, 1905

MORUS RUBRA L. Woods near Highland, *2393,* May 14, 1894

PARIETARIA PENNSYLVANICA Muhl. Dashville Falls, *2394,* October 12, 1901

ARISTOLOCHIA SERPENTARIA L. Moist woods, Highland, *2317,* August 10, 1895

Polygonum tenue Michx. Rocky slopes, Highland, *2298,* September 17, 1896

Paronychia fastigiata Fernald, Rhodora **38**: 421, 1936 (*Anychia polygonoides* Raf.). Dry soil near Highland, *2210,* August 4, 1902

Paronychia canadensis (L.) Wood (*Anychia dichotoma* Michx.). Dry woods, Highland, *2209,* September 9, 1892

Arenaria lateriflora L. Woods near Libertyville, *261,* June 28, 1897

Arenaria groenlandica (Retz.) Spreng., var. glabra (Michx.) Fernald. Ledges near Minnewaska, *260,* July 21, 1895

Stellaria borealis Bigel. Wet places in mountain woods near Claryville, *310,* June 6, 1898

Cerastium nutans Raf. Moist places near Highland, *276,* May 17, 1895

Cerastium oblongifolium Torr. Rocky soil, Clintondale, *274,* May 18, 1898

Lychnis chalcedonica L. Adventive, Highland, *284,* July 1, 1894

Agrostemma Githago L. Field near Highland, *288,* July 15, 1893

Silene Armeria L. Adventive, Highland, *299,* July 10, 1895

Silene stellata (L.) Ait. f. Woods near Libertyville, *307,* August 6, 1897

Saponaria Vaccaria L. Adventive, Highland, *296,* August 26, 1897

Dianthus deltoides L. Roadside near Highland, *280,* June 10, 1893

Claytonia caroliniana Michx. Woods near Claryville, *320,* May 12, 1897

Nymphaea odorata Dryand. Black Pond near Lloyd, *108,* July 11, 1893

Ranunculus flabellaris Raf. Marsh near Highland, *65,* May 14, 1894

Ranunculus ambigens S. Wats. (*R. obtusiusculus* Raf. ?). Wet soil near Highland, July 10, 1907

Ranunculus micranthus Nutt. Woods near Highland, *49,* May 10, 1893

Clematis verticillata DC. Rocky woods west of Highland, May 10, 1904

Coptis trifolia (L.) Salisb. "Pine Hole" swamp, 2 miles south of Ohioville, *34,* May 6, 1897

Trollius laxus Salisb. "Bailey's Gap," near Highland, *82,* April 21, 1903

Delphinium Ajacis L. Garden adventive, Highland, *35,* August 2, 1893

Cimicifuga racemosa L. Woods near Libertyville, *24,* July 17, 1897

Dicentra canadensis (Goldie) Walp. Mountain woods, Claryville, *129,* May 12, 1897

Adlumia fungosa (Ait.) Greene. Rocky woods, West Mountain near Highland, *122,* July 14, 1895

Berteroa incana (L.) DC. Roadside near Highland, *134,* November 6, 1893

Lunaria annua L. Persistent, Highland, *189,* May 8, 1898

Arabis canadensis L. Woods near Highland, *135,* May 23, and August 10, 1894

Polanisia graveolens Raf. Along Hudson River near Highland, *215,* August 22, 1896

Sarracenia purpurea L. Swamp near Highland, *112,* June 6, 1893

Drosera rotundifolia L. Borders of Saxton's Pond, Lloyd, *830,* July 8, 1895

Drosera intermedia Hayne. Border of Saxton's Pond, Lloyd, *828,* July 8, 1895

Saxifraga pennsylvanica L. Swampy meadow near Highland, *809,* May 19, 1896

Heuchera americana L. Thickets near Libertyville, *776,* June 28, 1897

Parnassia americana Muhl. (*P. caroliniana* of N. Y. Reports). Wet soil, Hackensack road, southeast of Poughkeepsie, Dutchess County, *787,* August 11, 1896

Ribes odoratum Wendl. Escaped and spreading, Highland, *793,* May 15, 1893

Sorbus americana Marsh. Woods near Bull Run, Denning, *726,* May 15, 1903

Waldsteinia fragarioides (L.) Tratt. Woods near Fallsburgh, *767,* May 15, 1897

Potentilla palustris (L.) Scop. Border of Black Pond, Lloyd, *700,* July 10, 1893

Potentilla Anserina L. Along Hudson River, 2 miles north of Highland, *691,* September 28, 1898

Geum macrophyllum Willd. Mountain woods, Bull Run, Denning, *681,* May 12, 1903

Geum rivale L. "Bailey's Gap," near Highland, *683,* May 31, 1905

Dalibarda repens L. Woods near Liberty, Sullivan County, *675,* July 21, 1904

Sanguisorba minor Scop. (*Poterium Sanguisorba* L.) Waste ground near Marlboro, *711,* October 14, 1903

Sanguisorba canadensis L. Wet soil, Lloyd, *710,* August 18, 1903

Cassia marilandica L. Thickets near Libertyville, *517,* July 15, 1896

Cassia nictitans L. Field near Highlands, August 18, 1907

Crotalaria sagittalis L. Field near Highland, August 20, 1907

Coronilla varia L. Meadow near Highland, *525,* August 12, 1892

Desmodium canescens (L.) DC. Woods near Libertyville, *536,* August 13, 1899

Desmodium bracteosum (Michx.) DC. Thickets near Highland, *539,* August 13, 1895

Desmodium laevigatum (Nutt.) DC. Woods near Highland, *540,* August 13, 1895

Desmodium marilandicum (L.) DC. Dry woods, Highland, *545,* August 28, 1892

Desmodium rigidum (Ell.) DC. Dry woods, Highland, *550,* August 21, 1896

Lespedeza procumbens Michx. Dry woods near Highland, *579,* September 11, 1896

Lespedeza repens (L.) Bart. Dry woods, Highland, *578,* September 7, 1896

Lespedeza violacea (L.) Pers. Dry woods, Highland, *580,* August 18, 1892

Lespedeza virginica (L.) Britt. Dry woods, Highland, *580,* August 18, 1892. (Mixed with the preceding and hence numbered the same)

Lespedeza intermedia S. Wats. (Hopkins, Rhodora **37**: 264–266, 1935). Dry thickets, Libertyville, *583,* August 29, 1900

Lespedeza Stuvei Nutt. Dry woods, Highland, *582,* September 12, 1896

Vicia Cracca L. Roadside, Highland, *646,* June 17, 1900

Lathyrus palustris L., var. myrtifolius (Muhl.) Gray. Wet soil near Libertyville, *571,* June 28, 1897

Linum virginianum L. Field near Highland, *391,* August 20, 1893

Oxalis violacea L. Moist woods near Poughkeepsie, Dutchess County, *409,* May 12, 1896

Erodium cicutarium (L.) L'Her. Weed in a cemetery, Highland, June 20, 1907

Polygala Senega L. Woods east of Poughkeepsie, Dutchess County, *482,* June 12, 1896

Euphorbia platyphylla L. Weed in cultivated field, Highland, *2370,* July 21, 1892

Callitriche palustris L. Shallow water, Ohioville, *837,* September 13, 1898

Callitriche heterophylla Pursh. Shallow water, Highland, *836,* September 6, 1895

Ilex montana Torr. & Gray. Thickets near Mohonk, *421,* May 25, 1896

Ilex laevitata (Pursh) Gray. "Pine Hole" swamp, 2 miles south of Ohiovile, *419,* June 3, 1896

Vitis Labrusca L. Thickets near Highland, *443,* June 6, 1893

Hibiscus Trionum L. Adventive, Highland, *367,* October 7, 1893

Hypericum gentianoides (L.) B. S. P. Dry soil near Highland, *350,* September 11, 1892

Viola lanceolata L. Shores, Mohonk, *240,* June 20, 1893

Viola canadensis L. Woods near Claryville, *235,* May 12, 1897

Cuphea petiolata (L.) Koehne. Meadow near Highland, *855,* August 17, 1892

Oenothera grandiflora Ait. Highland, *893,* July 8, 1899. Not stated whether an escape or not. Sepals 4.5–4.75 cm. long; petals 4–4.5 cm. long; style 3.5 cm. long; stigmas spreading, about 7 mm. long

Proserpinaca palustris L. Wet places, Highland, *847,* July 27, 1893

Zizia cordata (Walt.) DC. Dry woods, Highland, *998,* May 29, 1898

Heracleum lanatum L. Open moist places, Highland, *963,* June 16, and August 31, 1896

Angelica villosa (Walt.) B. S. P. Woods near Highland, *934,* August 31, 1892

Clethra alnifolia L. Lake Minnewaska, *1627,* July 21, 1895

Chimaphila maculata (L.) Pursh. Dry woods, Highland, *1623,* July 8, 1893

Pyrola secunda L. Woods near Highland, *1663,* June 18, 1893

Rhododendron canadense (L.) B. S. P. (*Rhodora canadensis* L.) Minnewaska, *1671,* May 8, 1896

Rhododendron maximum L. Woods near Minnewaska, *1669,* June 29, 1893

Kalmia Polifolia L. "Pine Hole" swamp, 2 miles south of Ohioville, *1638,* May 29, 1899

Andromeda glaucophylla Link. Borders of Saxton's Pond, Lloyd, *1616,* May 1, 1895

Chamaedaphne calyculata (L.) Moench. Borders of Saxton's Pond, Lloyd, *1621,* May 1, 1895

Chiogenes hispidula (L.) Gray. Mossy woods, Claryville, *1625,* May 12, 1897

Vaccinium macrocarpon Ait. Borders of Saxton's Pond, Lloyd, *1685,* June 20, 1895

Samolus parviflorus Raf. (*S. floribundus* H. B. K.). Wet meadow, Libertyville, *1714,* June 28, 1897

Lysimachia vulgaris L. Damp soil, Ohioville, *1711,* June 29, 1893

Fraxinus nigra Marsh. Wet woods, Highland, *1736,* May 12, 1893

Gentiana quinquefolia L. Woods near Libertyville, *1802,* September 28, 1896

Gentiana clausa Raf. Damp thickets, Highland, *1794,* September 26, 1893

Bartonia virginica (L.) B. S. P. Mossy woods near Highland, *1784,* July 21, 1900

Menyanthes trifoliata L. Borders of Saxton's Pond, Lloyd, *1809,* May 13, 1896

Asclepias tuberosa L. Dry soil, Millburn, *1765,* August 5, 1903

Asclepias purpurascens L. Open woods, Highland, *1759,* July 3, 1893

Asclepias quadrifolia Jacq. Dry woods, Highland, *1760,* June 12, 1893

Convolvulus spithamaeus L. Field near Butterville, *1892,* May 25, 1896

Cuscuta Epithymum Murr. On red clover, *Trifolium pratense* L. near Highland, *1900,* August 22, 1896

Verbena stricta Vent. Field near Highland, *2073,* July 23, 1902

Agastache nepetoides (L.) Kuntze. Woods near Highland, *2105,* September 7, 1899

Scutellaria parvula Michx. Slope near New Paltz, *2167,* June 6, 1903

Leonurus Marrubiastrum L. Waste ground, Highland, *2076,* October 4, 1897

Melissa officinalis L. Waste ground near Highland, *2113,* September 7, 1892

Blephila hirsuta (Pursh) Benth. Dry soil, Hackensack road near Poughkeepsie, Dutchess County, *2078,* July 26, 1899

Mentha alopecuroides Hull. Waste ground near Highland, *2121,* September 16, 1893

Solanum rostratum Dunal. Waste ground, Highland, *1939,* September 25, 1894

Physalis philadelphica Lam. (*P. subglabrata* Mack. & Bush). Moist field near Highland, *1929,* August 25, 1892

Physalis heterophylla Nees, var. nyctaginea (Dunal.) Rydb. Meadow near Highland, *1929,* August 25, 1892

Datura Tatula L. Waste ground, Highland, *1918,* August 28, 1893

Mimulus alatus Ait. Wet soil, Libertyville, *1991,* July 29, 1898

Lindernia dubia (L.) Pennell (*Ilysanthes dubia* Barnh.). Muddy shores, Libertyville, *1982,* July 21, 1895

Veronica Anagallis-aquatica L. Wet soil, Highland, *2021,* October 20, 1892

Veronica longifolia L. Established, near Lloyd, *2029,* July 16, 1903

Aureolaria pedicularia (L.) Raf. Woods near Highland, *1965* August 22, 1892

Aureolaria flava (L.) Pennell. Woods near Highland, *1960,* July 15, 1893

Gerardia purpurea L. "Pine Hole" swamp, 2 miles south of Ohioville, *1966,* September 18, 1896

Castilleja coccinea L. Meadow near Libertyville, *1946,* May 16, 1899

Utricularia cornuta Michx. Borders of Saxton's Pond, Lloyd, *2041,* July 8, 1895

Utricularia juncea Vahl. "Pine Hole" swamp, 2 miles south of Ohioville, *2042,* September 5, 1908

Conopholis americana (L.) Wallr. Woods near Highland, *2034,* July 17, 1894

Plantago cordata Lam. Hudson River near Highland, *2191,* July 1, 1893

Diodia teres Walt. Dry soil, Highland, *225,* August 10, 1907

Houstonia purpurea L. Meadow near Highland, *1082,* June 25, 1896

Lonicera Caprifolium L. Naturalized near Highland, *1028,* June 13, 1893

Viburnum prunifolium L. Thickets, Highland, *1050,* May 26, 1893

Dipsacus sylvestris Huds. Waste ground, Highland, *1011,* August 18, 1893

Specularia perfoliata (L.) A. DC. Dry slopes near Highland, *1611,* June 28, 1893

Campanula uliginosa Rydb. Marsh near Highland, *1603,* July 14, 1894

Lobelia Dortmanna L. Shallow water, Minnewaska, *1590,* July 21, 1895

Vernonia noveboracensis Willd. Wet soil near Highland, *1580,* August 18, 1892

Eupatorium sessilifolium L. Woods near Highland, *1344,* August 11, 1899

Mikania scandens (L.) Willd. Thickets along Hudson River near Highland, *1446,* August 28, 1892

Solidago patula Muhl. Marsh near Highland, *1531,* November 7, 1892

Solidago odora Ait. Minnewaska, *1529,* July 28, 1896

Solidago neglecta Torr. & Gray. "Pine Hole" swamp, 2 miles south of Ohioville, *1525,* September 18, 1896

Solidago ulmifolia Muhl. Thickets near Highland, *1551,* September 26, 1898

Aster Herveyi Gray. Woods near Highland, *1171,* August 20, 1899

Aster Tradescanti L. Wet soil near Highland, *1158,* October 16, 1892

Aster paniculatus Lam., var. acutidens Burgess. Dry soil near Highland, *1192,* October 18, 1892

Aster puniceus L., var. firmus (Nees) T. & G. Damp soil near Highland, *1185,* October 25, 1894

Aster linearifolius L. Dashville Falls, *1175,* October 11, 1901

Aster infirmus Michx. Open woods, Highland, *1172,* July 26, 1893

Rudbeckia speciosa Wenderoth. New Paltz, *1476,* September 6, 1899. Probably an escape.

Coreopsis tinctoria Nutt. Highland, *1288,* August 22, 1893. Not stated whether cultivated, naturalized or an escape.

Bidens comosa (Gray) Wiegand. Wet soil, Highland, *1232,* August 31, 1892

Bidens bipinnata L. Moist ground, Highland, *1231,* August 28, 1892

Bidens cernua L. Marsh near Milton, *1233,* September 15, 1896

This is the tall, erect form with rays exceeding the bracts and with elongated narrow leaves, prominently and distantly toothed. Being essentially glabrous it is often confused with *Bidens laevis.* It is the common form of this species in the marshes of the Hudson River and adjacent territory, and rarely elsewhere across the state.

BIDENS TRICHOSPERMA (Michx.) Britt. Saxton's Pond, Lloyd, *1289,* September 5, 1895. Possibly native, although the same plant has appeared at several localities in eastern New York within recent years, and evidently introduced

CHRYSANTHEMUM PARTHENIUM (L.) Bernh. Adventive, Highland, *1258,* September 10, 1892

SENECIO OBOVATUS Muhl. Woods near Highland, *1482,* May 25, 1896

CIRSIUM DISCOLOR Muhl. Open woods near Highland, *1294,* September 15, 1892

CIRSIUM MUTICUM Michx. Swamp near Highland, *1298,* October 11, 1893

CIRSIUM PUMILUM (Nutt.) Spreng. Dry fields, Highland, *1300,* August 26, 1892

CENTAUREA JACEA L. Waste ground, Highland, *1253,* August 7, 1903

LAPSANA COMMUNIS L. Waste ground near Highland, *1425,* June 21, 1897

KRIGIA BIFLORA (Walt.) Blake (*K. amplexicaulis* Nutt.). Weed in cultivated soil, Highland, August 8, 1923

KRIGIA VIRGINICA (L.) Willd. Dry soil, Highland, *1412,* June 7, 1894

VIREA AUTUMNALIS (L.) S. F. Gray (*Leontodon autumnalis* L.). Roadside near Highland, July 20, 1907

PICRIS HIERACIOIDES L. Waste ground near Highland, July 10, 1907

PICRIS ECHIOIDES L. Roadside near Highland, July 10, 1907

LACTUCA CANADENSIS L., var. OBOVATA Wiegand. Woods near Highland, *1419,* July 15, 1903

HIERACIUM PRATENSE Tausch. Fields near Highland, July 10, 1907

HIERACIUM GRONOVII L. Open woods near Highlands, *1396,* August 22, 1895

HIERACIUM CANADENSE Michx. Dry woods, Libertyville, *1393,* August 30, 1898

NEW YORK STATE MUSEUM
ALBANY, N. Y.

BOOK REVIEWS

Flora of Fukien

Flora of Fukien and Floristic Notes on Southeastern China. First Fascicle. By Franklin P. Metcalf, ix. + 82 double pages. Lingnan University, American Office, 150 Fifth Ave., New York City. $1.50.

This is the first part of a monumental work on the flora of southeastern China. Dr. Metcalf has already given twenty years to the task. He served as Professor of Botany in the Fukien Christian University from 1923 to 1929, and in the Lingnan University in Canton (formerly Canton Christian College) from 1931 to 1938. He and his students have collected extensively in China, and a Rockefeller fellowship made it possible for him to see practically all of the Fukien plants in the herbaria of the world. Since leaving

China he has been giving his whole time to this flora working with Dr. E. D. Merrill at the Arnold Arboretum.

According to Dr. Metcalf there is no book or group of books by which the plants of southeastern China can be identified and specimens have to be sent to specialists in Europe or America. This work will be a landmark in Chinese botany. Bentham's Flora Hongkongenis was published in 1861 and is out of date and out of print, besides covering only a small area.

This fascicle covers fourteen families from Cycadaceae to Fagaceae. There are keys to families, genera and species. There is a description of each Fukien species and additional notes on those found in adjacent provinces. No new species are described but attention is called to many novelties which are to be described later.

It is hoped that future parts can be published in China but the war made it necessary to publish this fascicle here. This work is another reminder of the many contributions of missionaries to Chinese botany. Hundreds of species were first sent to western botanists by friars, abbés and clergymen. In recent years good collections were being built up in the Chinese colleges until the Japanese interfered.

My only criticism is that in the interest of economy the page margins are very narrow and there is little room for additional notes. I should think that one using it very much would have to have it interleaved.

R. R. Stewart

Botanizing in Cuba

Itinéraires botaniques dans l'île de Cuba. (Première série). By Frère Marie-Victorin, F.E.C., D.Sc., Directeur de l'Institut botanique de l'Université de Montréal, and Frère Léon, Directeur du Laboratoire de botanique du Colegio de la Salle, Havana. Contributions de l'Institut botanique de l'Université de Montréal, No. 41. Montréal, 1942.

The writer of this review was companioned, on what was for us a botanizing trip from Capetown through Egypt to Jerusalem and farther, by the senior author of the above publication. It was immediately apparent that Frère Marie-Victorin was an insatiable diary keeper, an amiable weakness I thought! Until a copy of this diary, beautifully bound, was put into my hands some time after our return to Montreal, I confess I did not realize that weakness had become strength. Here before me was a volume almost fit for publication, displaying a general picture of the vegetation and its habitants, and a good many other matters not usually regarded as botanical, but enriching the picture from the human point of view. Very much such a work is that now lying before us. We well know that Marie-Victorin is enamoured of Cuba and has been busy for some time, in cooperation with Frère Léon, in studying its vegetation. But the results of their work embrace more than collections and descriptions of long lost or new species. One of these results is this volume of "Itineraries" by the perusal of which botanists interested in tropical vegetation (and what botanist is not?) will gain a vivid impression of what may be seen in the island of Cuba. This is the more so because of the plenitude of illustration. As the reviewer knows, the camera is almost a part of Marie-Victorin, and we see in this publication embellished with about 280 photographs, with a number of line drawings and a large map, an account which appeals directly to the eye. Thus one gets a full and detailed impression of how the country actually looks, and one feels as if he had seen Cuba for himself. The liberal use of native names and frequent descriptions of the uses made of the vegetable products enhances this impression. More than this, there are many allusions to human relations, some of which appeal directly to the heart.

Francis E. Lloyd

Diary and Travels of the Bartrams

Diary of a Journey through the Carolinas, Georgia, and Florida from July 1, 1765 to April 10, 1766. By John Bartram. Annotated by Francis Harper. Transactions of the American Philosophical Society **33**(1) : iv + 120. portrait, 8 maps, 37 fig. December, 1942. Paper cover $2.00.

Travels in Georgia and Florida, 1773–74; A Report to Dr. John Fothergill. By William Bartram. Annotated by Francis Harper. Trans. Am. Phil. Soc. **33**(2) : about 115 pp. portrait, 5 maps, 47 fig. Spring 1943. Paper cover $2.00. Parts 1 and 2 bound together in cloth $5.00.

John Bartram was a Quaker botanist to the King of England. He was the first botanical investigator of the upper reaches of the St. John's River in Florida, and of the greater part of Georgia. As a friend and guest of the élite in Charleston, and of several colonial governors, he observed and portrayed pre-Revolutionary life in the southern cities of Charleston, Savannah, and St. Augustine, as well as life on the plantations and in the wilderness. He described the architecture of the first Spanish period in St. Augustine, and told of the easternmost known calumet ceremony, at the Treaty of Picolata. On this trip he discovered *Franklinia, Pinckneya, Nyssa ogeche, Canna flaccida,* and other noteworthy plants. He was accompanied and assisted by his talented son, "Billy," who was destined to become the author of the immortal *Travels* (1791).

The record of these achievements appears in the simple, unvarnished diary of 1765–66, preserved at the Historical Society of Pennsylvania and hitherto largely unpublished. The full editorial comments and annotations provide a historical background, identify Bartram's plants and animals, and show his routes in detail by means of both colonial and modern maps. Photographs and drawings bring into vivid focus, after a span of nearly two centuries, many of the points of particular interest that were visited by John Bartram.

Much new light on William Bartram's celebrated *Travels* (1791) will be forthcoming with the publication, in part 2, of his lengthy manuscript report to his London patron, Dr. John Fothergill. This important document, which has long remained in obscurity in the British Museum, will be a distinct boon to all students of Bartram and of early American natural history. While it covers the same ground as the first part of the book of 1791, it is not a duplicate of that work, but contains much additional information on Bartram's itinerary, his chronology, his scientific and literary qualifications, and the identification of his plants and animals. The work is thoroughly annotated and indexed. The illustrations include the most significant collection of Bartram drawings ever brought together in a single publication.

Hunter College
New York, N. Y.

Harold H. Clum

Carnivorous Plants

The Carnivorous Plants. By Françis Ernest Lloyd. xv + 352 pages, 38 plates. Waltham, Mass., The Chronica Botanica Co., New York City, E. G. Stechert and Co. 1942. $6.00.

"For the present moment, I care more about *Drosera* than the origin of all the species in the world," wrote Charles Darwin, in 1860, to his friend Sir Charles Lyell. It is fortunate that he found time to consider both, for his investigations on *Dionea, Drosera,* and physiologically related plants resulted in the publication of the first book on this group, which has remained the only one available in English for the past sixty-eight years.

It is in a similar spirit that Dr. Lloyd has now summarized the researches in this field. Karl von Goebel reviewed the work in 1891 in a section of his book, "Pflanzenbiologische Schilderungen." Since then, various contributions have been made, including the skillful researches of Lloyd on *Utricularia* and the respective studies of Vines and Hepburn on the digestive action of the pitcher fluids of *Nepenthes* and *Sarracenia*. The glandular secretions of *Drosera* were investigated in a similar manner by Okahara. The existence of carnivorous fungi has recently been established, and new interesting interpretations of the mechanisms of closure of the leaves of *Dionea* and *Aldrovanda* have been made by Brown in the United States and Ashida in Japan.

There has long been a need for a comprehensive, modern treatment of the carnivorous plants (Dr. Lloyd prefers this term to insectivorous). The present volume seems entirely adequate. It is a precise and scholarly work. The author has carried on intensive investigations in this field since 1929, when he made his first observations on the trap of *Utricularia gibba*. The book contains a great stock of his own experiments and verifications of the results of others. For example, in the case of *Roridula*, Dr. Lloyd is now definitely able to exclude this genus from the carnivorous plants. Many of the plants, especially the Utriculariae, were studied in their native habitats. Two trips to Africa and one to Australia were made for this purpose.

The text is divided into fourteen chapters, each for the most part corresponding to a separate genus. The distribution of the plants is unusual. They either fall into groups which are widely distributed, like *Drosera* or *Utricularia*, or else they exist as monotypic or very local genera, as *Cephalotus, Genlisa, Dionea*, and others. The chapters are arranged according to the increasing order of complexity of the traps. Thus we find, in this rather ingenious system of classification, that the passive, pitfall traps, as represented by the pitchered leaves of *Heliamphora* and *Sarracenia*, are placed first. Passing upward through the lobster pots, snares, fly-paper and active, bear-trap devices, we come to the mouse trap, or most complex type which includes such forms as *Biovularia, Utricularia*, and *Polypompholyx*. One chapter is devoted to the fungi that prey upon small water animals, notably eelworms and rotifers. Modifications encountered in this unique group are hyphal loops that swell and clamp onto the body of a worm unluckly enough to enter, and sticky plugs that literally gag their victims to death. This appears to be the first complete discussion of the findings of Drechsler and others on these fungi. Although Dr. Lloyd, in reviewing the genus, mentions the use of the name "*Chrysamphora*" in place of the much more familiar "*Darlingtonia,*" which it antedates, he continues to use the latter name. The literature cited on *Utricularia* records twelve papers by the author embodying new concepts on the operation of the traps, and an additional two describing four new species discovered in Australia. An appendix is added as a sort of patent registry to describe an epoch making mouse catching device constructed on the principles of the *Utricularia* trap. Its efficacy is assured, since if it did not catch the mouse it would undoubtedly leave him with a severe nervous breakdown.

With very few exceptions, the drawings are original. They are ample and very well done. The plates are included at the back. Due to a regrettable economy of space, many of the photographs have been cut down and placed in a sort of mosaic on the page, with a resultant loss of clarity. In every other detail, however, the book shows great care in its preparation. The paper, print, and binding are good. The frontispiece is an old drawing of a species of *Nepenthes* from an early herbal.

Above all, it is well to remember that "The Carnivorous Plants" represents the achievement of more than twelve years of painstaking work. Dr. Lloyd has not left the smallest pebble unturned in his effort to follow up every source. As witness to his consuming interest in the field, there are very few chapters that do not contain some of his own pertinent, and usually outstanding, contributions.

COLUMBIA UNIVERSITY — OSCAR JANIGER

FIELD TRIPS OF THE CLUB

Trip of October 4, 1942, to Richmond, S. I.

Nine members of the Club took this trip. The main objective was the salt marsh, but many interesting plants were seen along the road on the way to the salt marsh. Over a hundred species were pointed out, and about as many more were passed by without mention because they were so familiar. Several members of the group besides the leader were alert in spotting plants, and helpful in identifying them and in making a list, as well as in finding the way out of the woods after leaving the salt marsh.

Some of the easily recognized grasses promised by the Field Chairman were the tall and spreading switch grass (*Panicum virgatum*), the always interesting hispid panicum (*P. clandestinum*), the very delicate old-witch grass (*P. capillare*), tall red top (*Tridens flavus*) with its purplish glumes that rub off black, the graceful and silky Indian grass (*Sorghastrum nutans*), the large coarse gama grass (*Tripsacum dactyloides*) with its polished jointed spikes, wild rye (*Elymus virginicus*), which, like a cat, resists being petted the wrong way, broom beard grass (*Andropogon scoparius*) with its spreading feathery hairs, Virginia beard grass (*A. virginicus*) and its bushy-headed form *A. glomeratus*, the delicate but savage rice cut-grass (*Leersia oryzoides*), and the bristly-sheathed salt-marsh cockspur grass (*Echinochloa Walteri*).

In or near a brook or road-side ditch were found, not in bloom, water-weed (*Elodea canadensis*), water starwort (*Callitriche palustris*), sweet flag (*Acorus Calamus*) and the hairy variety of swamp milkweed (*Asclepias incarnata* var. *pulchra*), the last in fruit.

Some of the less common trees and shrubs along the road were two somewhat southerly species, clammy locust (*Robinia viscosa*) and false indigo (*Amorpha fruticosa*), the latter in fruit; the middle western Osage orange (*Maclura pomifera*) in fruit; also hackberry (*Celtis occidentalis*) in fruit, box elder or ash-leaved maple (*Acer Negundo*), and a particularly large specimen of tulip tree (*Liriodendron Tulipifera*).

A high point on the hill, to which the road led, afforded a good general view of the salt marsh and its creek, with the characteristic winding or crooked form for which genuine *creeks* like this are named.

Eleven species of aster (including *A. paniculatus* and two of its varieties) were seen besides New York aster (*A. novi-belgii*) and the two salt-marsh asters *A. subulatus* and *A. tenuifolius*. Six species of goldenrod were found besides seaside or salt-marsh goldenrod (*Solidago sempervirens*).

In the moist ground near the salt marsh were found swamp thistle (*Cirsium muticum*), rough thoroughwort (*Eupatorium verbenaefolium*), soapwort gentian (*Gentiana Saponaria*), tall sunflower (*Helianthus giganteus*), ladies' tresses (*Spiranthes cernua*), Culver's-root (*Veronica virginica*) in fruit, and the tiny water pimpernel (*Samolus floribundus*).

Of the real salt-marsh plants the most interesting, besides the few already mentioned, were the two shrubby composites, groundsel tree (*Baccharis halimifolia*) with beautiful plumy white heads on the pistillate plants, and the less showy marsh elder (*Iva oraria*), the red patches of the fleshy glasswort (*Salicornia europaea*), the extensive wiry carpet of the so-called black grass (*Juncus Gerardi*), the dioecious alkali grass (*Distichlis spicata*), the pink-flowered salt-marsh fleabane (*Pluchea camphorata*) with its characteristic aroma, the beautiful and delicate marsh pink (*Sabatia stellaris*), the tall weak unattractive water hemp (*Acnida cannabina*), orach (*Atriplex patula* var. *hastata*) turning red in places, beaked spike rush (*Eleocharis rostellata*) looping its way along, salt-marsh bulrush (*Scirpus robustus*), Olney's bulrush (*S. Olneyi*), the low cord grass (*Spartina patens*), and the tall salt-marsh grass (*S. glabra* var. *alterniflora*—nomenclature of Gray's Manual used here and throughout).

Two characteristic plants known to grow in this salt marsh, but not seen by the group on this trip were a third species of *Spartina*, salt reed grass (*S. cynosuroides*), and the lovely sea lavender (*Limonium carolinianum*).

Hester M. Rusk

Trip of November 15, 1942, to Lakewood, N. J.

The walk included an old pine barrens bog, dry barrens, and the lake shore. The leader pointed out plants typical of the habitats and others of interest. The most important discovery was made by Mr. A. T. Beals, a moss which was finally identified by Dr. Grout as *Entodon seductrix* var. *minor* (Aust.) Grout. Mr. Beals writes in part, "This variety is a find (for New Jersey). It is not included in any list I have seen of New Jersey mosses, although it may have been collected previously in that state. The plant is more common further south and was named and described from a specimen found in Georgia."

In the late afternoon Mr. V. L. Frazee arranged for us to visit a Mr. Lecompte who is related to Dr. Knieskern. We saw some of Knieskern's collections.

Attendance: 24. Leader: Mr. James Murphy.

PROCEEDINGS OF THE CLUB

Minutes of the Meeting of November 2, 1942

The meeting was called to order at 8:25 p.m. by the President, Dr. C. Stuart Gager, at the Museum of Natural History. Thirty-two members and friends were present.

The minutes of the preceding meeting were accepted as read.

The election of Mr. Mario G. Ferri, Departamento de Botanica, Faculdade de Fiolsofia, Ciencias e Letras, Caixa Postal 2926, Sao Paulo, Brasil, to annual membership was unanimously approved.

The suggestions proposed in the report of the Per Capita Cost Committee were read by Dr. Matzke in the absence of the chairman of the committee.

The scientific program of the evening was presented by Dr. Henry K. Svenson who spoke on the "Vegetation of Western South America." The talk was illustrated with Kodachrome slides which depicted the vegetation, peoples and points of interest in that region.

The meeting was adjourned at 9:35 p.m.

Respectfully submitted,

Honor M. Hollinghurst
Recording Secretary

Minutes of the Meeting of November 18, 1942

The meeting was called to order at 3:30 p.m. by the second Vice-president, Dr. Clyde Chandler in the Members Room of the

New York Botanical Garden Museum. Twenty-nine members and friends were present.

The minutes of the preceding meeting were accepted as read.

The first part of the scientific program was presented by Mrs. Annette Hervey who spoke on "The Use of *Phycomyces Blakesleeanus* in the Assay of Thiamin in Agar." The talk was illustrated with slides.

The second portion of the program was presented by Mr. John D. Dodd who gave an illustrated talk on "Three Dimensional Cell Shape in the Carpel Vesicles of *Citrus Grandis*." The speaker's abstract follows:

Internal cells from the carpel vesicles (juice sacs) of grapefruit were examined in the living condition. Cell walls were stained lightly with neutral red. Records were kept by making a careful drawing of each cell. In order to insure completely impartial selection, the data were not tabulated and summarized until 100 cells had been drawn. Results showed an average of 13.85 faces per cell. The range in number of faces was from 9 to 18. The largest number of any one type was 22 cells each with 14 faces. Of the rest 39 cells had more than 14 faces and 39 had less. The number of edges per face varied from 3 to 8; 0.8% were triangular, 25.9% were quadrilateral; 41.6% were pentagonal; 23.6% were hexagonal; 7.0% were heptagonal and 1.1% were octagonal.

The meeting was adjourned at 4:30 p.m. and was followed by tea which was served by friends at the Garden.

Respectfully submitted,

Honor M. Hollinghurst
Recording Secretary

Minutes of the Meeting of December 1, 1942

The meeting was called to order at 8:25 p.m. by the President, Dr. C. Stuart Gager, in the Museum of Natural History. Thirty-five members and friends were present.

The minutes of the preceding meeting were accepted as read.

The scientific program of the evening was presented by Mr. Otto Degener who gave an illustrated talk on "Botanizing in Fiji." The speaker's abstract follows:

While a member of the Pacific cruise of the palatial junk-yacht, "Cheng-Ho," sponsored by Mrs. Ann Archbold, collections were made, under the auspices of the Arnold Arboretum and the New York Botanical Garden, amounting to about 2,100 numbers or a total exceeding 15,000 specimens.

These are being studied by Dr. A. C. Smith and various specialists. Thus far 64 novelties have been described, one proving to belong to an entirely new family related to the Magnoliaceae, Himantandraceae and Winteraceae. Mr. Degener, with the aid of his "adopted Figi son" Aloisio (Aloysius) Tabualewa, won the confidence of the Fijians who ordinarily do not look too kindly on the aggressive *papalangi* or white man, and lived with them in their elaborately constructed "grass" houses. This enabled him to collect data on their customs and how they used certain plants in their native medicine and arts. Their use, for example, of the latex of various species of *Alstonia,* as chewing gum, may help us solve the problem of soothing the nerves of countless ruminating stenographers, should our national supply of American chicle give out. Thirteen-year-old Leroy Peiler, a native Hawaiian refugee and Mr. Degener's ward, later served *yangona,* a beverage made from *Piper methysticum,* in proper Fiji style.

The meeting was adjourned at 9:30 p.m.

Respectfully submitted,

Honor M. Hollinghurst
Recording Secretary

Minutes of the Meeting of December 16, 1942

The meeting of December 16 was held in Larkin Hall of Fordham University. Thirty-seven members and friends were present. Preceding the regular meeting, the members of the Torrey Botanical Club were invited to inspect the biological laboratories and to observe microscopic demonstrations. Refreshments were then served.

The meeting was called to order at 4:50 p.m. by the President, Dr. C. Stuart Gager, who introduced the first speaker, Father Berger of Fordham University. The topic presented by Father Berger and Miss Eleanor Witkus was "The Prophases of Polysomatic Mitosis and their Relation to Meiosis." The speakers' abstract follows:

The essentials of Darlington's precocity theory of meiosis, the singleness of leptotene chromonemata, the attraction in pairs only and the repulsion between pairs of pairs, and metaphase pairing due to chiasmata, were presented and refuted in the light of evidence brought forward by our spinach material and the work of other investigators.

In the periblem of the root tips of *Spinacia oleracea,* in addition to diploid cells with twelve chromosomes, tetraploid and octoploid cells are regularly found. This condition of polyploidy arises by double chromosome reproduction during the resting stage. In the prophase and metaphase of certain of these polysomatic cells the chromosomes are in closely associated pairs.

In *Spinacia oleracea,* therefore, more than two chomonemata may be present in closely paired association. In such multiple associations there is no evidence of any repulsion between pairs. Paired associations are maintained from earliest prophase to metaphase without being held together by chiasmata.

After the discussion of these talks, Dr. Gager expressed the thanks of the Torrey Botanical Club to Father Berger and his staff for their kind hospitality. The meeting was adjourned at 5:45 p.m.

Respectfully submitted,

HONOR M. HOLLINGHURST
RECORDING SECRETARY

DATES OF PUBLICATION OF TORREYA, VOLUME 42

Number 1.	January-February	February 27, 1942
2.	March-April	April 10, 1942
3.	May-June	June 5, 1942
4.	July-August	November 12, 1942
5.	September-October	January 29, 1943
6.	November-December	April 24, 1943

ERRATA

Page 56, line 6 from bottom: for *nutalii,* read *Nuttallii.*

Page 66, line 7 from bottom: for Dr. Wm. J. Crocker, read Dr. Wm. Crocker.

Page 73, line 4 from bottom: for datas, read data.

Page 97, first new member listed: for Miss Marion Johnson, read Mr. Marion Johnson.

Page 101, fourth new member listed: should be Professor Hempstead Castle, Yale University.

Page 126, bottom line: for *Erythina,* read *Erythrina.*

Page 129, for *Rynchosphora,* read *Rynchospora.*
for *Scirpa,* read *Scirpus.*
for *Schleria,* read *Scleria.*

Page 143, line 5: for *Botrichium,* read *Botrychium.*

INDEX TO TORREYA—VOLUME 42

New names are in **bold face** type

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Helen M. Trelease
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1942-1944

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Mosses: E. B. Bartram
Liverworts: A. W. Evans, E. B. Matzke
Freshwater Algae: H. C. Bold
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OTHER PUBLICATIONS

OF THE

TORREY BOTANICAL CLUB

(1) BULLETIN

A journal devoted to general botany, established in 1870 and published monthly, except during July, August, and September. Vol. 68, published in 1941, contained 694 pages of text and 55 full page plates. Price $6.00 per annum. For Europe, $6.25.

In addition to papers giving the results of research, each issue contains the INDEX TO AMERICAN BOTANICAL LITERATURE—a very comprehensive bibliography of current publications in American botany. Many workers find this an extremely valuable feature of the BULLETIN.

Of former volumes, 24-68 can be supplied separately at $6.00 each; certain numbers of other volumes are available, but the entire stock of some numbers has been reserved for the completion of sets. Single copies (75 cents) will be furnished only when not breaking complete volumes.

(2) MEMOIRS

The MEMOIRS, established 1889, are published at irregular intervals. Volumes 1–18 are now completed. Volume 17, containing Proceedings of the Semi-Centennial Anniversary of the Club, 490 pages, was issued in 1918, price $5.00.

Volume 18, no. 1, 108 pages, 1931, price $2.00. Volume 18, no. 2, 220 pages, 1932, price $4.00. Volume 18 complete, price $5.00.

Volume 19, no. 1, 92 pages, 1937, price $1.50. Volume 19, no. 2, 178 pages, 1938, price $2.00.

(3) INDEX TO AMERICAN BOTANICAL LITERATURE

Reprinted monthly on cards, and furnished to subscribers at three cents a card.

Correspondence relating to the above publications should be addressed to

W. GORDON WHALEY,
Barnard College,
Columbia University,
New York, N. Y.

TORREYA

A Bi-Monthly Journal of Botanical Notes and News

John Torrey, 1796-1873

EDITED FOR

THE TORREY BOTANICAL CLUB

BY

HAROLD H. CLUM

VOLUME 43

New York

1943

Volume 43 July 1943 Number 1

TORREYA

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THE TORREY BOTANICAL CLUB

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John Torrey, 1796-1873

CONTENTS

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THE TORREY BOTANICAL CLUB

OFFICERS FOR 1943

MEMBERSHIP IN THE TORREY BOTANICAL CLUB

All persons interested in botany are invited to join the club. There are four classes of membership: *Sustaining,* at $15.00 a year; *Life,* at $100.00; *Annual,* at $5.00 a year and *Associate,* at $2.00 a year. The privileges of members, except *Associate,* are: (a) To attend all meetings of the club and to take part in the business, and (b) to receive its publications. *Associate* members have the privilege of attending meetings, field trips and of receiving the Schedule of the Field Trips and the Bulletin of the New York Academy of Sciences.

TORREYA

TORREYA was established in 1901 as a monthly publication of the **Torrey Botanical Club** for shorter papers and interesting notes on the local flora range of the Club. It also contains the proceedings of the Club, reports of field trips, and some book reviews and news notes. The Council of the **Torrey Botanical Club** has decided to devote volume 43 of TORREYA, 1943, to the publication of the papers presented in June 1942 at the 75th Anniversary Celebration of the Club, and to the Proceedings of the Club. This volume will be published in two numbers.

TORREYA is furnished to subscribers in the United States and Canada for one dollar per year (January-December): single copies thirty cents. To subscribers elsewhere, twenty-five cents extra, or the equivalent thereof. Postal or express money orders, drafts, and personal checks are accepted in payment. Subscriptions are received only for full volumes.

Claims for missing numbers should be made within sixty days following their date of mailing. Missing numbers will be supplied free only when they have been lost in the mails. All subscriptions and requests for back numbers should be addressed to the treasurer, Dr. W. Gordon Whaley, Barnard College, Columbia University, New York, N. Y.

Of the annual membership dues of the **Torrey Botanical Club,** $.50 is for a year's subscription to TORREYA.

TORREYA is edited for the **Torrey Botanical Club** by

HAROLD H. CLUM
HUNTER COLLEGE, 695 PARK AVENUE
NEW YORK, N. Y.

BOTANISTS ATTENDING THE 75TH ANNIVERSARY CELEBRATION OF THE TORREY BOTANICAL CLUB

Taken on the steps of the Museum Building of The New York Botanical Garden, Tuesday, June 23, 1942*

1. H. K. Svenson
2. Robert Hagelstein
3. C. Stuart Gager
4. John A. Small
5. Harold C. Bold
6. Clyde Chandler
7. Wm. J. Robbins
10. John S. Karling
11. A. E. Hitchcock
12. Mrs. Jerome W. Coombs
13. Prof. Marie-Victorin
14. Mrs. Robert H. Fife
15. F. D. Kern
16. E. D. Merrill
17. Gertrude E. Douglas
18. H. A. Gleason
19. Ernest Ball
20. Virgene Kavanagh
21. James Marvin
22. Arthur Hillegas
23. F. W. Kavanagh
24. C. F. Mook
25. W. A. Dayton
26. Charles E. Allen
27. A. B. Stout
28. H. H. Clum
29. Hettie Chute
30. Robert Bloch
31. F. W. Pennell
32. Walter P. Green
33. Mrs. Ernest Ball
34. Mrs. A. J. Eames
35. Anna F. Jenkins
36. John Dodd
38. Ethel Welti
39. G. S. Torrey
40. Mrs. Mary I. Turner
41. Lloyd Weaver
42. George H. Shull
43. Clara S. Hires
44. Ruth C. Yates
45. F. L. Howard
46. R. H. Wetmore
50. Mrs. Fern Crane
51. Penelope Smith
52. Dorothy Meier
53. Jean Stewart
54. J. H. Barnhart
55. Gussie F. Miller
56. Margaret Fulford
57. E. P. Killip
58. F. Lyle Wynd
59. Ann F. Bowler
60. A. J. Eames
61. Harriet Creighton
62. Grace Antikajian
63. Esther Zimmer
64. F. J. Seaver
65. Mrs. F. J. Seaver
66. Mrs. Helen Upson
67. D. Elizabeth Marcy
68. Carol Anderson
70. Lazella Schwarten
71. Mrs. R. R. Stewart
72. Alfred Gundersen
73. Aviva Kogon
76. Gordon Whaley
77. E. W. Sinnott
78. Annette Hervey
79. Anita Appel
80. Vivian Trombetta Walker
81. M. A. Chrysler
84. Sarah H. Harlow
85. Mrs. A. G. Vestal
86. Jennie L. S. Simpson
87. Erling Dorf
88. Norma Pfeiffer
90. A. G. Vestal
91. Dorothy Hammond
92. G. L. Wittrock
93. F. T. Lewis
94. R. R. Stewart
95. B. O. Dodge
96. Peter Johnston
97. Mrs. B. O. Dodge
98. M. A. Raines
99. A. F. Blakeslee
100. Mrs. E. D. Merrill
101. Cornelia Carey
102. Mrs. Marie Siegele
104. Roberta Ma
105. Stanley A. Cain
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107. J. P. Carabia
108. C. J. Porter
109. Roland Walker
110. John H. Pierce
111. W. H. Camp
112. E. B. Matzke
113. Frank Lehr

* Permission has kindly been granted by the Editor of *Journal of The New York Botanical Garden* to reprint this picture. As the list of names is not quite complete, the Editor of Torreya will be very grateful to anyone who will send him the names for the following numbers: 8, 9, 37, 47, 48, 49, 69, 74, 75, 82, 83, 89, 103, or correct any possible errors.

TORREYA

Vol. 43 July 1943 No. 1

Introduction

The Torrey Botanical Club is the oldest botanical society in America, and ever since its founding, its members have been active in all botanical movements, such as the discussions of rules of nomenclature, the establishment of the Botanical Section of the American Association for the Advancement of Science, and of other botanical organizations; and at the Semicentennial Celebration of the Club in 1917, preliminary discussions were held which have since led to the establishment of "Botanical Abstracts," now "Biological Abstracts." With this record of botanical achievement it seemed fitting that a Seventy-fifth Anniversary Celebration should be held. In the fall of 1941 Dr. J. S. Karling, then President of the Club, appointed a large committee to discuss the possibilities of such a celebration. It was decided to hold the celebration in New York in June 1942, independently of meetings of the American Association of the Advancement of Science and of other botanical societies. However, all botanists were invited to participate. It was also decided to hold four sessions, at which papers would be presented, in four different local institutions; to leave the afternoons free for recreation and inspection of these institutions; and to provide some evening entertainment and a field trip. Smaller committees were appointed to work out the details of securing speakers, and of arranging for the accommodation of visitors and delegates. As events worked out, the summer scientific meetings at Ann Arbor, Michigan, were canceled and the Botanical Society of America joined in the celebration of the Club in lieu of a separate summer meeting in the East.

Registration began Monday morning, June 22, 1942, at Columbia University. At 2:00 p.m. the first session was called to order by Dr. E. B. Matzke. Dr. Karling gave an interesting review of the development of the Department of Botany at Columbia from the early days before the University occupied its present site, and told of the establishment of the Elgin Botanical Garden as an aid to the teaching of botany. Then followed the papers by Drs. F. T. Lewis, C. E. Allen, R. H. Wetmore, and E. W. Sinnott. These are presented here, although the papers of Dr. Lewis and Dr. Sinnott are in somewhat abbreviated form.

After the formal program the visitors resorted to the Low Memorial Library for tea, and to examine a display of books and reports by John Torrey, and photographs of former botanists at Columbia and of others associated with the Torrey Botanical Club in earlier days. In the evening the anniversary

Torreya for July (Vol. 43, 1–85) was issued August 27, 1943

banquet at the Men's Faculty Club was well attended and proved to be an enjoyable occasion with Dr. C. Stuart Gager, President of the Club, presiding. Excerpts were read from many letters of felicitation from various organizations and from individual botanists who could not come.

On Tuesday morning the meeting was held at the New York Botanical Garden with Dr. William J. Robbins presiding. Dr. Robbins first gave a very interesting account of the history of the Botanical Garden, illustrated with a number of slides showing the activities of the Torrey Botanical Club in the establishment of the Garden, and in the erection of the museum building and greenhouses. Following this talk four papers on different aspects of taxonomy were given by Drs. H. A. Gleason, H. K. Svenson, E. D. Merrill, and F. D. Kern. These make up the last half of this number of Torreya. At the end of the program the accompanying picture of the group was taken on the steps of the museum building. The weather still seemed too threatening for lunch to be served out-of-doors, and arrangements were made for it on the main floor of the museum building. Fortunately, however, it cleared sufficiently for the inspection of the gardens in the afternoon.

On Wednesday, June 24th, the program was continued at the Boyce Thompson Institute for Plant Research. Here Dr. P. W. Zimmerman presided and Dr. William Crocker told of the establishment and growth of the Institute during the past twenty years. Three papers on growth problems were presented by Drs. L. O. Kunkel, P. W. Zimmerman, and O. Riddle. Following the program the Institute served a very nice luncheon; and then dividing the visitors into small groups, the staff of the Institute conducted everyone through the building and greenhouses on exceedingly well organized tours with a minimum of congestion or confusion. As reference was made in the last paragraph to threatening weather, and rain will be mentioned again toward the end of the volume, it is perhaps excusable to state that this was a perfect June day, and the rose arbor at the Institute was at its height of bloom.

In the evening Dr. William J. Robbins gave a lecture on vitamins at the American Museum of Natural History.

On Thursday the group met at the Brooklyn Botanic Garden. Dr. C. Stuart Gager presided and told of building the Botanic Garden, which has many phases of activity, is composed of a number of diverse unit gardens, and serves the public in many ways, on an originally unattractive piece of waste land. Four papers were given in the formal program by Drs. G. H. Shull, S. A. Cain, G. M. Reed, and A. F. Blakeslee. Luncheon was served in the Brooklyn Museum, and this was followed by an inspection of the gardens.

The papers presented on Wednesday and Thursday, and an account of the field trip of Friday and Saturday, will be published in the second number of Torreya.

H. H. C.

Haphazard as a Factor in the Production of Tetrakaidecahedra*

Frederic T. Lewis

This paper, more fully presented than was possible in oral delivery and with added reference to subsequent publications, has been published in the American Journal of Botany, **30:** 74–81. Jan., 1943. There it is entitled "A Geometric Accounting for Diverse Shapes of 14–hedral Cells: the Transition from Dodecahedra to Tetrakaidecahedra." A summary of the discourse follows:

The study of cell shapes in compact parenchyma, or in similar unspecialized aggregates, has led to a series of surprises. (1) Such cells, instead of being rhombic dodecahedral products of surface tension, in reality have an average of between 13.5 and 14 facets,—usually close to 14. (2) The cells, though having an average of 14 facets, very rarely present the 14–hedral shapes deduced by Lord Kelvin as dividing space into uniform bodies of minimal surface. Even irregular or distorted approximations of those shapes, with 8 irregularly hexagonal facets and 6 quadrilaterals that are far from true squares, occur in less than 1 per cent. of the cells studied. (3) Compressed solids, such as shot of a given size, no longer controlled by surface tension, assume the same irregular cell-like shapes with the same average of close to 14 facets (Marvin). (4) Aggregations of soap bubbles of as nearly uniform size as they can be made, responding to surface tension, and free to glide over one another, do not assume the Kelvin shapes. With an average of 14 facets, they present a variety of cell-like forms (Matzke).

Confronted with this situation, the aggregation of geometrically perfect rhombic dodecahedra was considered anew. At six corners of each rhombic dodecahedron, when surrounded by others like it, six polyhedra meet at a mathematical point. Let two of them deviate a hair from meeting the other four at a point, and let the deviations throughout the mass occur in all directions at random, and the aggregation of rhombic dodecahedra becomes an assemblage of irregular shapes with an average of 14 facets. The shapes range from 12– to 18–hedra, and have an abundance of pentagonal facets. When all edges are more or less of the same length, these irregular polyhedra present many of the forms common to cells, bubbles in foam, and compressed shot. The average of close to 14–facets in a disarranged space-filling mass of bodies of similar size thus appears inevitable. The occasional occurrence of five or six cells chancing to meet at a point, or of four meeting along a line, would slightly reduce the average.

* Read at the 75th Anniversary Celebration of the Torrey Botanical Club at Columbia University, Monday, June 22, 1942.

Cell division extends the difference in the number of facets both above and below the afore-mentioned range of 12 to 18. Yet if the average plane of division is hexagonal (which would be expected when division bisects a cell rather than cuts off a corner) it will not affect the average of 14 facets. It causes a diversity in cell size, incompatible with a full realization of the Kelvin pattern. Yet if division occurs in a prevailing plane, it can orient the cells, and orientation makes possible an approach to Kelvin's orthic 14–hedron, which approximation is indubitably present in the oriented pith of *Eupatorium* and in similar tissue.

We conclude, therefore, that an average of 14 facets can be due to chance, or to tension, or a combination of both. The mathematical solution of the problem of dividing space into uniform bodies of least surface area and of maximum stability has been solved by Lord Kelvin's minimal 14–hedron (or its close approach,—his orthic 14–hedron). Since such diverse forms as the stellate 12–rayed cells of *Juncus,* and the prosenchymal tracheids of the pine with from 18 to 22 facets apiece, are accountable as derivatives of the Kelvin 14–hedron, as well as all the forms in cork and pith, it may properly be regarded as the typical shape of cells in masses. There is no rival uniform pattern. But it is only through absolute uniformity in size, precision in alignment, and the dominance of surface tension (3 factors at least) that a foam of minimal 14–hedra may be expected. These conditions have apparently not yet been realized in any cells or any froth. The typical shape thus remains a mathematical abstraction, whereas the actual shapes are coming to be well understood, and haphazard is a factor.

Harvard Medical School
Boston, Massachusetts

The Evolution and Determination of Sexual Characters in the Angiosperm Sporophyte*

Charles E. Allen

One result of genetic study which bears definitely upon evolutionary theory is the demonstration that the determination of an apparently simple character depends upon the activity of many genes. It is indeed suggested that the interaction of all the genes of an organism may be essential to the appearance of any character; but for the present this broader conception remains in the realm of speculation.

Another contribution from the same source is the demonstration that similar or apparently identical phenotypes may be determined by diverse genic complexes. It follows that very different gene mutations in distinct lines of descent may result in the appearance of similar characters—a fact which in another aspect students of phylogeny have long stated in terms of parallel or convergent evolution.

Turning to a special class of characters, it is evident that sexual differentiation has arisen independently in many different plant and animal lines. There is no reason for assuming that the changes in the genetic mechanism which resulted in this differentiation were identical, or even closely similar, in diverse lines.

To this consideration is to be added that, after the first step in sexual differentiation, additional mutations occurred, independent and varying in different lines. These later steps resulted in differentiation between the organs in which gametes are produced; in differentiation of individual gamete-producing plants or animals as respectively female and male; and, in certain pteridophytes and in all seed plants, in a backward extension of sexual differentiation to involve structures of the parental spore-bearing generation.

A priori, then, it is not to be expected that the genetic mechanisms which determine sexual potentialities or which influence sex-expression should be the same in different groups of organisms. Yet it is characteristic of discussions in this field that unitary theories of "sex-determination" have been developed; each based upon phenomena observed in one or in a few related species, but each seeking to apply one mechanism to all groups of sexually differentiated organisms. There is, to be sure, one set of facts which may seem to support this conception of uniformity: namely, the occurrence in widely separated phyla of apparently similar bodies—the sex chromosomes—which are a part of the genetic mechanism whose nature is being sought.

* Read at the 75th Anniversary Celebration of the Torrey Botanical Club at Columbia University, Monday, June 22, 1942.

But it would not be surprising to discover that this type of similarity presents an additional instance of parallel evolution.

The history of angiosperms begins at a level at which the greatly reduced members of the gamete-bearing generation had long been sharply separated as female and male individuals. Sexual differentiation also had been projected backward to effect a distinction in the parental generation between female and male spore-bearing structures. These structures—macro- and micro-sporangia—were now borne upon or within likewise sexually differentiated organs later to be designated pistils and stamens.

Less confident must be any statement as to the *distribution* of pistils and stamens in primitive angiosperms. Three conditions are conceivable. Either the original angiosperm flower was bisexual (bisporangiate), the plant bearing it being hermaphroditic; or there were separate pistillate and staminate flowers, borne either on the same plant (a condition of monoecism) or on distinct plants (a condition of dioecism).

Attempts to choose between these possibilities were based first upon comparative morphology; then, as fossil evidence accumulated, the assistance of paleobotany was sought. The latter source has as yet contributed little to the problem here involved. It has shown that the equivalent of a bisporangiate flower was developed by Cretaceous times in the Bennettitales; and that the equivalent of a unisporangiate flower was present in the Caytoniales as early as the Triassic. But it is agreed that neither Bennettitales nor Caytoniales were ancestral to modern angiosperms. Probably the great majority of those who have discussed the question have concluded that primitive angiosperms had bisexual flowers. But unanimity upon this point is not reached; and the possibility of a polyphyletic origin, some lines starting with hermaphroditism, others with monoecism or dioecism, is not wholly excluded.

Since the sharp distinction between female and male gametophytes was established at a pre-angiosperm level, a discussion of the evolution of sexual characters in angiosperms can deal only with developments within the spore-bearing generation. It may be asked, first, what if any genetic evidence is there as to the type of distribution of sexual structures in primitive angiosperms? Second, what appears to have been the most probable course or courses of evolution of sexual characters since the dawn of angiosperm history?

Two general sets of facts, long recognized and both to be referred to later, suggest the derivation of unisexual from bisexual flowers. One of these concerns the presence in the majority of monoecious and dioecious species of pistil-rudiments in staminate flowers and of stamen-rudiments in pistillate flowers. The stage to which these rudimentary structures develop varies from that of a small hump of undifferentiated tissue to that of the reflexed stamens of the functionally female flowers of the grape, which produce non-viable or rarely viable pollen. The appearance of such variably developed but functionless or chiefly functionless organs is difficult to explain save by reduction in the course of descent from a hermaphroditic ancestor. A different conception may be based upon those species whose unisexual flowers show no trace of organs of the opposite sex. When, however, such plants belong to, or are obviously closely related to, families among whose members are some with bisexual flowers or with unisexual flowers containing staminodia or pistillodia, the obvious explanation of unisexuality is still that of descent by reduction from a bisexual condition. There remain the relatively few species that supply no indication, through either structure or relationship, of such descent. It was this condition in Casuarina which made it, in Wettstein's phylogenetic scheme (19), the starting-point for angiosperms.

The other set of facts with a similar bearing is the variability of sexual conditions in those angiosperms whose flowers are typically unisexual. In many monoecious and dioecious species, bisexual flowers now and then appear. Even more frequently, staminate replace pistillate flowers and *vice versa;* flowers of either sex appearing on the dioecious plant or on the part of the monoecious plant which regularly bears flowers of the opposite sex. Whatever its explanation, such lability of sex-expression in the sporophyte contrasts sharply with the rigid separation of sexual characters in the gametophyte. Comparable lability seems to characterize gyno- and andromonoecious, gyno- and androdioecious species.

In this connection, too, cases may be found which could be thought to point in an opposite direction. Among the dioecious species that have been extensively studied, three (two of *Lychnis* and one of *Bryonia*) present a very sharp sex-separation. Doubtless, when other less well-known species are studied, similar instances will be found. But in *Bryonia dioica* staminate flowers, in *Lychnis dioica* and *L. alba* both staminate and pistillate flowers, contain rudiments of organs of the opposite sex. The change in sex-expression in pistillate flowers or *Lychnis* under the influence of the anther smut is well known, although human ingenuity has yet found no means of accomplishing a like result. No modification of sex-expression is known to have been induced in *Bryonia dioica,* though there is one old report of a female plant bearing some bisexual flowers.

The common variability of the unisexual condition is among the facts which long ago led to the conclusion that in all angiosperms genotypic bases are present for both femaleness and maleness. No reason has appeared to question this conclusion; indeed, all later-adduced evidence has but served to confirm it. Correns (2) postulated for dioecious species an additional gene or gene-complex for sex tendencies superposed upon those representing sex potentialities. This formulation, recognizing a certain degree of genotypic complexity, is still, so far as it goes, valid as a formal statement of the case. As will appear, it is now evident that the story is even more complicated than Correns' statement would imply.

A first suggestion of the complexity to be expected appears in the fact that in dioecious angiosperms as in metazoa there are two general types of genotypic influence upon sex. In one, the more common type in both groups, the male is heterozygous, the female homozygous, for sex-tendency factors as well as for sex chromosomes. In the other, represented by strawberries and possibly by members of a few other genera, the male is homozygous, the female heterozygous. The difference is explicable by descent from hermaphroditic ancestors, different mutations in which have led to opposite results. It adds to the improbability of an assumption of the primitiveness of dioecism.

A type of mutation observed in a considerable number of hermaphroditic species involves a stoppage at some stage in the development of stamens (or their complete failure to develop), with the result either that no pollen is produced or, if produced, it is nearly or quite functionless. "Male-sterile" mutations of this general nature have been studied, for example, in the sweet pea, shepherd's purse, sorghum, *Oenothera,* onion, tomato, potato, barley (16). In these and in other plants, the condition in question seems to be due to a mutated gene (or to at least two genes in the tomato), the mutation being always or nearly always recessive. Mutations of a somewhat different sort bring about a replacement of stamens by petals or petaloid structures. It is clear that mutations of both types have occurred on a large scale in the past; witness the frequent occurrence, previously noted, of staminodia or stamen rudiments replacing some of the stamens in bisexual flowers or all the stamens in flowers which are now unisexual. Notable are the partial petaloid transformation of the last-remaining stamen of *Canna;* the often-observed occurrence of doubleness in consequence of a transformation of stamens; and the evidence from the morphological side that petals in many cases represent transformed and sterilized stamens. Mutations tending toward male sterility occur likewise in monoecious species. In maize, the most studied genetically of all plants, at least 27 distinct mutations of this general nature have been observed (7); 20 classed as "male-sterile," 5 as "tassel ear," one each of "antherless" and "pollen lethal." These 27 mutations involve as many distinct gene loci; all but two are recessive.

Such mutations in the direction of male sterility might be described as tending toward femaleness. Those of another type, known for example in *Silene, Cheiranthus,* and *Papaver,* in which stamens are replaced by carpels, may be similarly classed.

Comparable with the mutations which result in or tend toward male sterility are those leading toward female sterility. The striking fact shown by a review of the literature is that mutations of this type appear, in both hermaphroditic and monoecious species, to be far less frequent than are those leading toward male sterility. Female sterility, pistils being more or less aborted, seems to be recessive in mutants of *Phleum pratense, Antirrhinum,* rice, and raspberries. In *calycanthema* forms of *Campanula* and of *Rhododendron,* the mutant condition (pistils developed but sterile) is dominant. In *Geranium,* pistils functional as such but showing structural transitions toward the staminate character have appeared in interracial crosses. The behavior of the character in back-crosses, while not entirely clear, suggests a Mendelian segregation. In a cross between species of *Geum,* the results of further matings are likewise not clear-cut. It is possible that in these crosses, as apparently in a few interspecific crosses which have resulted in male sterility, cytoplasmic influences are involved.

In the same list of mutations in maize which shows 27 genes involved in male sterility, only 6 mutations leading toward female sterility are reported: two "anther ear," 2 "barren stalk," 1 "lethal ovule," 1 "silkless."

To the story of observed mutations in this direction must be added the known cases of pistillodia, which represent the result of past mutations; possibly the reduction in number of ovules in certain lines; and the relatively few cases of doubleness which have involved the transformation of pistils as well as of stamens into petals.

To be mentioned also are a few known mutations which, like two observed in intervarietal crosses in *Oryza* (12), tend simultaneously toward both male and female sterility. Obviously mutations of this class can hardly have played a direct part in evolution. In general they seem to result in monstrosities which, even apart from the accompanying sterility, would probably not be favored by selection. Chromosomal changes may be involved.

It is not yet clear why mutations toward male sterility are much more frequent than those toward female sterility. This difference holds not only for observed mutations. As to the past, it is evident that petals in a large proportion of instances represent sterilized stamens; only rarely can they be considered sterilized carpels.

The mutations thus far cited involve changes in the general direction from hermaphroditism toward dioecism. As already mentioned, very many variations (to be distinguished from mutations) occur in the opposite direction—involving the appearance in monoecious or dioecious species of bisexual flowers or, in dioecious species, of both pistillate and staminate (and sometimes bisexual) flowers on the same plant. Such variations are in large measure shown to be reactions to environmental conditions. They may be considered expressions of genotypic possibilities present from a remote ancestry, certain of which have been inhibited, but not completely suppressed, by mutations like those previously mentioned.

But apart from variability of this common type, now and then a demonstrable *mutation* occurs in the direction from dioecism or monoecism toward hermaphroditism. Such mutations are known in dioecious species of *Lychnis, Salix, Silene, Vitis,* and *Fragaria;* in *Salix* and *Silene* they have occurred in the offspring of interspecific crosses. One recessive mutation resulting in bisexual flowers is known in maize (7). Most monoecious or hermaphroditic strains derived from dioecious species and subjected to genetic experiment have behaved as though they were mutated males; a very few have seemed to be mutated females. In *Lychnis* both mutated males and mutated females have been recognized cytologically. Those hermaphrodites (the term is often somewhat loosely used) which appear to be mutated males in general behave in breeding like males; that is, their progeny shows them to be heterozygous for a sex-tendency gene. In this respect they differ from regularly hermaphroditic species, which of course transmit hermaphroditism uniformly to all their progeny. This genotypic difference, as Correns pointed out, justifies the description of the appearance of hermaphroditism in a dioecious or monoecious species as a case of "backward evolution." The implication is that in a dioecious species derived from a primitively hermaphroditic one a mutation has produced a reversion to the phenotypically original character—although this change is not due to a reverse mutation of a previously mutated gene.

Not always readily distinguishable from these variations and mutations are the reported cases, in species classed as dioecious, of strains which regularly vary in degree of sex-separation. In *Urtica cannabina, Spinacia,* and *Mercurialis,* for example, plants shown to be genetically distinct occur which are monoecious or hermaphroditic. In other instances differing degrees of sex-separation are manifested by different strains. Comparable but not fully elucidated cases are presented by gynodioecious species. In the absence of direct evidence as to their origin, these diverse conditions are capable of explanation either as steps in an evolutionary sequence leading toward dioecism, individuals showing intermediate conditions not yet having been eliminated; or as evidences of mutation in the reverse direction comparable with the cases studied in *Lychnis.*

Mutations, then, may and do occur both in the general direction from hermaphroditism toward dioecism and in that from dioecism toward hermaphroditism. Those of the latter class are much the less frequent, and the best known of them lead to a hermaphroditism which is not genetically like the hermaphroditism which may be considered primitive. It is evident, too, that mutations away from hermaphroditism have been numerous in the past and that, as shown by the persistence of rudimentary structures, very many of them have become fixed as part of the specific genotype.

The conclusion indicated by genetic evidence hence agrees with that most strongly suggested by morphological study; the general tendency in angiosperm evolution has been from a primitive hermaphroditism toward dioecism. In many species various intermediate stages have been reached; in something less than 5000 according to available counts (20), the final step to dioecism has been taken.

The mutations that have been chiefly concerned in the evolution of sexual conditions in angiosperms have involved a diminution or loss of the power of spore-production; commonly also a loss or reduction of the organs concerned. The mutations of this nature which are appearing at present are with rare exceptions recessive. It is reasonable to assume that similar mutations in the past history of angiosperms have, at their origin, likewise been chiefly recessive. Those mutations which have played the major rôle in floral evolution agree, therefore, in two respects—in involving a loss or diminution of potentialities and in being originally recessive—with the general run of observed mutations in all organisms. So far, then, as concerns one important group of structures and functions within one subdivision of the plant kingdom, evolution has proceeded by means of the type of mutation which genetic study has shown to be the prevalent type. In connection with this particular phylogenetic problem, the familiar difficulty of reconciling "progressive evolution" with genetic results does not arise.

It may be added that the mutative changes here shown to have been important are in harmony with the tendency toward the sterilization of sporogenous tissue which has characterized the evolution of bryophytes, pteridophytes, and seed plants.

The succession of steps in the changes from primitive hermaphroditism must remain for the present speculative. Obviously male sterility and female sterility may appear in different plants of a single species, as has happened in *Rubus* (4). In *Rubus*, however, dioecism is not yet reached, for matings of certain male and certain female plants produce some hermaphrodites and some "neuters" (without functional stamens or pistils). The species may at present (not considering the neuters) be classed as trioecious. At least two additional genetic changes would seem to be necessary (11) in order for the ultimate goal to be reached. Since mutations are likely to occur independently, it is to be expected that in the transition from hermaphroditism species now dioecious have passed through several intermediate stages.

It is possible to imagine the early steps to have been by way of gyno- or andromonoecism, trimonoecism, or monoecism. Any of these conditions could conceivably be reached by the establishment in homozygous condition of one or (more probably) more than one mutant gene. How dioecism may arise from monoecism is illustrated by the success of Jones (8, 9) and of Emerson (6) in the production of dioecious races of maize through the selection of appropriate mutations. In each case two mutations were involved; and in each of the three dioecious races obtained, one pair of chromosomes differed with respect to a mutant gene which is epistatic to the mutant allele of the other selected pair.

Another conceivable transition from hermaphroditism to dioecism is by way of gynodioecism, which has been considerably studied, or of androdioecism, about which nothing is known genetically. If within a hermaphroditic species male sterility becomes a fixed character of one strain, evidently other strains of the species must usually retain functional pistils if the species is to persist—that is, a condition of gynodioecism must ensue. An alternative would be the development (by an additional mutation) of a structurally female but functionally parthenogenetic species. This seems to have happened in *Hieracium excellens* (14); but such mutational coincidences must be rare. A mutation (or mutations) transforming the hermaphrodites of a gynodioecious species into males would lead to dioecism.

The difficulty of explaining the behavior of gynodioecious species by any simple genic scheme led Wettstein (18) to the assumption of a cytoplasmic influence—an idea tentatively accepted by Correns (3) and recently emphasized and generalized by Lewis (10, 11). Apart from the inadequacy of an explanation based upon one or two mutations, the argument for a cytoplasmic inhibition in the female upon the functioning of male-tending genes rests upon the demonstration of such an apparent influence in several typically hermaphroditic plants, including forms of *Linum, Nicotiana, Geranium, Epilobium,* and *Streptocarpus*. With the exception of one case in maize (15), the known phenomena of this nature are limited to interspecific hybrids. On the other hand, also, gene mutations leading to male sterility are, as has been seen, of frequent occurrence. It is entirely possible that, when the variable behavior of gynodioecious species becomes better known, a (perhaps complicated) Mendelian explanation may be found possible.

Nearly twenty years ago Emerson (5), pointing out that "there are at least nine pairs of genetic factors which influence the expression of sex in maize," suggested that "the genetic situation in maize . . . . may perhaps afford some help toward a solution of sex problems." The prophecy has been abundantly confirmed. Today more than 40 genes are known in maize, borne on at least 9 of the 10 chromosomes, whose presence in the "normal" or usual condition is directly essential to the sex-expression typical of the species as it exists at present. There are others, likewise essential in this regard, whose more conspicuous influence is upon the form, size, or vigor of the plant. There can be no serious doubt that the sex-expression of other angiosperms, many of whose mutations parallel those observed in maize, is likewise dependent upon the activity of many genes.

A large proportion of the genes concerned in the sex-expression of contemporary species may have come down unchanged or little changed from primitive angiosperms. Those early species were themselves the outcome of a long evolutionary history in whose course had been developed a complex genotype. As has been seen, the passage from hermaphroditism to other sexual conditions need involve only a comparatively small number of mutations of genes already present. One step—perhaps in general the final step if maize may serve as an example—involved the establishment in some members of heterozygosis with reference to one pair of genes as to which other members of the species are homozygous. The pair of chromosomes bearing this allelic pair now plays a part in sex-determination.

Again to judge from maize, the selection of different mutant genes may in different cases give rise to the same phenotypic result—namely, dioecism. This example shows, too, how different pairs of chromosomes may in different cases come to function in sex-determination, as the X-Y pair appears to function in some seventy-odd species of dioecious angiosperms. The relation of the sex chromosomes to the differentiating genes may vary from species to species. In *Rumex* (13), as in *Drosphila,* the Y chromosome plays no demonstrable part in sex-differentiation. In *Lychnis,* on the other hand (17), its rôle is a positive one. In *Fragaria,* as in one of Emerson's derived races, the "X-Y" pair characterizes the female of the species; in all other well-known cases in angiosperms, this pair is the property of the male. While a partial picture is thus presented of the functioning of a pair of chromosomes in sex-separation, no satisfactory explanation is yet available for the frequent visible differentiation between the members of this pair. At the same time, it is shown in more than forty investigated angiosperms that there is no necessary correlation between the final genic differentiation which in a dioecist influences sex and a perceptible difference in chromosome size or appearance.

The mutations that have determined the transition from hermaphroditism have not produced in most cases, if in any, an absolute fixity of sexual character. Instead, whatever the inhibiting tendencies of a particular mutation, it remains possible, under favoring conditions, for some or all of the old potentialities to be manifested; as when bisexual flowers appear on a monoecist or dioecist. No rigidity of sex-separation seems to have been reached by the angiosperm sporophyte such as characterizes the angiosperm gametophyte or the gametophyte of a dioecious bryophyte.

The conception which emerges of the genetic basis for sex can not be satisfactorily formulated in terms of so many genes for maleness and so many for femaleness. The elements which constitute this mechanism at any particular period in the history of a species influence in various ways and in varying degrees the development and functioning of stamens and pistils; they influence also the numbers and arrangement of these organs, whether in the same or in separate flowers, as well as the time of appearance of the respective flowers and their positions on the plant.

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Literature Cited

Most of the studies referred to in the present paper are cited in the first article listed below. For this reason only a few references to specific papers have been included.

1. Allen, C. E. The genotypic basis of sex-expression in angiosperms. Bot. Rev. **6**: 227–300. 1940.
2. Correns, C. Die Bestimmung und Vererbung des Geschlechtes nach neuen Versuchen mit höheren Pflanzen. 1907.
3. ———. Bestimmung, Vererbung und Verteilung des Geschlechtes bei den höheren Pflanzen. Handbuch der Vererbungswissenschaften (Baur and Hartmann) II, C. 1928.
4. Crane, M. B., and W. J. C. Lawrence. The genetics of garden plants. 2d ed. 1938.
5. Emerson, R. A. A genetic view of sex expression in the flowering plants. Science N. S. **59**: 176–182. 1924.
6. ———. The present status of maize genetics. Proc. 6th Int. Congr. Genetics **1**: 141–152. 1932.
7. ———, G. W. Beadle, and A. C. Fraser. A summary of linkage studies in maize. Cornell Univ. Agr. Exp. Sta. Mem. 180. 1935.
8. Jones, D. F. Dioecious maize. Science N. S. **73**: 432. 1931.
9. ———. Unisexual maize plants and their bearing on sex differentiation in other plants and in animals. Genetics **19**: 552–567. 1934.
10. Lewis, D. Male sterility in natural populations of hermaphrodite plants. New Phytol. **40**: 56–63. 1941.
11. ———. The evolution of sex in flowering plants. Biol. Rev. **17**: 46–67. 1942.
12. Nagai, J. Studies on the mutations in *Oryza sativa* L. I–IV. Jap. Jour. Bot. **3**: 25–96. 1926.
13. Ono, T. Chromosomen und Sexualität von *Rumex Acetosa*. Sci. Repts. Tôhoku Imp. Univ. 4th Ser. Biol. **10**: 41–210. 1935.
14. Ostenfeld, C. H. Castration and hybridisation experiments with some species of *Hieracia*. Bot. Tidskr. **27**: 225–248. 1906.
15. Rhoades, M. M. The cytoplasmic inheritance of male sterility in *Zea Mays*. Jour. Genet. **27**: 71–93. 1933.
16. Suneson, C. A. A male sterile character in barley. Jour. Hered. **31**: 213, 214. 1940.
17. Warmke, H. E., and A. F. Blakeslee. Sex mechanism in polyploids of Melandrium. Science N. S. **89**: 391, 392. 1939.
18. Wettstein, F. Über Fragen der Geschlechtsbestimmung bei Pflanzen. Naturwiss. **12**: 761–768. 1924.
19. Wettstein, R. Handbuch der systematischen Botanik. 4th ed. 1935.
20. Yampolsky, C., and Helene Yampolsky. Distribution of sex forms in the phanerogamic flora. Biblioth. Genet. **3**: 1–62. 1922

Leaf-stem Relationships in the Vascular Plants*

Ralph H. Wetmore

It is an arresting fact that in the year of our Lord 1942 there is still no general agreement on the organization of the Vascular Plants. Perhaps the nearest one can get to a generalization is the admission that Vascular Plants ordinarily comprise root systems and shoot systems. Studies of the shoot systems indicate the usual presence of stems, leaves and reproductive parts. The interpretation of the relation of leaves to the stem which bears them has been varied. From time to time there have been those who adhered to the phyton hypothesis, a hypothesis that made the leaf the important unit of construction of the shoot system, each leaf consisting of the foliar appendage and its subjacent stem segment or internode. This concept by which the stem becomes a vertical aggregation of leaf bases was probably advocated first by Gaudichaud in 1841, and subsequently by Schultz (1843) and by Delpino (1880, 1883). Little of really scientific contribution could be attributed to these workers. Their fanciful ideas, however, were given an artificial bolstering by Čelakovský (1901) when he brought toegether a group of serious arguments supporting the foliar nature of the stem. However, as Schoute (1931) points out these same facts upon which Čelakovský's arguments were based could equally well be explained otherwise. This early hypothesis did not have a large or literal following. No more did Chauveaud's phyllorhiza hypothesis (1921) a modification of the phyton concept, meet with general acceptance.

Alternative ideas, which held the stem to be an independent organ bearing foliar appendages, have been prominent and generally much more in favor. Our textbooks bear witness to this fact.

With these two concepts of the shoot system in mind, I should like to present the results of certain recent and current developmental studies. Since the work of Buder (1928) and his students (Schmidt, 1924, etc.) on apical meristems there has grown a body of knowledge which challenges the formalized interpretations of developmental patterns in the apices of root and shoot attributed to Hanstein (1868). These studies have been continued especially by the significant works of Schüepp (1926) and Foster (1935, 1936, 1938, 1939a, 1939b, 1940, 1941a, 1941b). The latter investigator has made progress on a comparative study of the diverse types of apical meristems in different plant groups. The already classical works on Helm (1931, 1932) and Louis (1935) have extended our knowledge of the whole stem tip with its developing leaves. More recently numerous workers have contributed

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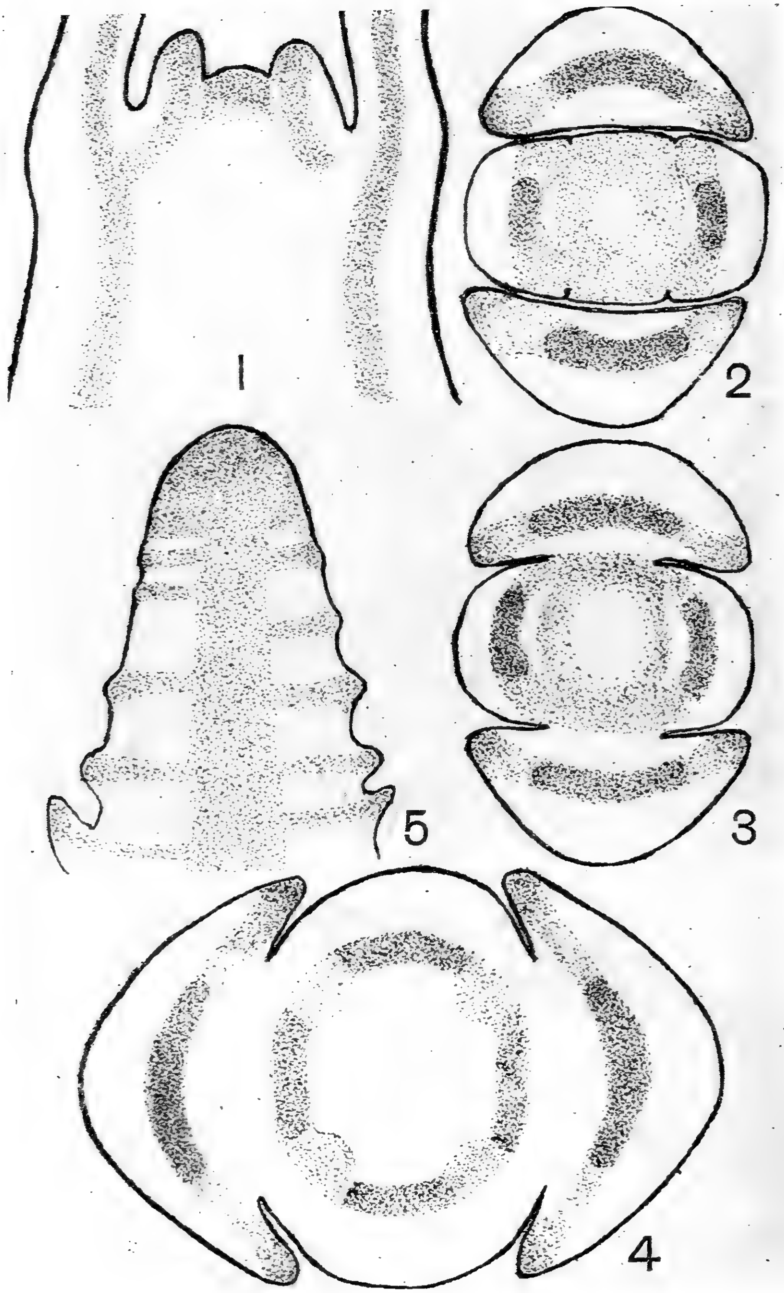
to this field,—Priestley (1928, 1929, 1935, 1936) and his associates (Griffiths and Malins, 1930; Majumdar, 1942; Scott and Priestley, 1925), Esau (1938, 1939, 1940, 1942, 1943), Cross (1937, 1939, 1940, 1941, 1942) to name a few. These studies bear directly on any interpretation of the leaf-stem relationship.

Louis reported in detail on the development of the stem apices in nine Angiosperms and one Gymnosperm—*Taxus baccata*. In his study of *Syringa vulgaris,* with opposite leaves, he called attention to the general flat appearance of the apical meristem upon which the paired leaf primordia are elevated (Fig. 1). In their early appearance these peg-like protuberances are composed of cells like those of the meristem itself. At this level a transverse section of the tip indicates an oval or near rectangular shape, with each end of the rectangle called a leaf buttress,—Majumdar's leaf foundation (1942)—on which originates an erect leaf primordium. Such a transverse section Louis (following Schmidt, 1924) considered as made through a *region of maximal area* (Fig. 2). If another transverse section be cut immediately below this pair of leaf primordia, a circular outline is obtained; Louis considers such a circular section as cut through a *region of minimal area* (Fig. 3). A section through the bases of the next lower pair of leaves provides another region of maximal area, with its major axis at right angles to the first. Thus the stem tip is composed of alternating zones of maximal and minimal area, each buttress of the former always bearing a leaf primordium. Obviously then a leaf buttress is topographically a part of the stem with no clear boundary between it and its elevated leaf primordium.

Studies of successive leaves proceeding downward from the apex give one a progressive picture of developmental changes in the leaf. As Louis points out, such studies point to a general increase in vacuolation on the outer or abaxial side of each young primordium and its buttress. Shortly thereafter in each leaf an adaxial area appears as equally vacuolated. Thus in Syringa there is left between the two vacuolated areas, continuous with the apical meristem, a band of tissue as seen in transverse section (Figs. 2, 3, 4).

Careful examination shows this band to be heterogeneous, and comprised of a leaf bundle in procambial stage flanked by residual meristem (Esau, 1943). As one follows the sections downward it is seen that the first two pairs of leaf buttresses completely surround the stem, at which level the four abaxial ground meristems, appearing extensively vacuolated, now envelop the stem as the incipient cortex (Fig. 4). Successive sections also show that each adaxial, highly-vacuolated ground meristem has become continuous with the pith, thereby forming the so-called *leaf gap*.

Thus at a level below the second pair of leaves (Fig. 4) the stem of *Syringa* consists externally of a protoderm surrounding a potential cortex. A pith is clearly evident as an early vacuolated, central ground meristem (Fig. 1, 4).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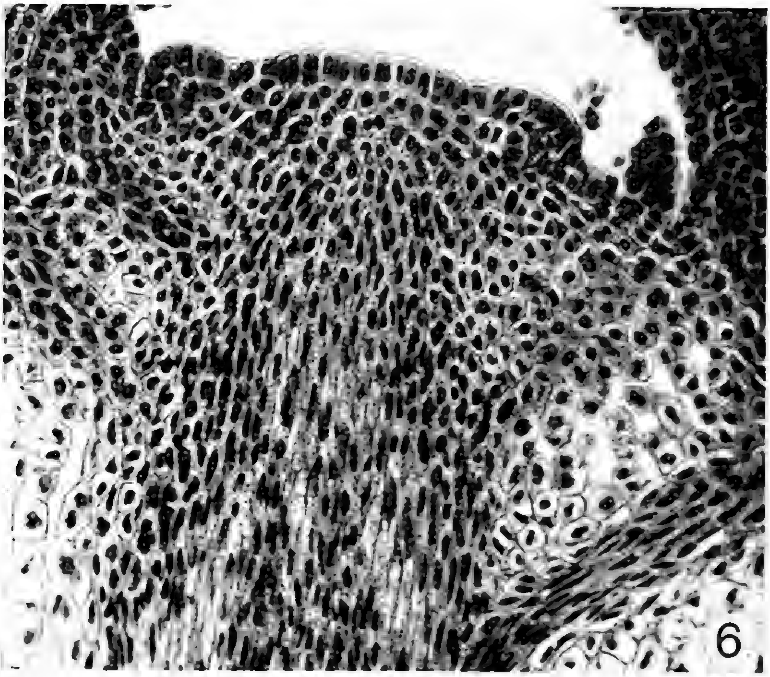
Between these cortical and pith ground meristems exists a ring of small-celled tissue which Louis has designated *prodesmogen*. An examination of this ring, however, shows it to be heterogeneous in nature, not homogeneous as Louis supposed. Confronting each leaf buttress is a small-celled arc of differentially staining tissue—the procambium of the leaf trace—which is continuous with that of the developing leaf. On either side of this leaf trace bundle, in the ring, is a narrow zone of residual meristem,—the *primary ray*. Immediately above each outward-bending leaf trace is the highly vacuolated local break in the ring, referred to above as the *leaf gap* (Fig. 1, right). Louis' investigation of *Syringa* does not include the development of procambium. However subsequent study by the writer indicates the continuity of this procambium with differentiating primary vascular tissue below, its development being continuously acropetal.

Allowing for variations according with the phyllotactic pattern, size of leaf and number of leaf traces per leaf in the large number of Angiosperms now investigated,* it would seem fair to state that in this large group of plants vascular and cortical patterns are generally correlated with the formation of leaves at the apex. The pith by contrast seems to belong to the axis. It was on the strength of such studies in his own laboratories that Priestley and his associates propounded the idea of "the unit of shoot growth" for Angiosperms, a modified phyton and a unit closely resembling the "Sprossglieder" of Čelakovský. Each such unit consists of a leaf and a subtending longitudinal sector of the stem—not a whole segment as earlier phytonists had considered it. There are many interesting points in this hypothesis as Priestley has developed it. Time does not permit their consideration. It is true that in the Angiosperms investigated by Priestley the facts could be so interpreted. It is perhaps equally pertinent to question whether the generalization which he makes will hold for all cases in the Angiosperms. In this connection I should like to call your attention to *Hippuris vulgaris,* which Louis has also

* Studies by Foster (1938, 1939b, 1940, 1941a, 1941b) and his student Gifford (1943), Crafts (1940), Cross (1939, 1940, 1941), etc., would indicate that this statement is pertinent also for *Ginkgo,* the Cycads, the Conifers and *Ephedra.*

Explanation of figures 1-5

Figs. 1–4. *Syringa vulgaris.* Fig. 1. Longitudinal section of stem tip (×90). Fig. 2. Transverse section of stem tip showing region of maximal area through buttresses of first pair of leaves (×130). Fig. 3. Transverse section slightly lower through buttresses of first pair of leaves near region of minimal area; leaf gap almost confluent with pith (×130). Fig. 4. Transverse section below attachment of first two pairs of leaves to show the ring composed of procambium and primary rays or interfascicular residual meristem (×130). Fig. 5. Longitudinal section of stem tip of *Hippuris vulgaris* (×130). (Figs. 1–5 after Louis.)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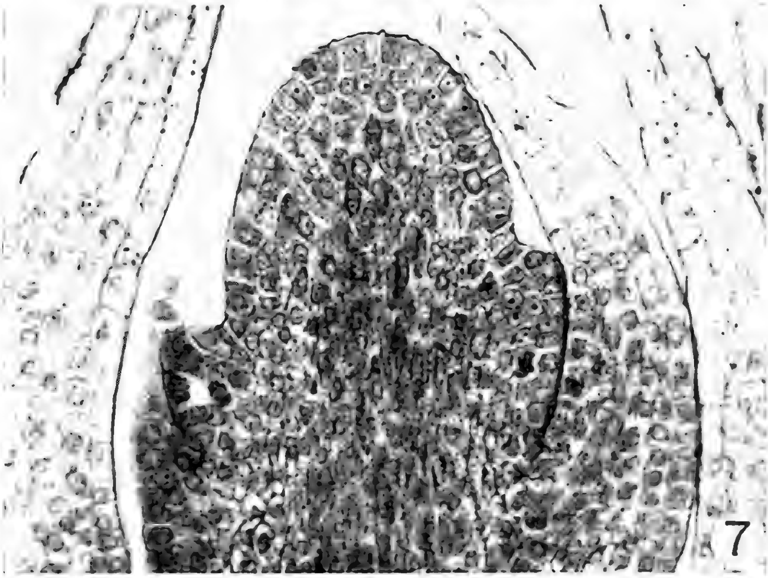
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illustrated. As is well known, this plant possesses a protostele in the stem. The apical meristem is not flat as in most Angiosperms; the leaves are borne laterally (Fig. 5). There is a central procambial column—i.e., no pith—which rises above the last leaf primordium. Cortical ground meristem also exists above the highest leaf primordium. In other words, the stem now shows a potential epidermis, a potential cortex, and conducting tissues without the "influence" of leaf primordia.

It may be argued that this aquatic plant is modified in relation to its environment. Possibly so; nevertheless, it seems significant that the plant should be developing at all, if the axis of Angiosperms is a system of phytons or growth units only. On such slight evidence one can do no more than suggest the possibility that Angiosperms have a shoot system, potentially both cauline and foliar, in which ordinarily the leaves possess a dominant and the stems a minor "influence" on development, but in which on occasion the stem may hold the major rôle and the leaves a minor though necessary one. In this connection one might refer to certain seeming cauline bundles—certainly not associated with leaves—which Boke (1941) reports in the cactus *Trichocereus spachianus.*

It is instructive to examine other groups of vascular plants for developmental patterns. Basing one's judgments on the Angiosperms alone may well produce a limited outlook. May I call your attention to the genus *Lycopodium* in which our laboratories have been interested for some time. The conclusions are based on a careful investigation of nine species. Those representatives which we have studied from the Urostachys segregation of *Lycopodium, L. lucidulum* Michx. and *L. Selago* L. have a flat-topped apical meristem with erect foliar primordia (Fig. 6). The protostelic vascular cylinder is forecast in a recognizable column of procambial tissue which rises higher toward the apex than the place of origin of the youngest leaf primordium. Young leaf primordia already show procambial strands related to them, never discontinuous with the central column. The cortical ground meristem is belated in appearance. There is never a pith nor is there any adaxial vacuolated ground meristem with its associated leaf gap. By studying successive transverse sections below the apex it is seen that the cauline vascular tissues—the *metaxylem* and *metaphloem*—are outlined or blocked out, within 100μ of the apex in *L. lucidulum,* whereas the first sign of the differentiation of *protoxylem* occurred only about 300μ from the apex. However, though blocked

Explanation of figures 6 and 7

Longitudinal sections of serial stem tips of *Lycopodium* to show proximity of procambial column to the stem apex. Fig. 6. *L. Selago;* stem apex flat-topped (×260). Fig. 7. *L. sabinaefolium;* stem apex conical (×300).

out, no differentiation of this cauline tissue into metaxylem and metaphloem is seen to occur until after differentiation in the leaf traces themselves has become well established, and then only centripetally from the protoxylem and *protophloem* (Fig. 8). It is interesting to recall that such a blocking out of the metaxylem and metaphloem pattern, before differentiation occurs, is reported commonly in Angiospermous roots. (Esau, 1940; Williams, 1940.)

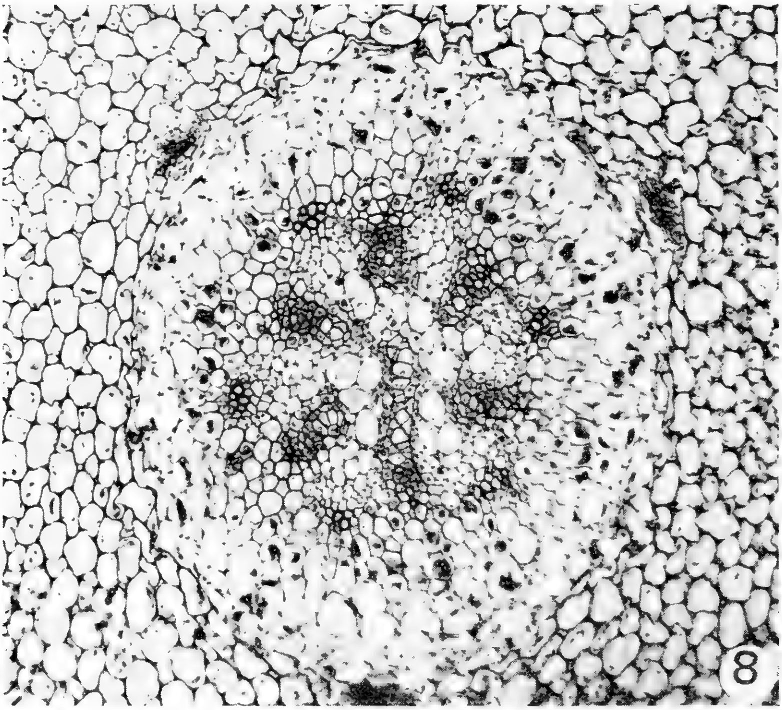

Fig. 8. Tranverse section of aerial stem of *L. sabinaefolium,* 2710μ from apex, showing pattern of the radially organized stele already blocked out, but differentiation only present in the peripheral strands of protoxylem and protophloem (×260).

In the remaining part of the genus *Lycopodium,* as represented by the seven species studied,* the apex is not flat, but conical, with laterally borne leaves (Fig. 7). Here, however, the developmental story is generally the same (Fig. 8). So is it true for the numerous species of *Selaginella* now in process of investigation; the detailed study is not yet complete. Before leaving

* This study includes *Lycopodium inundatum* L., *L. cernum* L., *L. annotinum* L., *L. clavatum* L., *L. obscurum* L., *L. sabinaefolium* Willd., *L. complanatum* L., and its variety *flabelliforme* Fernald.

Lycopodium, I should like to mention that all the underground rhizomes of *L. obscurum* so far examined have only membranous scale-like leaves with no traces. It is significant that this rhizome develops vascular tissues and cortex, however, not dissimilar to those normally present in a leaf-bearing rhizome.

In substance, these living Lycopsida seem to have a shoot system composed of a cauline part with foliar primordia borne initially in either erect or lateral position. Here there seems to be a peripheral set of bundles, which form a primary network and which are connected with the leaves, bundles originating from procambial strands which are truly acropetal and continuous in their origin. In addition, ordinarily differentiating only after leaf connections are established, though blocked out earlier, is the whole central portion of the central cylinder which is cauline in nature and which is never directly connected with the leaves.

What of the Horsetails, Ferns, and Gymnosperms? In *Equisetum,* the story is far from complete. A study of native species of this genus now in progress in our laboratories gives evidence of a continuous acropetally developing procambium to the leaves and branches. It is not yet clear, however, from this work, nor that of Barratt (1920), Queva (1907) or Vidal (1912), just how the nodal ring is developed. Certainly it would be difficult to think of this ring as entirely foliar in nature.

In the Ferns, the study is fragmentary. The work of Gillette (1937) on *Psaronius* and of Schoute (1926) on living Marattiaceae suggest the complicated stele to be of foliar origin. In the three native species of Osmundaceae, as yet unreported studies from our laboratories show no sign of cauline bundles, though Kaplan reports such. In his summary on the Ferns in Verdoorn's MANUAL OF PTERIDOLOGY, Schoute (1938) states (p. 84): "In the Ferns the original Pteridophyte stele with its external sheaths, its phloem and its central solid xylem has been reduced into a mere topographical tissue column, acting as a recipient for leaf-traces, but without any tissue differentiation of its own."

Before leaving the Ferns, I must refer to certain scale-bearing stolons of species of *Nephrolepis,* studied by Lachmann (1885, 1889) and others. Originally described as roots, they proved to be stems with a cortex and a protostelic central cylinder resembling much more that of sporeling Ferns or mature axes of *Gleichnia, Lygodium* or *Hymenophyllum* which remain permanently protostelic.

In the Gymnosperms, the classical account of Koch (1891), followed by those of Barthelmess (1935), Cross (1939, 1940, 1941, 1942), Foster (1938, 1939b, 1940, 1941a, 1941b), Gifford (1943), Korody (1937), and Louis (1935), indicates diverse patterns of apical meristem in the different gymnospermous assemblages. The work is too incomplete to give any summary statement. Barthelmess (1935), in his study of various Conifers, considers the primary vascular tissue composed of leaf traces only, variously united into sympodia. However, his interpretation of procambium developing basipetally is not in agreement with Cross' findings (1942) in *Cunninghamia lanceolata,* Crafts (1940) in *Sequoia,* and our as-yet unpublished findings in *Pinus Strobus* and *Ginkgo biloba.* In general, Barthelmess points out the similarity of the coniferous apical region to that described for the Angiosperms by Helm (1931). One observation of Barthelmess' should be referred to, that of a shoot of *Pseudotsuga* which in the course of its development failed to produce the normal needle-like leaves and instead gave only membranous, scale-like structures with no leaf traces. Yet this shoot when examined gives a normal structural picture for a shoot of *Pseudotsuga* except that the vascular cylinder is unbroken by the usual interfascicular parenchyma or primary rays.

A summary survey of the literature and current research pertaining to the organization of primary shoots of diverse groups of the vascular plants certainly leaves the writer with no final dictum on the nature of the shoot. There is cumulating evidence, however, that in *Lycopodium* and *Selaginella* the vascular cylinder is mostly of cauline, to a lesser degree of foliar, origin. Even here, though blocked out somewhat earlier in development, the differentiation of metaxylem and metaphloem ordinarily does not seem to occur until the leaf traces are themselves in a process of differentiation.

The evidence for *Equisetum,* Ferns, and Gymnosperms is still too incomplete to permit of generalizations. The rhizomes of *Lycopodium obscurum,* the leafless stolons of *Nephrolepis,* the unusual shoot of *Pseudotsuga,* and other leafless cauline axes considered by Troll (1937, p. 287–304), give indication that stems in these groups may develop epidermis, cortex and vascular tissues even though no leaves be present. Certainly the early appearance of pith in the majority of species of Horsetails, Ferns, and Gymnosperms would suggest for it a cauline origin, for this pith is often found higher in the axis than the most apical, foliar, procambial connection. As Schoute (Verdoorn, 1938) points out in his summary for the Ferns, there can be no question as to the "influence" of megaphyllous leaves on the differentiation of vascular tissues.

In the Angiosperms, developmental studies generally give indication of the importance of foliar structures on the entire developmental sequence of events in the axis. There is little evidence to suggest a separate rôle for the axis in the development of vascular tissues, except possibly in certain aquatics such as *Hippuris,* possibly in the interesting case of the cactus *Trichocereus,* and a few other instances. However, the fact that roots develop vascular and cortical tissues without foliar appendages must not be forgotten.

Is it possible to consider the shoot system as an entity within which a division of labor has occurred, the leaf being set off physiologically from the axis bearing it even though it originated as a product of the same meristematic activity which adds to the stem tip? There is increasing evidence that in many cases in diverse groups of Vascular Plants each foliar primordium so produced is provided with procambium continuous from below at all times (Esau, 1943; Wetmore and Smith, 1942, etc.). Whatever the later orderly differentiation of primary xylem and primary phloem may be, that continuity seems of significant import. The boundary then between leaf and axis is indefinite with leaf buttresses present as those parts of the axis from which leaf primordia are elevated. It must be pointed out, however, that the "influence" of the leaf is of different degrees in different groups of plants. Certainly in roots, in rhizomes of *Lycopodium obscurum,* in leafless axes of *Nephrolepis,* and in the leafless shoot of *Pseudotsuga,* cortex is produced as well as a vascular cylinder. In the cauline structures, the cortex is ordinarily retarded in its development. In *Lycopodium* and *Selaginella,* microphyllous plants, cortex is ordinarily slow in developing. In the Conifers, one finds needle-like or scale-like small leaves and a slowly developing cortex. In the Angiosperms and Ferns with their characteristic large leaves, cortical and vascular differentiation is early, yet small-leaved types such as *Linum* show the usual delay (Esau, 1942). As Kaplan (1937) has suggested, cortex appears soonor or later but leaves seem to accelerate the process of cortical vacuolation.

If I, this early, should venture to epitomize the leaf-stem situation, it would be something as follows: The early, psilopsid land plants, still leafless, were protostelic. With the advent of leaves, microphyllous or megaphyllous, various changes have occurred in stem organization. Microphyllous plants possess in their primary axes a small amount of "foliar" trace vascular tissue, peripherally connected to the cauline, vascular cylinder. In megaphyllous groups, the foliar vascular system and its stem connections become more significant and the potential cauline portions, failing in varying degrees to differentiate, appear as pith. The shoot system is the sum total of foliar and cauline expression. From the practical point of view, the shoot is still composed of leaves borne on a stem system. From a developmental point of view, where one of necessity is faced with factors underlying development, an understanding of the varied developmental patterns of shoot expression in the vascular plants seems significant. How else can one approach experimentation to determine the underlying physiological and biochemical background than with a knowledge of the structural and developmental variables?

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Literature Cited

Barratt, Kate. 1920. A contribution to our knowledge of the vascular system of the genus *Equisetum*. Ann. Bot. **34**: 201–235.

Barthelmess, A. 1935. Ueber den Zusammenhang zwischen Blattstellung und Stelenbau unter besonderer Berüchsichtigung der Coniferen. Bot. Arch. **37**: 207–260.

Boke, N. H. 1941. Zonation in the shoot apices of *Trichocereus spachianus* and *Opuntia cylindrica*. Amer. Jour. Bot. **28**: 656–664.

Buder, J. 1928. Der Bau des phanerogamen Sprossvegetationspunktes und seine Bedeutung für die Chimärentheorie. Ber. Deut. Bot. Ges. **46**: (20)–(21).

Čelakovský, L. J. 1901. Die Gliederung der Kaulome. Bot. Ztg. **59**: 79–114.

Chauveaud, G. 1921. La constitution des plantes vasculaires révélée par leur ontogénie. Payot et Cie, Paris.

Crafts, A. S. 1940. Vascular differentiation in the shoot apex of *Sequoia*. Amer. Jour. Bot. **27**: 705.

Cross, G. L. 1937. The morphology of the bud and the development of the leaves of *Viburnum rufidulum*. Amer. Jour. Bot. **24**: 266–276.

———. 1939. The structure and development of the apical meristem in the shoots of *Taxodium distichum*. Bull. Torrey Bot. Club **66**: 431–452.

———. 1940. Development of the foliage leaves of *Taxodium distichum*. Amer. Jour. Bot. **27**: 471–482.

———. 1941. Some histogenetic features of the shoot of *Cryptomeria japonica*. Amer. Jour. Bot. **28**: 573–582.

———. 1942. Structure of the apical meristem and development of the foliage leaves of *Cunninghamia lanceolata*. Amer. Jour. Bot. **29**: 288–301.

Cross, G. L. and T. J. Johnson. 1941. Structural features of the shoot apices of diploid and colchicine-induced tetraploid strains of *Vinca rosea* L. Bull. Torrey Bot. Club **68**: 618–635.

Delpino, F. 1880. Causa meccanica della fillotassi quincunciale. Nota preliminare. Genova.

———. 1883. Teoria generale della fillotassi. Atti della R. Universita di Genova 4.

Esau, K. 1938. Ontogeny and structure of the phloem of tobacco. Hilgardia **11**: 343–424.

———. 1939. Development and structure of phloem tissue. Bot. Rev. **5**: 373–432.

———. 1940. Developmental anatomy of the fleshy storage organ of *Daucus carota*. Hilgardia **13**: 175–226.

———. 1942. Vascular differentiation in the vegetative shoot of *Linum*. I. The procambium. Amer. Jour. Bot. **29**: 738–747.

———. 1943. Origin and development of primary vascular tissues in seed plants. Bot. Rev. **9**: 125–206.

Foster, A. S. 1935. A histogenetic study of foliar determination in *Carya Buckleyi* var. *arkansana*. Amer. Jour. Bot. **22**: 88–147.

———. 1936. Leaf differentiation in angiosperms. Bot. Rev. **2**: 349–372.

———. 1938. Structure and growth of the shoot apex in *Ginkgo biloba*. Bull. Torrey Bot. Club **65**: 531–556.

———. 1939a. Problems of structure, growth, and evolution in the shoot apex of seed plants. Bot. Rev. **5**: 454–470.

———. 1939b. Structure and growth of the shoot apex of *Cycas revoluta*. Amer. Jour. Bot. **26**: 372–385.

———. 1940. Further studies on zonal structure and growth of the shoot apex of *Cycas revoluta* Thunb. Amer. Jour. Bot. **27**: 487–501.

———. 1941a. Comparative studies on the structure of the shoot apex in seed plants. Bull. Torrey Bot. Club. **68**: 339–350.

———. 1941b. Zonal structure of the shoot apex of *Dioon edule* Lindl. Amer. Jour. Bot. **28**: 557–564.

———. 1942. Practical Plant Anatomy. D. Van Ostrand Co., New York.

Gaudichaud, Ch. 1841. Recherches générales sur l'organographie la physiologie et l'organogénie des vegetaux. Paris.

Gifford, Ernest M. 1943. The structure and development of the shoot apex of *Ephedra altissima* Desf. Bull. Torrey Bot. Club. **70**: 15–25.

Gillette, N. J. 1937. Morphology of some American species of *Psaronius*. Bot. Gaz. **99**: 80–102.

Griffiths, A. M. and M. E. Malins. 1930. The unit of shoot growth in dicotyledons. Leeds Phil. and Lit. Soc., Proc., Sci. Sec. **2**: 125–139.

Hanstein, J. 1868. Die Scheitelzellgruppe im Vegetationspunkt der Phanerogamen. Festschr. Niederrhein. Ges. Natur- u. Heilkunde. 109–143.

Helm, J. 1931. Untersuchungen über die Differenzierung der Sprosscheitelmeristeme von Dikotylen unter besonderer Berücksichtung des Procambiums. Planta **15**: 105–191.

———. 1932. Über die Beeinflussung der Sprossgewebe-Differenzierung durch Entfernen Junger Blattanlagen. Planta. **16**: 607–621.

Kaplan, R. 1937. Über die Bildung der Stele aus dem Urmeristem von Pteridophyten und Spermatophyten. Planta. **27**: 224–268.

Koch, L. 1891. Über Bau. und Wachsthum der Sprossspitze der Phanerogamen. I. Die Gymnospermen. Jahrb. f. Wiss. Bot. **22**: 491–680.

Korody, Elisabeth. 1937. Studien am Spross-Vegetationspunkt von *Abies concolor, Picea excelsa* und *Pinus montana*. Beitr. Biol. Pflanz. **25**: 23–59.

Lachmann, P. 1885. Recherches sur la morphologie et l'anatomie der Fougères. Compt. Rend. Acad. Sci. **101**: 603–606.

———. 1889. Contributions à l'histoire naturelle de la racine des Fougères. Thesis. Lyon.

Louis, Jean. 1935. L'ontogénèse du système conducteur dans la pousse feuillée des Dicotylées et des Gymnospermes La Cellule. **44**: 87–172.

Majumdar, G. P. 1942. The organization of the shoot in *Heracleum* in the light of development. Ann. Bot. n.s. **6**: 49–81.

Priestley, J. H. 1928. The meristematic tissues of the plant. Biol. Rev. **3**: 1–20.

———. 1929. Cell growth and cell division in the shoot of the flowering plant. New Phytol. **28**: 54–81.

Priestley, J. H., L. I. Scott, and E. C. Gillett. 1935. The development of the shoot in *Alstroemeria* and the unit of shoot growth in monocotyledons. Ann. Bot. **49**: 161–179.

Priestley, J. H., and L. I. Scott. 1936. The vascular anatomy of *Helianthus annuus* L. Leeds Phil. and Lit. Soc., Proc., Sci. Sec. **3**: 159–173.

Queva, C. 1907. Histogénèse et structure du stipe et de la fronde des *Equisetum*. Soc. Hist. Nat. d'Autun, Bull. **20**: 115–152.

Schmidt, A. 1924. Histologische Studien an phanerogamen Vegetationspunkten. Bot. Arch. **8**: 345–404.

Schüepp, O. 1926. Meristeme. In K. Linsbauer's Handbuch der Pflanzenanatomie. Bd. 4.

Schoute, J. C. 1926. On the foliar origin of the stelar structure of the Marattiaceae. Rec. Trav. Bot. Néerl. **23**: 269–304.

———. 1931. On phytonism. Rec. Trav. Bot. Néerl. **28**: 82–96.

Schultz, C. H. 1843. Die Anaphytose oder Verjüngung des Pflanzen. Ein Schlussel zur Erklärung des Wachsens, Bluhens und Fruchttragens, mit praktischen Ruck-sichten auf die Cultur der Pflanzen. Berlin.

Scott, L. I., and J. H. Priestley. 1925. Leaf and stem anatomy of *Tradescantia fluminensis,* Vell. Jour. Linnean Soc., Bot. **47**: 1–28.

Troll, Wm. 1937. Vergleichende Morphologie der höheren Pflanzen. 1 Band. 1 Teil. Gebrüder Borntraeger, Berlin.

Verdoorn, Fr. (editor). 1938. Manual of Pteridology. Martinus Nijhoff, The Hague.

Vidal, L. 1912. La croissance terminale de la tige et la formation des bourgeons chez l'*Equisetum palustre.* Ann. Sci. Nat., Bot., 9e sér., **15**: 1–38.

Wetmore, R. H., and Ada C. Smith. 1942. Development of shoot system in Lycopodium. Amer. Jour. Bot. **29**: 19s.

Williams, Bert C. 1940. Differentiation of vascular tissue in root tips. Amer. Jour. Bot. **27**: 10s.

Cell Division as a Problem of Pattern in Plant Development*

Edmund W. Sinnott

The plane in which a cell divides and the position of the new wall laid down between the two daughter cells involve important problems, not alone as to the behavior of individual cells, but also as to the development of multicellular plant structures, since the planes of division in a mass of growing tissue must evidently be related to the direction in which growth occurs, and thus to the form of the organs produced.

Various hypotheses have been suggested as to factors which determine the position of the new wall in a dividing cell. Hofmeister showed that such walls are usually formed at right angles to the longer dimensions of the cell. Sachs observed that a new wall tends to meet the old one at right angles. The direction of mechanical pressure, light, electrical currents, and gradients of various chemical substances have been shown to affect the orientation of the division wall. Errera and Berthold, later supported by D'Arcy Thompson and others, maintained that since cell walls in embryonic tissues are thin and semi-liquid, their position is governed by molecular forces and will be such that minimum surface and maximum stability result, so that no more than three walls meet at one point. All these "rules" can be abundantly illustrated from plant material, but every histologist has seen exceptions to them. Some of these have recently been discussed by the writer and Dr. Bloch. The problem is evidently too complex to be explained by any one hypothesis. It has too often been approached simply as a question relating to the activity of single cells rather than of these cells as members of an organized multicellular system. The present paper reports a study of cell division as it occurs in a simple plant structure, in an attempt to determine what relation there may be between the manner in which a cell divides and the position which it occupies in such an organized entity.

The shoot axis of *Equisetum* provides particularly good material for such a study. Its growth is centered in a single apical cell and the lineages of cells arising from this are relatively easy to follow. The structure of the axis is without serious complication and the leaves are small, simple and in whorls. A number of previous studies have been made on various species of this genus and for many of them the development of the shoot apex is well known. It seems worth while, however, to examine the facts for a single

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The writer wishes to express sincere appreciatian to his colleague Dr. Robert Bloch, who carried out the technical part of the study here reported and prepared the illustration•

species in some detail from the particular point of view of the problem of cell division.

Equisetum hyemale, one of the larger of our native species, was chosen for study. This has a rather massive meristematic region as compared with some of the more delicate types. Transverse and longitudinal sections, both median and tangential, were cut through the stem tips which had been collected at various times from March until June, the period when meristematic activity and growth are best studied. Cell divisions occur not only at the apex of the meristem near the apical cell, but for some distance back along the axis during the differentiation of various tissues.

The manner in which division takes place was found to differ markedly depending on the location and character of the cells concerned. Some of the types are as follows:

The large apical cell cuts off a daughter cell from each of its three inner faces, successively. The new wall is approximately parallel to the old so that the two daughter cells are dissimilar in shape and usually in size (Fig. 1).

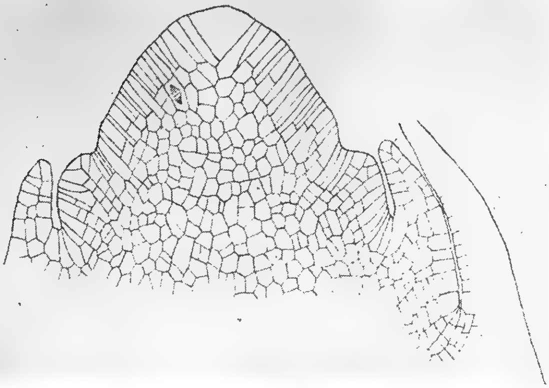
The lower cell elongates, as seen in longitudinal section, and divides periclinally. The inner of its daughter cells contributes, by rather irregular divisions, to a mass of tissue just below the apical cell. The outer one divides anticlinally, and thus parallel to its long dimension. This portion of the meristem thus consists of a surface layer of elongate cells and an inner mass of irregularly-shaped ones (Fig. 1).

Most subsequent divisions in the outer layer are anticlinal, thus violating Hofmeister's rule, with the new division wall straight and parallel with the sides of the mother cell. Occasionally, however, usually at the point where a new leaf primordium will develop, the inner edge of the phragmoplast begins a straight course but before it reaches the end of the mother cell it swerves to one side, usually in the basal direction, until it meets the anticlinal wall of the old cell (Fig. 2). The smaller of the two daughter cells thus produced, somewhat V-shaped in section, will form the apical cell of one of the leaf primordia which begin to appear a little further back. Such a wall as here described is neither across the shorter dimension of the cell nor does it conform to a least-surface configuration, although in the inner part of its course it becomes curved.

Shortly below this level there may be seen in longitudinal section a series of cell divisions across the axis. This marks the beginning of one of the diaphragms which is such a conspicuous feature of the stem anatomy of *Equisetum*. These divisions are always approximately at right angles to the axis regardless of the particular shape of the cells in which they occur and, therefore, occupy positions in these cells which violate many of the "rules."

Such divisions continue until a considerable amount of diaphragm tissue is formed (Fig. 3).

The point where each incipient diaphragm meets the outer surface of the meristem marks the base of a whorl of leaf primordia. While these are still



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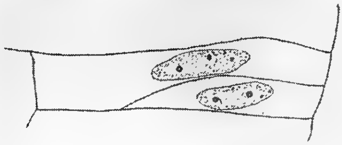

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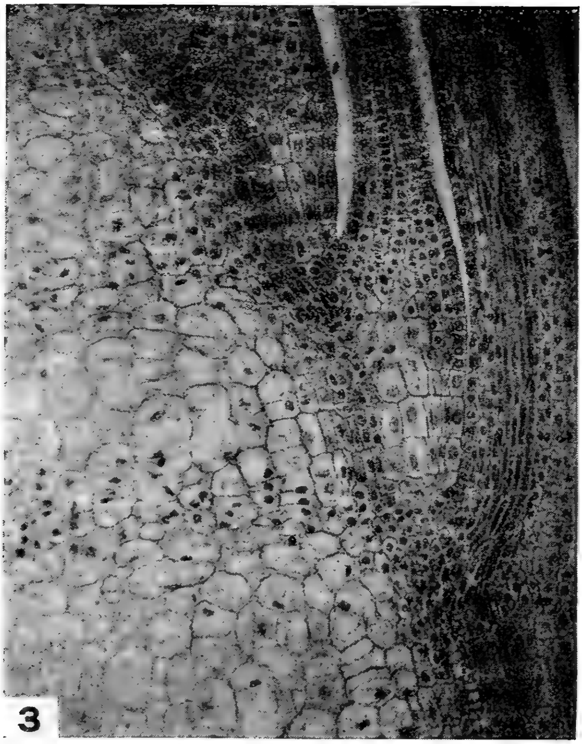
FIG. 1. Section through the extreme tip of the growing shoot of *Equisetum hyemale*, showing apical cell, surface layer of elongate cells, central mass of irregular cells, and young leaf primordia.

FIG. 2. An oblique division in one of the surface cells. The smaller one will produce an apical cell of a leaf primordium.

very small there begins to be differentiated within the base of each a series of provascular strands from which the circle of vascular bundles will later develop (Fig. 3). Each of these strands arises by a series of longitudinal divisions (thus at right angles to those in the diaphragm) in a cell row near the surface of the meristem. These divisions, like those in provascular tissue generally, run parallel to the long axis of the cell.

In the subepidermal layer of the meristem, along the future ridge of the axis, where the photosynthetic tissue will later develop, the method of division is still different. Here the anticlinal longitudinal walls in a given cell are in



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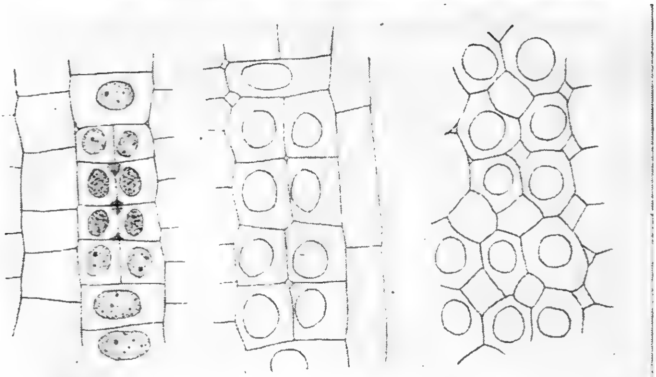

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Fig. 3. Photograph through a lower region of the meristem showing parts of several diaphragms, two leaf bases and the beginnings of provascular tissue in stem and leaf.

Fig. 4. Three stages in the development of a row of aerenchymatous tissue. Most of the division walls are opposite those in vertically adjacent cells.

most cases exactly opposite similar walls in the cells above and below, so that in such a group of cells, as seen from its outer surface, four walls usually meet at a point instead of three as in most tissues. The point where these cells come together is evidently subject to a good deal of strain as the cells expand and intercellular spaces thus develop here very early (Fig. 4). These become much enlarged in the mature tissue. The relation between such a type of cell division and the development of aerenchyma has previously been pointed out by the writer.

The surface cells which are to give rise to stomata undergo a remarkable series of divisions. In a vertical row of cells, every second one is a stomatal mother cell. The first division in it is longitudinal and usually unequal, with the new wall convex toward the smaller daughter cell. The next, in the larger cell, is convex in the opposite direction, so that a lens-shaped cell has now been cut out with a larger cell on either side. The lens-shaped cell then divides into two guard cells.

This diversity in the type and direction of cell division in developing plant tissue is of course not confined to *Equisetum* but is a familiar feature of the process of differentiation in all multicellular plants. The important fact which it emphasizes is that no single method of division is universal, and that every "rule" is frequently broken. Evidently many factors may be concerned with determining the plane of cell division. What a given cell will do depends not upon some general principle of division, common to all cells, but upon the conditions which exist at that particular place and time. Every cell is a part of a general developmental pattern, and not only in the way it divides but in every other aspect of its behavior it seems to be governed by its particular place in that pattern. Driesch nearly half a century ago summed this up in his famous aphorism that "the fate of a cell is a function of its position," and Vöchting many years before said the same thing in almost the same words.

This general fact of development, so well illustrated by the controlled diversity of mode of cell division in the meristematic tissues of plants, should be recognized by all students of morphogenesis. In a search for the mechanisms which operate in the remarkable processes of organic development, we tend to oversimplify the problem and to postulate factors which have a specific method of operation. Thus the rôle of auxin, of light, or of a given gene is often assumed to be a definite and invariable one, whereas its effect actually is dependent in very great measure on the internal and external environment in which it operates. In an eagerness to find specific organ-forming substances and stimuli we have too often neglected the complex reaction system, the developmental pattern in which these must work. Knowledge about specific factors is very useful and is rapidly accumulating, but far more important would be an understanding of the complex organic system in which they work and which determines their effect. About this we still know very little.

The problem may perhaps be stated somewhat more vividly by comparing the operation of a developing organic mechanism with that of others more familiar to us. A nickel inserted into a slot, for example, will activate a turnstile or a juke box or a coin telephone. There is but little specificity in the "stimulus" but a great deal in the mechanism which it activates. If one knew everything about nickels and how they differ from other coins he still would fail to understand how a nickel could produce these results, for an answer to this question lies in the character of the reacting mechanism. In somewhat the same way, auxin produces one effect in one part of the developing organism or under one set of conditions, and quite another elsewhere; and the principle of minimal surfaces may determine the position of new cell walls at one region of the meristem but may be overruled by other factors in another.

The developing organism is a patterned whole, the parts and activities of which derive their particular character from their relation to this whole, and should be studied in this relation and not only as independent structures or processes. An understanding of this organized pattern and the way in which it controls development and differentiation is the chief task of the science of morphogenesis.

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Contributions of the Torrey Botanical Club to the Development of Taxonomy*

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Travel back in your mind to 1867. Andrew Johnson occupies the White House at Washington. Carpet-baggers are rampant in the South. Boss Tweed has his thumb on the city of New York. Millions of buffalo graze the plains of Kansas. The first transcontinental railway has not been completed.

And what of science in this country? Botany is still regarded as a proper subject of study in a ladies' seminary. Of plant physiology there is none, although a young Maine physician, George Goodale, may be musing on the subject. Of plant pathology there is none, although a country school teacher, Charles Peck, a storekeeper, Benjamin Everhart, and a farmer, Job Ellis, are actively collecting fungi, and a young medical student, William Farlow, is beginning an interest in the subject. Of genetics there is none, although there is a great deal of talk about a recent book called the Origin of Species. No ordinary college student has yet peeked through a microscope as a part of his regular classwork, but a sophomore at Michigan Agricultural College, Charles Bessey, is wishing that he could and a few years later gave the opportunity to his own students.

In taxonomy conditions are very different. Three distinguished botanists stand out above all the rest for their taxonomic research, Gray of Cambridge, Torrey of New York, and Engelmann of St. Louis, although measured by influence on the teaching and study of botany and consequently by their inspiration of another generation, Torrey and Gray must divide their honors with another New York man, Alphonso Wood. The plants of the eastern states are already thoroughly known and no one gives much attention to this region. In the south Chapman is still discovering undescribed species, and in the unsettled and largely uncivilized west several adventurous botanists are sending east large quantities of new material to Gray, Torrey and Engelmann.

In New York, Professor Torrey was the only research botanist, but there were several young folks who were interested in plants, who liked to tramp over the hills, along the beaches, or through the pine barrens. These young folks met with Professor Torrey, exhibited their botanical treasures, recounted the adventures of their trips, and rejoiced together over the collection of some uncommon species. Torrey did not encourage them to work for a doctor's degree or require them to register for formal courses in botany. He did not advise them to explore the jungles of the tropics, where new species could

* Read at the 75th Anniversary Celebration of the Torrey Botanical Club at The New York Botanical Garden, Tuesday, June 23, 1942.

be found, or to monograph the genus Carex. Wise in proportion to his years, he knew that good taxonomists can develop but can not be forced, and he probably felt and hoped that from such a group there might arise from time to time a few taxonomists who, through their deep interest, their keen observation, and their taxonomic curiosity, would really contribute to the advancement of science. He, therefore, neither overwhelmed them with his own knowledge nor belittled their own amateur work, but listened patiently to the accounts of their adventure, praised them for their discoveries, and by his geniality and interest encouraged them to further study. These were the men who organized themselves into the Torrey Botanical Club in 1867.

After the death of Torrey, the Club was left to stand or fall on its own merits. During the seventies it was held together partly by the common interest of its members, which could be expressed in meetings and field excursions, and partly by the responsibility of publishing the Torrey Bulletin.

As the first contribution which the Torrey Club has made to taxonomy, we naturally think of its publications. For many years the largest item in the budget of the Club has been for the production of the BULLETIN, the MEMOIRS, and TORREYA. And as the Club has been generous, so have taxonomists, not only the members of the Club but non-members as well, been fortunate in finding in it a dignified and reputable means of presenting their results to the world.

Those who have had occasion to look through the early volumes of the BULLETIN know that the membership of the Club was originally composed almost entirely of amateur taxonomists, of young men interested in the local flora, and that Dr. Torrey was the only professional taxonomist in the group. From the pens of these young men came a series of short notes, almost all taxonomic or floristic in nature and most of them very amateurish. Some of them soon graduated into actual research work; among them T. F. Allen and C. F. Austin, who began during the seventies to publish critical discussions and descriptions of new species of Chareae and Hepaticae.

The BULLETIN soon began to attract the attention of other American botanists, and during the seventies and early eighties its pages contain contributions from such well-known men as F. L. Collins, A. H. Curtis, J. B. Ellis, George Engelmann, Asa Gray, Charles H. Peck, John Donnell Smith, William Trelease, L. M. Underwood, and Francis Wolle. As its circulation grew, so did the length and importance of its articles. Little by little the local observations disappeared and were replaced by sober research, until during the eighties and nineties it had become without doubt the leading American outlet for the publication of taxonomic research. To supplement the BULLETIN and to provide for longer articles, the MEMOIRS were established in 1889 and have given the bulk of their pages also to taxonomy. TORREYA was established in 1901, primarily for a revival of opportunity for the discussion of local botany, but it also has given a fraction of its space to taxonomic research.

As a matter of statistics, it may be recorded that to the end of 1941, the Club has published a total of 22,098 pages of printed matter devoted to pure taxonomy or to cognate subjects primarily of interest to taxonomists. I feel certain that this impressive total is not approached by any other American magazine during the same three-quarters of a century.

In the preparation of this paper, I have leafed through the publications of the Club and have compiled two graphs showing the amount of taxonomic publication year by year, and the proportion, expressed in percentage, of the total publication which has been devoted to taxonomy. In doing so I have often had to make hasty judgments as to the taxonomic or non-taxonomic classification of an article, and I have also tried to take into account the general nature of the membership of the Club and of its audience at the different periods in its history. Consequently I have included in taxonomy many short articles from the early volumes which, if printed today, would be regarded merely as interesting notes of no special botanical value. The resulting graphs, to revive an ancient New York simile, were as crooked as Pearl Street and their general trend was badly obscured by the huge annual fluctuations. For presentation today I have smoothed them out severely so that neither the highest peaks nor the lowest depressions now appear. These graphs speak for themselves and require little comment or explanation (Fig. 1).

The first curve shows the number of printed pages in the Club's publications which have been used for taxonomy. It shows the feeble results of the Club's activities during its struggling first decade; the rapid rise of taxonomy in the nineties, as Britton and Rusby came into action and as the BULLETIN became a national rather than a local organ; the huge productivity in taxonomy at the turn of the century when those active young men Britton, Small, and Rydberg were at their best; and the gradual decrease in total taxonomic matter in the last three decades as space became available in several new publications. Since the curve is smoothed it does not show the peak of publication, which was 932 pages in 1906, nor the lowest point of the last half century, which was 101 pages in 1926.

The second curve shows the percentage of total publication which has dealt with taxonomy. It shows the almost exclusively taxonomic interests of the membership in the early days of the Club, followed by twenty years of gradual diversification; a temporary rise over another twenty years, as the unparalleled productivity of New York botanists overbalanced the generally growing interest in morphology and physiology; a general period of decline during the next thirty years, as the interests of the members became more diversified;

and finally a rise in the proportion during the last decade, doubtless in response to the general revival of interest in taxonomy.

The magnitude and importance of the Club's contribution to the advancement of taxonomy by means of its publication is, I am sure, realized and appreciated by all taxonomists, and I trust that my figures have served to make it clear to the non-taxonomic members of the audience.

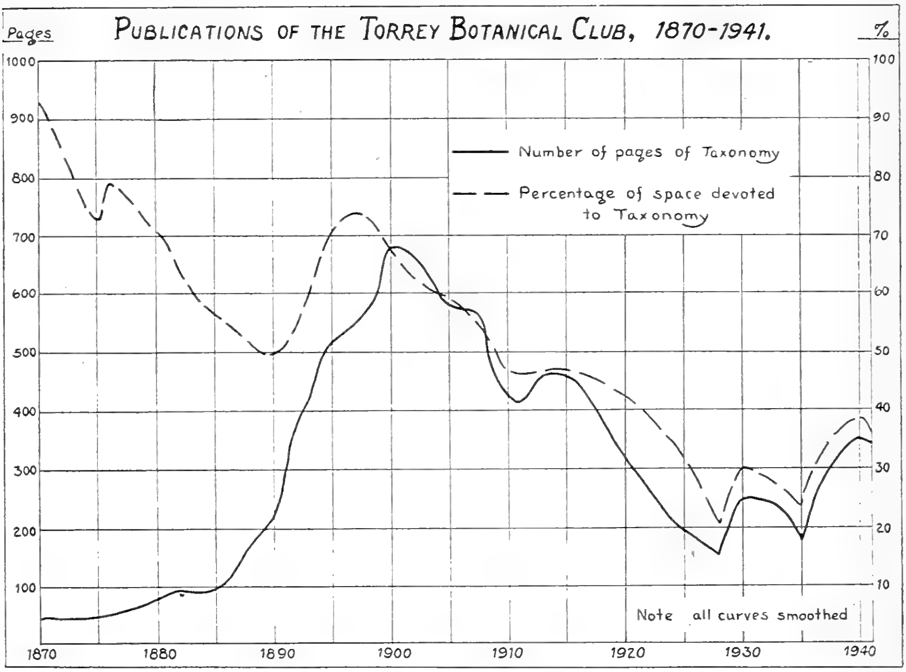

FIG. 1

As a second and minor contribution I may mention the development of the Torrey Club herbarium. Begun so long ago that I fail to find the date of its inception, this herbarium grew very gradually through the donations of the local members. Not long after the Museum Building of the Botanical Garden was completed the herbarium was transferred to it, and continued to expand through the voluntary activity of interested local botanists and through the collections of the Garden staff. The Club then presented the herbarium to the Botanical Garden and it has since been maintained as a separate unit, covering the area known as the Torrey Club range, which is roughly all the territory within a hundred miles of New York, and illustrating the flowering plants and ferns of this region by some 65,000 mounted specimens. The herbarium may be consulted by any person interested in the local flora, which is almost completely represented.

A botanical club, considered as a unit, can of course do no research, and the Torrey Club has not employed taxonomists for research nor given grants in support of it. Besides the two contributions to taxonomy which I have already mentioned, is there any other way in which the Torrey Club can be or has been of genuine service? There is a third way, which may not occur to you immediately, in which the Club has been active, and through which, measured by the extent and importance of the results, the Club has rendered a highly valuable service, a service which has been partially outmoded by the changed conditions of the twentieth century, but for which there is still an opportunity and a demand. I refer to the encouragement and inspiration of botanists. Botanists, like poets, are born, not made, but after birth they must be developed. Today we have colleges and graduate schools for that purpose, but such was scarcely the case in New York in the seventies and early eighties. Even a formal education is not always sufficient. Probably every one of us can look back to our earlier years and remember the inspiration which we received from some one botanist, an inspiration which may have determined us to become botanists rather than to enter some other profession.

Obviously, the professional botanists of New York today were not made into botanists because of the influence of the Torrey Club, nor do they remain botanists for that reason. Conditions were different sixty or seventy years ago, when the death of Dr. Torrey left the Club without a leader and the botanical interests of its members were kept alive largely through the encouragement of mutual contact, through the emulation of their fellow-members, through the stimulation of new ideas, through the applause for the work they accomplished.

There are some professions which can easily demand one's full time, leaving no opportunity for a hobby; there are some which offer excellent opportunities for productive research to those who are so minded. There are still others in which the prospect of large financial gain acts as a stimulus to continuous work. Financial success, once it has been attained, is also apt to lead one to devote his leisure time to the more fashionable forms of pleasure.

I shall cite to you five men who were trained and educated in a different line, who earned their bread and butter in a different profession, whose interest in botany was merely a young man's hobby, but who maintained this interest throughout their life and in two instances finally made it their life's work. One of these men had political advancement apparently within his reach, but turned from it to enter botany at the bottom of the professional ladder. A second had opportunity for research in a different subject. A third turned from his original profession into botany before he was thirty. Two achieved financial independence and still remained botanists by avocation.

Surely there was a cause for this continued interest in plants, and I fail to find any plausible cause other than the factor of encouragement and inspiration received through the Torrey Botanical Club. Then, when you hear the results achieved by these men, when you realize the part they have played in the development of American taxonomy and in the provision of taxonomic opportunity for others, you will agree that the most important contribution yet made by the Torrey Club has been the inspiration and encouragement of these men and of others whom I have not time to mention. The five are sufficient to demonstrate my point.

Eugene P. Bicknell, as a boy, was an amateur ornithologist and began publishing in that subject at the early age of eighteen. As a man, he was a banker. It was undoubtedly his membership in the Torrey Club and the stimulus which he derived from it that gradually converted him into a clever botanist. He was an exceedingly careful and discriminating observer of plants in the field, and the bulk of his published work deals entirely with his field studies. He was among the first to take his taxonomy into the field and to base his conclusions primarily on his personal observations and only secondarily on herbarium material. Do not understand from this statement that all his taxonomic predecessors had been exclusively herbarium botanists; nothing would be farther from the truth. But, in general, they had formed their ideas first in the herbarium and then substantiated them in the field, while Bicknell reversed the procedure.

His results were astonishing. Right here in the vicinity of New York, where botanical work had been carried on for a century, he began to discover undescribed species. Eastern botanists were surprised to learn, through his careful field work, that there were more than one species of *Helianthemum* in the vicinity. The common black snakeroot had always been referred to a single species, or to a species and a variety, and Bicknell showed conclusively that there were four. *Scrophularia* had held a single species in the eastern states, and here he found a second. *Agrimonia* had long contained only two accepted species; Bicknell's careful field study showed several others. In rapid succession he turned his attention to other genera, *Carex, Sisyrinchium, Lechea, Asarum, Teucrium, Rubus, Rosa,* and various grasses, and in every case his detailed and complete observations threw new light on their taxonomy. In *Rubus* in particular, he early pointed out that the characters of the microspecies of blackberries are of a different nature from those of the hawthorns, and this observation, based on field study alone, is now being confirmed by cytogenetics.

In short, it was Bicknell, more than any other man of the period, who returned taxonomy to the field and who re-opened the eastern states for taxonomic research. In the great revival of taxonomy during the last quarter-century, our own region has been found a fertile field for investigation. I do not claim that Bicknell was directly responsible for this, but it is obvious that he was followed, not preceded, by such similarly careful field men as Deam, Stone, Wiegand, Marie-Victorin, and Fernald. The Torrey Club may well be proud that it had a part in this development through its encouragement and support of the work of the banker, Eugene Pintard Bicknell.

The second man whom I shall mention was a successful lawyer, a prominent judge in the New York courts, Addison Brown. He was a member of the Torrey Club during the seventies, but being already established in his profession he had less time and opportunity for field work. His botanical work was chiefly centered on the collection of the various kinds of alien plants which appeared on ballast dumps in the vicinity of New York City. His few printed papers, published in the early volumes of the BULLETIN, show that he collected many rare or unusual plants, some of them previously unknown in America. His collecting stations are now mostly covered with buildings and ballast-dumps are a thing of the past, but his specimens, conserved in the herbarium of the New York Botanical Garden, show that his results were accurately reported. Judge Brown's contributions to botany were chiefly financial. It was he who assumed the financial responsibility for the publication of Britton and Brown's Illustrated Flora, without which the work could never have been issued. I believe that I am correct in saying that no single book ever did as much as this to revive and stimulate interest in the native flora of the northeastern states and that his willingness to underwrite it derived from his faith in Britton and his personal interest in plants, for both of which the Torrey Club is responsible.

The third man was a geologist, who worked for a short time at mining and then became a sanitary inspector for the City of New York. Interested in politics, deeply concerned with all forms of civic improvement, he was soon taking an active part in the affairs of the city and was appointed to several city positions of increasing dignity and responsibility. In the middle of this career he returned to science, which he had always followed as a hobby, entered the graduate school, received his degree of doctor of philosophy, and became one of the leading paleobotanists of America. Arthur Hollick's name and reputation are familiar to all of us and many of us remember him personally, so that further comment is unnecessary.

The fourth man was also a geologist who, for some five years after the completion of his work at Columbia College, was employed by the Geological Survey of New Jersey. During this time he seldom missed a meeting of the

Torrey Botanical Club, and his interest in botany, increased and encouraged by the Club, soon led to his determination to choose botany for his future career. Accordingly he accepted a minor position at Columbia College, was rapidly promoted to a professorship, and retired as professor emeritus at the early age of thirty-seven. His name was Nathaniel Lord Britton, and his retirement from the educational field was only to enable him to devote his tireless energy to the development of the New York Botanical Garden. It was his understanding and vision which led to the building of a scientific institution rather than a specialized park, to the accumulation of a great herbarium and a splendid taxonomic library, and through them to the provision of opportunity for taxonomic research by two score members of his staff, by some hundreds of visiting taxonomists, and through the loan of herbarium material by still more botanists in all parts of the world. In this place and before this audience we do not need to dwell on the taxonomic achievements of Britton. They are well known to all of us. But let us remember, as Britton himself remembered, that to the Torrey Botanical Club he owed his botanical inspiration and that to the Club he returned his thanks by his final generous provision for its permanent endowment.

Fifth and last is a physician, Henry Hurd Rusby, whose name first appears in the BULLETIN of the Torrey Club in 1878. So interested in botany was he that even before he completed his medical education he had spent much time collecting plants in the southwest, and soon after receiving his medical degree he left for South America to explore for medicinal plants; a search which was successful, as we all know. This mixture of botany and medicine made of him a pharmacognocist. During the remainder of his long life, 42 years of which were spent as professor and dean at the New York College of Pharmacy, he had every incentive to devote his energies entirely to pharmaceutical education and the fight for pure food and drugs, in which he took a prominent part. Without doubt, it was the enthusiasm which he drew from the Torrey Club which led him to continue botany as his hobby and to devote to it every possible minute which he could save from his regular work. Even in his last decade, when failing eyesight made botanical work exceedingly difficult, he continued to study his collections and to write short articles.

In 1887 Rusby had before him his extensive collections of South American plants, largely made by himself but supplemented by many sheets from the older Bolivian collectors Mandon and Bang. None of them was named; comparative material was scanty in the herbarium of Columbia College, and even current literature was poorly represented in the Columbia library. So far as North American botanists were concerned, South America was almost terra incognita. Undismayed by the difficulty of the task, Rusby set to work on these plants and also enlisted the aid of the rapidly rising young botanist, N. L. Britton. Rusby made three later trips to South America and never lost his interest in its flora. Neither did Britton, although he delegated most of the work to others, returning to it personally only in his later years and especially after his retirement in 1929.

These studies of the flora of South America grew and spread to other American institutions and are primarily responsible for all our present interest in South American botany. The important taxonomic work of Johnston and Smith of the Arnold Arboretum, Moldenke of the New York Botanical Garden, Killip of the National Herbarium, Pennell of the Philadelphia Academy of Sciences, Standley of the Field Museum and several others, have all evolved directly or indirectly from the initial work of Rusby.

Rusby's career as a taxonomist was peculiar. I fail to find that he ever contributed to the general theory of classification, that he ever wrote a taxonomic monograph, that he was ever a leader in taxonomic thought. But Rusby was a two-fisted fighter, absolutely fearless of consequences to himself, who fought adulterated food and impure drugs with the same intrepidity that he faced the Amazonian jungles, who never admitted defeat and who seldom was defeated. And here again I fail to find that he ever fought for a questionable cause or for his own personal advantage. Instead he was a champion of the right, as he understood it, and his understanding was correct.

Rusby was among the earliest to agitate for a botanical garden in the City of New York and one of the leaders in the struggle for the necessary mandatory legislation at Albany. Later the directorship of the newly chartered garden was in controversy and it was Rusby more than any other one person who fought and worked to prevent the office from being merely another political plum and to effect the appointment of N. L. Britton.

It has been my desire to express here my admiration and respect for one of our former members, but my words are too feeble for my thoughts. Henry Hurd Rusby has gone from among us, but the results of his influence, his energy, and his courage continue and widen from year to year.

Finally and in summary: The Torrey Botanical Club has not merely served as a publishing agency, but it has also produced men, and these men, by their additions to knowledge, by their provision of opportunity, by their influence on modern thought, have been the chief contribution of the Club toward the advancement of taxonomy. Let us hope that the Club will be equally useful during the next seventy-five years.

The New York Botanical Garden
New York, New York

Modern Taxonomy and Its Relation to Geography*

Henry K. Svenson

Taxonomy in the last seventy-five years has had increasingly close connections with geography, but the subject is so vast that only a small portion of the field can be covered at this time. The most that can be done is to review some of the geographical theories that have been in the light for two decades or more, and with which we all are more or less familiar. These subjects are so intertwined that separate discussion of any of them is difficult and all of them are but loose ends of the tangled thread that represents our fund of knowledge of plant geography.

As to geographical location, we are practically astride the terminal glacial moraine which runs the length of Long Island, and which was a collecting ground for Asa Gray when he was associated with Torrey in New York. Much ink has flowed on the subject of glaciation and its effect on plants since Gray published his remarkable report on the similarities of the flora of eastern Asia and eastern North America, in 1859. This date, which coincides with that of the "Origin of Species," was only eight years before the founding of the Torrey Club, which can therefore be said to have occupied practically the whole period of modern biology. Gray's remarks were based on a collection by Charles Wright, who is also well-known for his collections in Cuba and for those in his own part of the Torrey Club Range, in Hartford, Connecticut.

As every taxonomist knows, the genera and even many species which we find in our southern Appalachians are the same as those of the mountains of western China and of Japan. The following quotations are from Gray's paper, Amer. Acad. Arts and Sci. Mem. **6:** 1859: "The fundamental and most difficult question remaining in natural history is here presented; the question whether this actual geographic association of congeneric or other nearly related species is primordial and therefore beyond all scientific explanation, or whether even this may be to a certain extent a natural result. The only noteworthy attempt at a scientific solution of the problem is that of Mr. Darwin and Mr. Wallace,[1] partially sketched in their short papers, 'On the Tendency of Species to Form Varieties; and on the Perpetuation of Varieties and Species by Natural Means of Selection' " (p. 443).

"At length, as the post-tertiary opened, the glacier epoch came slowly on—an extraordinary refrigeration of the northern hemisphere, in the course of ages carrying glacial ice and arctic climate down nearly to the latitude of the Ohio. The change was evidently so gradual that it did not destroy the temperate flora,

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[1] Journn. Linn. Soc. (Zoology). **3:** 45. 1858.

at least not those enumerated above as existing species. These and their fellows, or such as survived, must have been pushed on to lower latitudes as the cold advanced . . . , portions of which, retreating up the mountains as the climate ameliorated and the ice receded, still scantily survive upon our highest Alleghenies, and more abundantly upon the colder summits of the mountains of New York and New England."

" . . . perhaps the most interesting and most unexpected discovery of the expedition is that of two strictly Eastern North American species of this order [Berberidaceae],—each the sole representative of the genus,—viz. *Caulophyllum thalictroides,* and *Diphylleia cymosa,* of Michaux . . . are we to regard them as the descendants of a common stock . . . or are we to suppose them independently originated in two such widely distant regions?" (p. 380).

"*Smilacina* (*Majanthemum*) *bifolia* extends around the world, but under three pretty well marked geographical varieties:—the European, which extends to eastern Siberia; the var. *Kamtschatica,* which replaces the former on the Pacific Siberian coast, in Japan, and in North America west of the Rocky Mountains; and the var. *Canadensis,* throughout all the northern part of this country east of the Mississippi and the Rocky Mountains" (p. 414).

These quotations, it will be seen, are important from three points of view in our modern taxonomy: 1) affirmation of the idea of evolution by the natural selection of variations, 2) the negation of the bicentric origin of species, 3) recognition of a holarctic Cretaceous flora of common origin, and its disruption by the Glacial period.

And we arrive here at one of our first taxonomic difficulties. Shall these geographic variants, which Gray showed to be of common origin, be classified as a single species or shall they be segregated as separate species? This important question we cannot decide. As Weatherby[2] has noted: "so long as we have to rely on judgment at all, the accuracy and soundness of any taxonomic category, definition or no definition, will be in direct proportion to the accuracy and soundness of judgment of the individuals who apply it." The pendulum swings this way and that over periods of time. For example, the yellow lady's slipper (*Cypripedium pubescens*) of eastern United States has long passed as distinct, but only recently Correll[3] has with some justification treated it as a variety of the Eurasian *Cypripedium Calceolus.* The common brake of eastern North America, long held as a separate species under the name *Pteridium latiusculum,* has recently been returned by Tryon to its very old status as a subdivision of the wide-spread *Pteridium aquilinum.* And in Rhodora for this very month of June we find the common water-plantain, which through later years we have been patiently calling *Alisma subcordata,* blooming forth after

[2] Rhodora **44**: 160. 1942.

[3] Harvard Bot. Museum Leaflet **7**: 1-18. 1938.

a fashion as a small-flowered variety of the Eurasian *Alisma Plantago-aquatica.* Not only are species and their subdivisions the product of opinions of individuals, but the same is true of the limits of genera and of higher groups. Not much is to be gained by a painful recital of the infinite variation of nomenclature under present conditions; it is much more illuminating to review the geographic conditions which have made or should make a background for nomenclature.

This problem of glaciation in eastern North America has been ably treated by Professor Fernald. He has shown that many species of restricted distribution in Western Newfoundland, in the Gaspé Peninsula of eastern Quebec, and in some areas adjacent to the Great Lakes, are ancient plants (in contradistinction to Willis' "Age and Area" hypothesis) that have persisted in places not covered by the Wisconsin stage of the Pleistocene glaciation. The vegetation of the glaciated area we may presume to have been obliterated during the ice age, and since the deposits of the coastal plain are of comparatively recent origin (chiefly marine) the uplands of the southern Appalachians and the Ozark Mountains remain as areas from which the flora now inhabiting the coastal plain has probably been derived. These various areas are shown in detail in Fernald's[4] recent work on the Virginia coastal plain.

Species which cover the three main areas (Appalachian uplands, glaciated area, and coastal plain) often show marked divergences in structure in these individual areas, and constitute geographic varieties, which if the variations increased (according to the Darwinian interpretation mentioned in my opening paragraphs) might become distinct species. The Appalachian plateaus still harbor many species of the coastal plain, and from my own observations on the vegetation of the barrens of Middle Tennessee, it seems probable that such plants as *Panicum meridionale, Rynchospora macrostachya, Scleria reticularis,* and *Eleocharis microcarpa* have moved into the Great Lakes area from the siliceous uplands of Tennessee and Kentucky through Indiana, as we may infer from isolated occurrences in the last named state. The bicentric range of *Lilaeopsis carolinensis* in south-eastern United States and in the Argentina region of South America is also shown. A similar disrupted distribution is common in other groups, especially in the Cyperaceae, and is well shown in a number of species of *Eleocharis.* Whatever may be the geographical explanation, the problem of correlating published varieties and other subspecific units in variable species with such bicentric ranges is well-nigh insuperable; it is perhaps the most cogent argument for the non-recognition of varieties.

We may now turn attention to a recent publication of extraordinary interest by J. C. Willis,[5] the author of "Age and Area." This work, entitled: "The

[4] Rhodora **42**: 367. 1940.

[5] Cambridge University Press, England. 1940. 200 pp. Quotations by permission of The Macmillan Company, publishers, U. S.

Course of Evolution by Differentiation or Divergent Mutation," is a negation of evolution by the natural selection of variations as propounded by Darwin and Wallace and affirmed by Asa Gray. The idea is not an original one, but is based largely on what Guppy called "differentiation," in his work on the vegetation of tropical islands. The eleventh chapter leads out, "Natural selection, being a common phenomenon of everyday experience, has exercised such a fascination that it has to a notable extent inhibited people from trying properly to think out how a principle, whose essence is competition with partial escapes into usually temporary success every now and then by improved adaptation, can produce the ordered arrangement, taxonomy, and morphological or structural uniformity with which we are familiar" (p. 103). Many, if not most or even all, of the characters of distinction that mark families, sub-families, and even smaller groups, are such that they can have no serious value upon the physiological side which is the only one that matters from the point of view of natural selection or gradual adaptation. These mutations are assumed by Willis to require long periods of time and to occur infrequently. "If one suppose a genus to give off new species more or less in proportion to the area that it covers (which again will be more or less in proportion to its age among its peers), it is clear that all the offspring will carry a large proportion of the characters of the parent, and that therefore while offspring arising near together will be most likely closely to resemble one another, there is no reason why a close resemblance should not arise with a wide geographical separation" (pp. 155, 156). "It will commonly be found, in studying the distribution of the species of a genus, especially if it be of small or moderate size, that they are more densely congregated toward the centre of the distribution of the genus, and fall off gradually toward the edges, so that when one draws a line round the outermost localities of each species one obtains a picture not unlike that which is called a contour map by geographers . . . " thus, Willis illustrates the distribution of the species of *Ranunculus* found in New Zealand (pp. 149, 150). "Here one finds 'wides' (as I have called the species which have a dispersal outside the country in question) occupying the whole area of the islands of New Zealand, and also reaching eastwards to the Chatham Islands, 375 miles away . . . The endemics are evidently crowded together rather south of the middle of the South Island, whilst they fade out completely before the north end of the North Island is reached . . . The general impression that one gains from a map like this is that the genus *Ranunculus* entered New Zealand probably from the south, and at some place in the southern half of the South Island, where the incoming species began giving rise to endemics, and on the average each species, wide or endemic, spread to the distance allowed by its age, and suitability to the conditions with which it met."

We now come to a region which has played a prominent part in taxonomy, the Galapagos Islands and the adjacent coast of South America. These islands were visited by Darwin in 1835, and upon the variations of birds and tortoises from island to island, as well as upon the plants which were named by the younger Hooker, were laid the foundations of evolution by geographic isolation. The plants were briefly discussed by Darwin in the "Origin of Species" (p. 349): "Dr. Hooker has shown that in the Galapagos Islands the proportional numbers of the different orders are very different from what they are elsewhere. All such differences in number, and the absence of certain whole groups of animals and plants, are generally accounted for by supposed differences in the physical conditions of the islands; but this explanation is not a little doubtful. Facility of immigration seems to have been fully as important as the nature of the conditions.

"Many remarkable little facts could be given with respect to the inhabitants of oceanic islands. For instance, in certain islands not tenanted by a single mammal, some of the endemic plants have beautifully hooked seeds; yet few relations are most manifest than that hooks serve for the transportal of seeds in the wool or fur of quadrupeds. But a hooked seed might be carried to an island by other means; and the plant then becoming modified would form an endemic species, still retaining its hooks, which would form a useless appendage . . . trees growing on a continent, might, when established on an island, gain an advantage over other herbaceous plants by growing taller and taller and overtopping them. In this case, natural selection would tend to add to the stature of the plant, to whatever order it belonged, and thus convert it into a bush and then into a tree."

It is interesting to note in this connection that the only genus of plants now recognized as endemic to the Galapagos Islands is *Scalesia*, which is bushy or sometimes nearly herbaceous in the lower parts of the islands, but some species become large trees where the moisture is more plentiful. Stewart in 1911 estimated that 40 percent of the plants (varieties and forms being included in the count), were endemic, but as in the case of the birds, the larger percent of the endemic plants occur in a few groups. Many supposed endemics, furthermore, have been recently found on the desert coasts of Ecuador and northern Peru; these areas have a climate strikingly similar to that of the Galapagos Islands, and together with the islands seem to form a marked geographic province. Taxonomic problems which vex the botanist have cropped up among the ornithologists. For example, J. Huxley writes of Swarth (quoted by Goldschmidt in "The Material Basis of Evolution," p. 209), "after classifying them [the Galapagos finches] into five different genera with over thirty species and subspecies, . . . it would be almost as logical to put them all in one genus and species." So far as the Galapagos are concerned the astounding extremes of climate which occur in the same or adjacent localities in both islands and the mainland may perhaps become as important to taxonomists as the question of isolated land masses. Nor do these examples complete the difficulties of the taxonomic picture. The coasts of Ecuador and Peru have been visited in a desultory manner by botanists for over two centuries: Feuillee, Cavanilles, Ruiz, Pavon, Humboldt & Bonpland, Hartweg, Andersson, Spruce, and Weberbauer. New species were described bountifully, more frequently than not without any references or comparisons with what had been described before. In this repect there is still much room for improvement in taxonomy.

This brings us to the last item, the question of taxonomy in respect to the organism as a whole. A number of recent papers might be mentioned, but none, it seems, quite comes up to the recent Memoir of the Torrey Club by Stebbins, "Studies in the Cichorieae; Dubyaea and Soroseris, Endemics of the Sino-Himalayan Region." Such a treatment includes taxonomy, anatomy, cytology, morphology of pollen grains, and probable phylogeny, especially in relation to the geography of the species. If taxonomy in general were treated with such care, many of our most distressing problems of nomenclature would vanish.

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Some Economic Aspects of Taxonomy*

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One dictionary definition of taxonomy is: "Classification; especially classification of animals and plants according to their natural relationships; also the laws and principles of such classification." Another, a bit longer is: "The laws and principles of taxology, or their application to the classifying of objects of natural history; that department of science which treats of classification; the practice of classification according to certain principles." And in this same dictionary taxology, a term I have never wittingly used, and which I shall eschew, is defined as: "The science of arrangement or classification; what is known of taxonomy." Here I infer that the lexicographer responsible for the definition of both taxonomy and taxology may have preferred the latter to the former, but taxonomy, widely and universally used, will scarcely be replaced by taxology, no matter what a lexicographer may prefer.

Under the first definition, including the laws and principles of classification, one could wander far afield and become bogged down in discussions of the laws of nomenclature for nomenclature cannot be disassociated with taxonomy, for we must, of necessity, use names for the objects with which we are concerned. However, I have no intention of thus widening the subject to include problems of nomenclature and interpretations of the rules and regulations set up by international botanical congresses to govern the application of names, for such discussion would be endless.

This topic was assigned to me and is, perhaps, not one that I would have chosen voluntarily. Thus I feel relatively little personal responsibility as to just how I may develop the subject, realizing very fully that no two individuals would treat it in a comparable manner. To limit the definition to "classification according to natural relationships" would be unwise, for in practice, while it is fully realized that arrangement according to natural relationships is the objective that is always desirable, this is not always practicable. Often our reference collections are totally inadequate, and we have to do the best that we can with what is available. The result is that not infrequently we are obliged to utilize characters of a more or less obvious nature, and not always those that indicate the closest natural relationships between various groups, whether these be major or minor categories. Again, we may utilize a combination of obvious utilitarian characters associated with others that clearly indicate natural affinities, in order to attain a certain objective.

As long as the learned world of the early European civilizations up to and

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including the middle ages knew and utilized only a few hundred basic plant species, botanical science and taxonomy was indeed a simple matter. In those distant days a rough classification, as to major groups, as trees, shrubs, and herbs sufficed. Species were designated by shorter or longer descriptive Greek or Latin sentences. But even in these early days there was, here and there, the beginnings of classification by obvious characters indicating varying degrees of natural relationships. In the Europe of renaissance the pulse quickened. Up to this time those who were at all concerned with plants and their utilization, being scholastically minded, could think only in terms of the ancient Greek and Latin masters. All attempted to refer their plants to those recognized and named by the classical authors, particularly Dioscorides. In northern Europe, with the invention of printing and the general advancement in learning, it became evident that many of the species characteristic of this part of the continent were really different from those of the Mediterranean region. Once this break came with classical traditions, progress was greatly accelerated, as evidenced by the masterful works of Fuchs, Brunfels, Bock, and others, for these pioneers had returned to the actual study of plants as opposed to merely a study of the classics. Following the epoch making discoveries of the pioneer Portuguese and Spanish navigators the small stream of botanical knowledge became a flood.

Still for the most part the cumbersome system of designating species by descriptive sentences prevailed and no radical change was made in nomenclature until 1753, when Linnaeus promulgated his very simple and very obvious binomial system. I say "very simple and very obvious" because it was so simple and so practicable that one constantly wonders why it was not developed as a system some centuries earlier. The idea of the genus had taken root at an earlier date, and following Linnaeus's innovation this radical departure in designating plant species by a *binomial,* a generic and a specific name, quickly prevailed. After all, in common everyday parlance the binomial system of designating plants was widely used among the common people of many countries, but there was a wide gulf between daily usage of the people and the learned world. Witness binomials in the common names of plants, such as white oak, red oak, cork oak, burr oak, live oak, scrub oak, swamp oak, post oak, chestnut oak, valley oak, holm oak, pin oak, water oak, willow oak; stone pine, sugar pine, white pine, red pine, yellow pine, nut pine, Scots pine, Austrian pine, black pine, loblolly pine, jack pine, and digger pine. This system of common names as binomials is not modern, but is one of the most ancient things in many languages, this usage being very widespread in the world at large, and among primitive as well as among culturally advanced peoples.

But coupled with the Linnaean binomial system was his artificial system of classification based essentially on the number of carpels and the number and arrangement of the stamens. This was a very *practicable* system for arranging genera as a matter of convenience and it dominated the field for somewhat longer than the succeeding half century, although by the end of the eighteenth century the handwriting was on the wall, and in the early part of the nineteenth century the artificial system was generally replaced by the natural system of classification with which we are familiar.

If the proposal of the binomial system by Linnaeus raised a mild storm among those accustomed to the earlier much more cumbersome system of nomenclature then in vogue, a storm that quickly subsided leaving the binomial system universally established and accepted, the proposition to arrange the genera in natural families raised a veritable hurricane among the devotees of botany accustomed to the simple and convenient Linnaean system. This storm raged for some decades and we of the present age have little conception of it.

In 1831, John Torrey published his American edition of Lindley's "Introduction to the Natural System of Botany." He states in advertisement: "In France, the natural or philosophical method has for many years past taken the place of the artificial sexual system of Linnaeus, and recently by the labours of Brown, Lindley, Hooker, Greville, and others, it has begun to be employed in England and Scotland. . . . . I at once perceived that a desideratum in British and American botany, long felt and lamented, was at length supplied. It therefore occurred to me that I could not do a more acceptable service to the friends and cultivators of Botanical Science in the United States, than by preparing an American edition for the press forthwith. . . . . This is an epitome of modern philosophical Botany, and will be found highly useful to those who wish to obtain an accurate knowledge of the Natural Classification of the Vegetable Kingdom."

At this time all botanists in the United States, with the exception of Rafinesque, were professed Linnaeists; there was no other system of classification as far as they were concerned. What happened? Consider Amos Eaton's statement of 1833.[1] In speaking of Torrey's edition of Lindley he wrote:

"Since Dr. Faustus first exhibited his printed bibles in the year 1463, no book, probably, has excited such consternation and dismay as Dr. Torrey's edition of Lindley's Introduction to the Natural System of Botany. And to make the horrors of students, as well as of ordinary teachers still more appalling, Dr. Torrey's Catalogue of American Plants at the end of his Lindley, was so singularly presented, that it would seem to indicate an awful catastrophe to all previous learning. To relieve all concerned, let me make this pledge: Nothing new is presented either in the text or in the catalogue [*i.e.*, Eaton's own Manual], excepting what ought to have been discovered in this *progressive* science, since the fifth edition of this Manual was printed; and

[1] **Eaton, A.** Manual of Botany for North America, ed. 6, i-vi. 1833.

not much *real improvement* has been added, as between the fourth and fifth editions. . . . . As far as I have any influence I pledge it here, that the embarrassing innovations of De Candolle and others are *no possible use* to the science of Botany. . . . . An attempt is made in his Lindley to prove that the Artificial method of Linnaeus is unnecessary. In doing this he proposes an *Artificial Method*[2] of eleven pages. As those who have not read Torrey's Lindley will scarcely believe this unaccountable absurdity, they are requested to examine, unbiased, that work between pages lxvi and lxxx of the introduction. This artificial system [artificial key to families] is said to lead to the Natural Method. . . . . The improvements upon Linnaeus, which have been made, do not authorize any change in the science of Botany other than mere additions and corrections. . . . ."

This caustic critique of the natural system of classification is eliminated from the seventh (1836) and eighth (1840) editions of Eaton's "Manual," and in these, although he adhered to the Linnaean artificial system of classification, he so far relented as to include an epitome of the natural system. If, however, one needs a good illustration of a closed mind, here we have it, and this statement is made in all due regard to Eaton's remarkable accomplishments[3] although it is only fair to explain that in botany Eaton never claimed originality. He states[4] that in the field of botany he never aspired to be anything above that of a *teacher, translator,* and *compiler.* It should be noted that Eaton italicized his characterization of botany as a *progressive* science, yet at the same time insisted that the suggested improvements on the Linnaean system did not authorize any changes in the science of botany other than mere additions and corrections! This is an ultra-conservative, nay, even a reactionary attitude.

McAllister, p. 235, quotes from John Torrey's letter of November 2, 1833, to L. D. von Schweinitz giving his reaction to edition 6 of Eaton's "Manual": "This time Torrey was *more effusive* (italics mine) in his praise of the *Manual* when he wrote to his friend De Schweinitz 'Have you seen the 6th edn. of Eaton's Manual of Botany? . . . . I began to read the preface in a bookstore the other day & it seemed to be a most remarkable performance.'" In view of the circumstances one wonders if the term "effusive" is the corect one, for in

[2] Eaton apparently wrote this very hurriedly, for this statement regarding an artificial method is an error. What is presented is an *artificial analysis* of the orders in the form of a key to the classes (Vasculares, Cellulares), subclasses (Exogenae or dicotyledonous plants, and Endogenae or monocotyledonous plants), tribes (Angiospermae, Gymnospermae, Petaloideae and Glumceae), and to the families under each division and subdivision, these, as to limits (but naturally not as to sequence as at present understood) much the same as they stand today. Torrey's "singularly presented" catalogue is merely an arrangement of the genera of North American plants by families under the natural system!

[3] **McAllister, Ethel M.** Amos Eaton. Scientist and Educator, i-xiii, 1–587, illus. 1941.

[4] Manual. ed. 7. iv. 1936.

the same letter Torrey also says[5] that he had scarcely seen more than the covers of the book and that he was interrupted before he had finished the first page; and this first page begins with Eaton's castigation of Torrey, my quoted passage: "Since Dr. Faustus first exhibited his printed bibles in the year 1463, no book has, probably, excited such consternation and dismay as Dr. Torrey's edition of Lindley's Introduction to the Natural System of Botany." I am afraid that the dear lady didn't read this preface, for under the circumstances Torrey's statement to De Schweinitz can only be interpreted as sarcastic and ironic, as far as a gentle soul like John Torrey could be ironic and sarcastic, certainly not as "effusive" praise! The relationships between Eaton and Torrey had their ups and downs. Clearly we do not have to confine our reading to the opinions of modern botanists to learn just how certain individuals judge their contemporaries, for throughout botanical history individuals have not hesitated to say just what they thought about the work of this or that author. In the constant quibbles that one notes in taxonomic literature one is reminded of a remark ascribed to President Lowell when some acute problem regarding the interrelationships of certain prima donnas among Harvard botanists needed to be settled: "What is it about the pretty little flowers that makes the botanists quarrel so much among themselves?"

Within a decade or two from the time that Eaton castigated Torrey for his progressiveness, the Linnaean system of classification was entirely outmoded and abandoned, and was replaced by the natural system that he so violently condemned. Eaton, the non-progressive botanist is, as a botanist, only a vague memory among the devotees of this science today. But Torrey, who was the subject of his scorn, forged steadily ahead to become the outstanding American botanist of his time; and this organization, the Torrey Botanical Club, the oldest botanical association in America, today celebrating the seventy-fifth anniversary of its establishment, honors John Torrey's name, and its founders incidentally honored the organization itself, in the selection of its name, a perpetual reminder of the services rendered by this outstanding individual and botanist. Had Torrey been another Eaton, clearly there never would have been a Torrey Botanical Club.

Because of the vast number of organisms that the naturalist must deal with as to species, to say nothing of higher categories such as genera and families, it is clear that it is impossible to arrange large groups *in any lineal arrangement* that will show all natural relationships. This is particularly true of the major groups. We may follow the Bentham and Hooker system for convenience, treating in sequence first the dicotyledonous plants, then the gymnosperms, and then the monocotyledonous groups, although this is a very unnatural arrangement because the gymnosperms are infinitely more primitive, among the flow-

[5] Mem. Torr. Bot. Club **16**: 280. 1921.

ering plants, than the dicotyledons and the monocotyledons. Or we may select to follow the Endlicher system as developed by Engler and Prantl, treating the gymnosperms first, then the monocotyledons and finally the dicotyledons; or we may decide with Wettstein and others, that the dicotyledons should be placed before the monocotyledons if the system is to be a natural one, in accordance with various lines of evidence as to the comparative times of development of these last two groups.

It is inevitable that when a proposed system becomes very widely used, like that of Bentham and Hooker, or that of Engler and Prantl, it will become more or less fixed, partly from the weight of authority, partly because of convenience and for comparative purposes. We may all realize that the Engler and Prantl system of arranging families, in some respects is far from a *natural* one, and that radical changes are indicated, particularly in reference to the position, in sequence, of such families as the Magnoliaceae, Ranunculaceae, Berberidaceae, etc., which seem clearly to be much more *primitive* than the Amentales, for example. System after system may be proposed, but relatively few of these will, from the very nature of things, become widely accepted as to the sequence of arrangement of major groups, partly from inertia on the part of working botanists, partly because it is always desirable to be able to make direct comparisons with the work of others, and partly because one is never sure as to just when some morphologist may discover evidence that upsets all previously proposed systems and sets up another "improved" one. It all comes down to the simple fact that within the plant kingdom, when one is dealing with such groups as natural families, it is impossible to make any *lineal* arrangement that will show all relationships and inter-relationships, for development and differentiation has not followed a straight line from a lower to a higher group, but in many cases it has been divergent, and, we may suspect, reversions have played their part. To indicate natural relationships we must construct variously branched "trees" to show origins and relationships as well as historical sequences; but in a book we must hew pretty closely to the straight line, whether we are dealing with a series of families in a system of classification, or whether we are dealing in terms of a simple manual for field use, for one page follows another from beginning to end.

Again, we must always keep in mind that the objects with which we are dealing are variable; that our accumulated knowledge constantly increases; that a system that we might set up today, on the basis of the available data, may be outmoded a few years hence when more comprehensive collections, and when a more intensive study of obscure details, perhaps supplemented by anatomic, cytogenetic, genetic, historic, and geographic data, become available. This comment applies more to the problem of species and their inter-relationships than it does to larger categories such as genera and families. All active systematists are familiar with these factors from their own daily work. As examples, I may cite my own experience. In 1904, I hopefully prepared a key to the 21 then known Philippine species of *Medinilla,* not realizing what changes would be necessary within a few years, for less than twenty years later, about 125 species of this genus had been described from or accredited to the Philippines. In 1900 there were actually known from the Philippines only 13 species of the Pandanaceae, *Freycinetia* with 7 species, and *Pandanus* with 6, of which only one was definitely understood and could be placed in reference to other described species of this genus, five described by Blanco appearing in all botanical literature as *species ignotae* or *species dubiae*. Twenty-five years later not only had all of Blanco's "unknown" species been placed, but the total for the family stood at 93 species, *Freycinetia* 45, *Pandanus* 47, and *Sararanga* 1. This is what has happened in family after family and genus after genus within the present century as comprehensive collections have been assembled from the botanically little known parts of the world such as China, the Philippines, Malaysia outside of Java and to a certain degree the Malay Peninsula, Siam, Indo-China, tropical Africa and tropical America. What is the reaction of local taxonomists, working on a restricted flora, the constituent elements of which are well known, in reference to such a work as that of Schlechter[6] in which no less than 1153 new species of orchids are described in one work, and these all from German New Guinea? The area of German New Guinea is 68,500 square miles, and for comparison that of New York State is slightly less than 50,000 square miles. Incidentally, approximately 2500 new species of orchids have been described from the Island of New Guinea since 1900. These cited examples merely represent a few that demonstrate the acceleration of what happened within the present century as various parts of the world were opened up to botanical exploration. What happened in various parts of the world happened in the United States when the West was opened up by exploration, and still later when a respectable body of local botanists developed in the West. This is, in part, the basis of the break between Asa Gray and E. L. Greene, for Greene was on the ground and was intimately acquainted with the local flora of California; I say "in part" because there was also an entirely different concept between the two as to what constituted a species.

It will be a long time yet, at our present rate of progress—which may be greatly slowed down in the coming years—before the imperfectly known regions mentioned above may be considered to be even reasonably well explored. Until this end is attained all treatments of all large groups that have representatives growing in these vast and only partly explored areas can

[6] **Schlechter, R.** Die Orchideen von Deutsch-Neu-Guinea. Repert. Sp. Nov. Beih. **1**: i-lxvi. 1-1079. 1911-14.

be considered only as tentative. We do the best that we can with what we have at hand, and optimistically hope for the best. One closing example. In 1800, about 65 species of *Ficus* were more or less definitely known from the entire world. In 1801 Willdenow[7] described four new species and rather naïvely remarked: "Je ne doute pas que dans le climats chauds il n'existe encore plusieurs espèces de figuiers encore inconnues," little realizing that before the year 1940, a total of approximately 2,400 binomials would actually be proposed in this Brogningnagian genus—God forbid that these 2,400 binomials represent 2,400 distinct species, but the number of valid ones is very great, certainly approaching 2,000, even without splitting hairs on specific differences. If any taxonomist is looking for new worlds to conquer, I recommend that he undertake a monographic treatment of this vast assemblage.

In citing the above examples of the rapid increase in the numbers of proposed species in certain genera, far be it for me even to suggest that the actual naming and describing of new species is an end in itself, or if there is anything difficult about the art. As a matter of fact it is a very easy and simple matter to name and describe a species *as new;* it isn't so easy to determine whether or not the particular form in hand has been named and described by some earlier botanist or whether it actually constitutes a sufficiently distinct entity to be considered worthy of consideration as a species; to say nothing about macrospecies or microspecies, nor even to mention subspecies, variety, subvariety, form, proles, or any other category that has been suggested, but never too well defined, to indicate minor entities. With the myriads of forms with which we must deal we must have names. The competent monographer follows and either embalms our possible error by recognizing a species as valid, or sinks it into synonymy; and if the latter happens then at some future date some other monographer may reinstate it with the chances that in the interim some other optimistic taxonomist may have renamed and redescribed the same form under a new name in his confidence that a published reduction is always a reduction, which, perhaps unfortunately, is not always the case.

The special properties of a very high percentage of our thousands of species of economic plants, whether utilized for food, for medicine, for fibers or for any other purposes were originally discovered by empirical processes and by observation rather than by direct and deliberate investigations. This is the history of most plant species of economic importance whether it be the lowly bean used for food, or the insignificant looking *Ephedra sinica* now extensively utilized in the practice of medicine. Although this *Ephedra* has been utilized by the Chinese for many centuries it is only within the present century that it was definitely demonstrated that its curative principle ephedrine is really of

[7] **Willdenow, C. L.** Determination de quelques nouvelles espèces de Figuier, et observations générales sur ce genre. Mem. Acad. Sci. [Berlin] **1801:** 91–104. *t.* 2–5. 1801.

distinct value in the treatment of asthma and various diseases of the nasal passages. Through taxonomy, however, a realization of the relationships of plants, we find what may be an important lead. If *Ephedra sinica* yields ephedrine, isn't it possible or even probable that other species of the same genus may yield the same curative agent? Thus a pharmacological investigation of all species of *Ephedra* might be indicated, for the sole natural source of *Ephedra sinica* is northern China, although other species of the genus occur in various parts of Asia, Europe, and North America. It is admitted, now that ephedrine has been synthesized, that further work on representatives of this particular genus may scarcely be worthwhile, but the case serves to illustrate the problem of botanical analogy.

Take the case of chaulmoogra oil, now extensively and successfully used in the treatment of leprosy. For centuries this oil was used in India for the treatment of leprosy and various skin diseases. For nearly a hundred years the situation was confused because the plant named by Roxburgh as *Chaulmoogra odorata* Roxb., but never actually described by him, was supposed to be the species that yielded the effective drug; yet the seeds of Roxburgh's species, later described as *Gynocardia odorata* R. Br., when investigated, were shown to contain no active curative principle. It was not until 1900 that Sir George Watt cleared up the confusion and determined the botanical source of the true chaulmoogra seeds as *Taraktogenos Kurzii* King = *Hydnocarpus Kurzii* Warb. Rock,[8] who has discussed this subject, states that it is quite probable that not only seeds of this species but also those of *H. castaneus* Hook. f. & Th. and other species of *Taraktogenos* and *Hydnocarpus,* as yet undescribed, are sources of the chaulmoogra oil of commerce. The botanical confusion that prevailed for a hundred years unquestionably retarded a critical and serious investigation of chaulmoogra oil as a remedy for leprosy. It is only within the present century that this cure has come into its own.

Intrigued by the problem of analogy and suspecting that the seeds of some of the Philippine species of *Hydnocarpus* might contain the same curative principles as the true chaulmoogra oil, I was instrumental in fostering an investigation of those Philippine species that were available, including *Hydnocarpus Alcalae C. DC., H. subfalcata* Merr., *H. Woodii* Merr., and *H. Hutchinsonii* Merr. Various studies were made in the Bureau of Science culminating in 1928, when Messrs. Perkins and Cruz[9] investigated the oils of ten species including four from the Philippines and Borneo, and found that in these four species the oil was very similar in chemical composition to commercial chaul-

[8] **Rock, J. F.** The Chaulmoogra tree and some related species: A survey conducted in Siam, Burma, Assam, and Bengal. U. S. Dept. Agr. Bull. **1057**: 1–29. *t. 1–16.* 1922.

[9] **Perkins, G. A.** and **Cruz, A. O.** A comparative analytical study of various oils in the chaulmoogra group. Philip. Jour. Sci. **23**: 543–569. *t. 1.* 1928.

moogra oil except that *Hydnocarpus Alcalae C. DC.* contains a very large amount of chaulmoogric acid and little or no hydnocarpic acid. The total percentage of oil varied from a minimum of 11 percent to a maximum of 39 percent. Now as far as known none of the Philippine and Bornean species was utilized for any purposes by the native population. They were, of course, unknown to the small technical public outside of the very few botanists, and it is an interesting commentary to note that as to the Bornean *Hydnocarpus Woodii* Merr. trees were actually found to be growing within the limits of the leper colony on Sandakan Harbor; a remedy actually at hand, but previously unknown, and its potentialities hence unrealized.

In the latest treatment of this group[10] *Taraktogenos* Kurz is reduced to *Hydnocarpus* Gaertn. and a total of forty species are recognized. Not more than one-fourth of these species have been investigated from a pharmaceutical standpoint; and yet from what is known of the properties of those that have been investigated it is safe to assume that the seeds of most of the species of the genus will be found to yield the same curative principles as are found in the true chaulmoogra oil.

Thus from analogy, working from a Burmese species, the curative principles in its seeds being known, investigations extend to the seeds of the Philippine and Bornean species of the same genus, *Hydnocarpus,* with potentially important economic results. These examples will suffice to demonstrate what has been done in special cases, and by analogy we may expect that in the future similar investigations will be extended to very many species that have hitherto never been considered as even worthy of investigation; but in a reasonable percentage of cases we may definitely assume that these species, as yet unknown and unappreciated from an economic standpoint, will be shown to produce needed and otherwise unattainable products. Here the tempo increases under the pressure of necessity brought about by war conditions in reference to supplies of rubber, quinine, and various other products for which, in the past, we have depended largely on Asia and Malaysia for our supply; and our economy and even way of life was increasingly geared to various imported basic products which now are unobtainable elsewhere. Now new sources must be developed, if not from the same species so successfully developed in the specialized agriculture of certain parts of the Old World (even although in some cases based on native American plants, such as *Hevea* and *Cinchona*), then from others that yield similar products. It is in this specialized field of potential substitute plants that may yield important products that we now lack, that the trained and experienced taxonomist can render, and is rendering, fundamentally

[10] **Sleumer, H.** Monographie der Gattung *Hydnocarpus* Gaertner nebst Beschreibung und Anatomie der Früchte und Samen ihrer pharmakognostisch wichtigen Arten (Chaulmugra). Bot. Jahrb. **69**: 1–94. *t. 1–4.* 1938.

basic services. It is this type of individual who knows his plants and who knows plant relationships who can serve to great advantage, for his accumulated store of special knowledge cannot be matched by those botanists trained and experienced in other fields remote from that of taxonomy and systematic botany. Let us hope that those charged with selection for super-specialized services such as those indicated in this field of botanical analogy, will select wisely and well. After all there is much truth in the popular conception of what a botanist is—an individual who knows and can name plants; yet the vastly higher percentage of our professional botanists have almost no knowledge and less experience in this specialized field of taxonomy, and many of them have no interest in it. They are for the most part specialists in totally different branches under the all-inclusive term botany, for in our times the term botanist covers not only the taxonomist and systematist, but also the fields of morphology, physiology, ecology, cyto-genetics, cytology, histology and various other subdivisions; the numerous devotees to these subdivisions of botany are all "botanists" in spite of the popular definition cited above. A very high percentage of them would be utterly lost were they to be assigned to special problems in this distinctly complicated field of botanical analogy.

Within the field of medicine or pharmacology, here is a simple illustrative case. The European *Digitalis purpurea* Linn. is the source of an important drug, digitalin, and we have generally depended on Europe for our supply. With these supplies now cut off by the war, local sources must be developed. I have no idea of how extensively the plant is now cultivated in the northern United States, but Fernald, on the basis of his own extensive field knowledge, calls attention to the fact that the species is not only thoroughly established in certain parts of Newfoundland, but that in places it is dominant and a veritable pest; a source of supply that only needs to be tapped if there be need to build up our dwindling stocks, and an indication that certain parts of Newfoundland are ideally adapted to the actual cultivation of the species on a large scale if this be needed.

It is clear to all taxonomists and all systematic botanists, that in spite of the imperfections in our current system of naming and describing plant species, and in spite of the distinctly Rafinesquian character of the work of certain individual botanists who can see differences where tangible differences scarcely exist, that taxonomy and the accurate identification of plants is basic to a proper understanding of myriads of problems in the general field of economic botany, pharmacology, agriculture, plant breeding, plant pathology, genetics, forestry, morphology, physiology, and many other fields into which plant science or botany *sensu latiore* has been subdivided. We have little patience with the investigator, no matter what his problem may be, who ignores this basic problem of accurate identification of the material with which he deals. Obviously if one deals with misidentified material his findings may prove to be valueless, for future investigators will find it difficult if not impossible to check his results. There are too many errors in botanical literature due to this lack of critical consideration of this simple basic problem, and much time, and some space in our technical periodicals, has been wasted due to the ignorance or the blind faith of investigators, or those who have stimulated research on a particular subject, who have not considered it to be either essential or even worthwhile to check, or to have some competent taxonomist check, the identity of the plant utilized to prove this or that conclusion. Here is a horrible example:

In 1902 there was published in one of our leading botanical magazines a paper on the morphology of the flower and embryo of *Spiraea* that admirably illustrates the importance of accurate identification. The investigator worked with material representing a single species, the plant widely known among horticulturists under the erroneous name of "*Spiraea japonica*." Far from being a representative of *Spiraea* or even of the family Rosaceae this plant is *Astilbe japonica* A. Gray of the Saxifragaceae. The author completed his detailed study without even suspecting that he was dealing with a misidentified plant, from which we may assume that he could not have done much bibliographic research as the differences between *Astilbe* and *Spiraea* are remarkable. Is this blind faith in a labelled growing specimen or sheer carelessness or ignorance on the part of those who suggested and supervised the work and thus victimized an innocent graduate student who had faith in the knowledge of his preceptors? The net result was to discredit the student, for about all he got out of it was some training and experience in laboratory technique, discredit to the periodical in which the article appeared, and, may we hope, some discredit on those who sponsored the investigation. It is a classical example of how not to elucidate a morphological problem, for the net result merely served to stimulate the glee of the lowly taxonomists who, as a group, are thoroughly satiated with the "holier than thou" attitude of some of our colleagues in the laboratory aspects of botany. I am much less charitable than was Rehder who called attention to the error.

What do we taxonomists think, when we observe in a physiological paper a tabulation of species whose seeds will not germinate until after they are subjected to freezing temperatures and note the strictly tropical *Carica Papaya* listed in this category? True, pawpaw and papaya are common names of *Carica Papaya* but pawpaw is also the common name of our entirely different northern *Asimina triloba* Dun. We can only assume that the seeds of *Asimina* were what this investigator had, for *Carica* is a plant entirely intolerant to freezing conditions. All of which merely illustrates that we should not put our trust wholly in the currently used common names of plants. After all, "What is in a name, a rose by any other name would smell as sweet" but in cases like these, one is reminded of an expression used by one of the characters in that intriguing comedy, "You can't take it with you" when he was expressing his opinion of the dancing ability of another character in the play.

In this part of the discussion I am rapidly approaching a category recently discussed in the daily press. Under date of May 18, it is reported from Raleigh, North Carolina, that some years ago the Daughters of the American Revolution planted, with elaborate ceremony, a little tree purported to be an offspring of the "Continental Elm" at Cambridge, Massachusetts, under which George Washington is supposed to have taken command of the Continental Army in 1775. They even kept a box of earth taken from around the roots of the parent tree for use in christening the "elm" when it grew up. The little "elm" has grown up and is now blooming; but it is a cherry tree and not an elm at all. Assuming that the young tree that was planted was provided by some nurseryman this merely proves that nurserymen and horticulturists can make mistakes just as botanists do, but is this any reason why a botanist making a really serious study of a plant problem should accept without question as to its correctness, a commonly used but erroneous horticultural name, or should determine what binomial he should use merely by looking up a common name?

One closing example, that of the investigator who had laboriously dug up and intensively studied the root tips of *Tilia* in one of our large collections, and could not understand the discrepancies between the chromosome counts of the root tips and of the branchlets taken from the same trees in a number of cases. It was only after the study had been completed, but fortunately not published, that he learned that many of these species of *Tilia* were grafted, the roots representing an entirely different species from the growing tree. Thus for certain types of investigations we cannot even trust the living plants without knowing something about their history.

I have above referred to the fact that during the many centuries Europe was dependent on its own economy, its inhabitants utilized only a relatively few plant species; a few hundred important ones at most. As various parts of the world were opened up within the few centuries following the expansion of the European colonizing nations the number of species utilized rapidly increased; and this tempo of increase continues unabated. In 1853, Linnaeus recognized 5,950 species of plants in all groups for the entire world, while he and his immediate followers estimated that there might be as many as 10,000 species of plants, in all groups, in the world. The estimate had been increased to 30,000 known species by 1820, and 50,000 indicated as probable for the entire world. By the middle of the century the estimate of known species was 93,000.

Within the present century about 265,000 new binomials have been published for the flowering plants and vascular cryptogams alone, of which about 194,000 represent hopefully proposed new species, the remainder shuffles or transfers from one generic name to another. The yearly average for the higher groups alone is now approximately 6,500 *as new binomials,* of which about 4,750 represent proposed new species. This is the record of the twentieth century to date. The total number of binomials published from 1753 to 1942 is in the neighborhood of 750,000 for the higher groups of plants alone, and to this must be added those published for the cellular cryptogams; our grand total should be in excess of 1,000,000.

As to the total number of distinct and more or less "known" species, who shall say? Jones has briefly discussed this matter[11] calling attention to the remarkable discrepancies that occur in recent texts, with a spread in the estimates of from 133,000 (Uphof's estimate of 1910) to 175,000 for the angiosperms alone, and concludes that the total for all known groups is in the neighborhood of 335,000. Because of various complications that it is unnecessary to discuss here, I suppose that we may conclude that one guess is as good as another; but knowing something about synonymy; something about the limiting factors in the geographic distribution of individual species; something about more or less universally distributed species; something about the extraordinary richness of tropical floras; something about the remarkable local endemism in various tropical areas; something about the high percentage of novelties that are found in all new collections from hitherto inadequately explored areas; something about those regions that, within the past four decades, have been particularly rich in the crop of new species—my guess is pretty close to that of Jones, and that the total number of reasonably valid described species in all groups is well in excess of 300,000. Even if the number of valid species should be only half this total, what scientist, no matter what his field, would even have the temerity to suggest that we can get along without taxonomy and nomenclature?

In this discussion I have deliberately been discursive rather than specific. One could cite case after case of the applications of taxonomy to various scientific and economic problems, but a few will serve to bring out the points at issue. Besides those mentioned above in my discussion of botanical analogies we may list the problem of the *Citrus* relatives; the case of *Coffea arabica* Linn. versus *Hemileia vastatrix* Berk.; *Berberis* versus wheat rust; the *Pinus-Ribes* complex in reference to the blister rust of the white pines; the little problem of special strains in such lowly organisms as the yeasts and the fungi when these organisms are basic to certain industrial processes—the list would be unending, for no agricultural crop exists in which problems of plant breeding, of protection against fungus diseases and insect pests do not exist. Many prob-

[11] **Jones, G.** Science II. **84**: 243. 1941.

lems have been solved, but many more are still with us, and new ones develop from year to year. With all due regard to the qualifications and accomplishments of the specialists in the various fields concerned, I maintain that the better equipped the investigator is in basic taxonomic knowledge, the better is he fitted to work on his special problems. This does not mean that all botanists should be taxonomists, but it does mean that all specialists and all laboratory botanists should realize the importance of accurate identification, the implication of botanical analogies, and that they should appreciate the facilities outside of their own fields that are available in specialized institutions in various parts of the country. We will go much further with reasonable cooperation than we will by maintaining a pigeon-hole type of specialization.

There should be no real antagonisms between the devotees of various aspects of botanical science, for the inter-relationships are close—much closer than some of our specialists realize. We are all laborers in the same vineyard, and our objective is progress; progress in pure science as well as in the economic aspects of the subject as a whole. To those representatives of the laboratory school of botany who are hypercritical regarding taxonomists and systematists, I would call attention to the fact that progressive taxonomists are now taking advantage of the findings of their associates in other fields including the histologists, pollen experts, geneticists, cytologists, ecologists, and entirely outside of the biological field invoking the aid of geologists, hydrographers, geographers and others in their attempt to solve certain problems of plant relationships.

This very organization that this week celebrates the seventy-fifth anniversary of its establishment was founded by individuals whose fields of interest were essentially field botany, taxonomy and systematics. It has evolved, during the course of years into a national organization and has wisely and progressively widened its activities, yet the unifying idea that maintains it is still that of its founders who were interested in plants and who knew plants as they grew in nature rather than merely as laboratory subjects. I repeat what I have written before: "It has been fashionable in some quarters in modern times to decry both the importance and the value of systematic botany. Because of its vitality, its human interest, its practical bearing on other phases of plant science, and on our everyday life, one suspects that some of its critics have lacked the breadth of view of leaders in science, and have been misguided in criticizing that which they did not fully understand."

Let us take the broader view, live and let live, keep our respective houses in order, avoid egregious blunders, and attain a realization of the fact that after all there is a unity in plant science in spite of its diversity, and that the entire field is interlaced with the binding bonds of system and order; and this is taxonomy.

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The Importance of Taxonomic Studies of the Fungi*

Frank D. Kern

The naming and classifying of living organisms has been going on for centuries. It has been well said that "a large part of our thinking about living things is bound up with some system of classification." Another writer has pointed out the fact that we depend much upon classification in our general experiences. "It is the innate propensity of active minds," he says, "to form species, *i.e.*, successively to make distinctions, to point out similarities, and then to assemble the things that are alike into their kinds. It applies to everything from chemical elements to college fraternities."

The recognition of the need of names for plants dates from the days of Pliny, the Roman naturalist, and Dioscorides, the Greek physician, in the first century of the Christian era. Plants could not be discussed without names. They could be named, however, without classification. They could be classified, also, without a conception of phylogeny. In other words, nomenclature deals with names which may or may not be arranged according to a system of classification; and classification deals with groups which may or may not indicate relationships. Many biologists, on the other hand, attempt to arrange groups on a basis of similarities, which they believe to be expressions of actual relationships. It is of particular interest today to note that the modern development of these aspects of botanical science has been made during the years since the founding of this Club. The first real progress in working out a universal system of nomenclature was made at an International Botanical Congress in Paris in 1867. A natural system of classification, although early recognized as desirable, has made its most progress since the theory of evolution provided a basis for phylogenetic interpretations. Darwin's Origin of Species, just a few years earlier, furnished the evolutionary concepts which soon became so significant in taxonomy.

Even a cursory examination of some of the early attempts to classify the fungi is sufficient to reveal that the results were most general in nature. Bauhin, in the days of the "herbals" purported to bring together all the plants known to him and to all those who preceded him (Pinax Theatri Botanici, 1623). The concept of the genus as a group of species had not then become definitely established. In the group which he called *Fungus* were included 81

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species which are now distributed to at least nine families. Tournefourt, in the latter part of the 17th century, made a considerable contribution to the genus concept. He recognized six genera of fungi and one of lichens. Dillenius and Vaillant added some genera and the latter published illustrations which were a real contribution to the study of the fungi. He maintained the genus *Fungus* in which were included most of the forms of the family Agaricaceae.

The foremost pre-Linnaean student of the fungi was Micheli. By the time of the publication of his "Nova plantera genera" in 1729 the microscope had become a working-aid and he made use of it. His work was excellent for the time. It included consideration of the genera of flowering plants, ferns, mosses, lichens, algae, and fungi. Both large and small forms of fungi were given consideration. He germinated and grew spores of the larger fungi and observed both mycelium and sporophores.

The early workers who studied the microfungi under the microscope rather naturally tried to interpret them in the light of their knowledge of the parts of flowering plants. In the case of the bread-molds the sporangia seemed like little fruiting pods containing seeds. By analogy rust spores were similarly interpreted although the situation there was not so easily demonstrated as with the molds. In 1807 DeCandolle, referring to the spores of *Uromyces* and *Uredo,* said that "with a microscope this powder seems composed of ovoid or globular spores . . . . filled with many small grains that are considered spores." He thought that a teliospore might contain at least 100 such "spores." This interpretation prevailed among such workers as Fries, Léveillé, and the Tulasne brothers, and persisted until the time of De Bary in the middle of the 19th century.

Linnaeus set himself the task of bringing together in his "Species Plantarum" (1753) all the known species of the plant world. He included the fungi in his class Cryptogamia but it cannot be said that he advanced the knowledge of them to any appreciable extent.

The first author to make a distinct advance in the classification of the fungi after the beginning of binomial nomenclature was Persoon. In a paper published in 1794 (Neuer Versuch einer Sytematischen Eintheilung der Schwämme, Romer's Neues Mag. Bot. **1**: 63-128) he recognized 77 genera of fungi, which he placed in two classes: Angiothecium and Gymnothecium. The three genera of rusts, which were included, were the first rust genera to be established after the solitary rust genus of Micheli 65 years before. Several authors of important works during the first quarter of the nineteenth century followed Persoon's classification in the main. Among these were Schumacher, Rebentish, Albertini and Schweinitz, De Candolle, and Brongniart. During the same period Link brought out a new classification which was accepted wholly or in part by Schlechtendal, S. F. Gray, and Wallroth.

During the middle of the nineteenth century great contributions to the knowledge of the larger fungi were made by Elias Fries. He had "not only a poor opinion of the parasitic fungi but an antiquated conception of their nature." In his third volume of "Systema Mycologicum" (1832) he used the name Hypodermii to include the rusts, smuts, and some other fungi and characterized them as having "No proper vegetative body; sporidia originating from the metamorphose of the cellular structure of living plants: an inferior kind of fungi." Nevertheless the work of Fries which extended over more than a half a century gave a great impetus to the study of fungi. His prestige was so great that there were many who accepted his leadership. Among these may be mentioned Endlicher, Léveillé, Corda, Rabenhorst, Strauss, Berkeley, and Cooke. Most of these authors made changes in the arrangement of the genera. Corda's extensive publication (Icones Fungorum) is notable not only for its contribution to the knowledge of the structure of the larger fungi but also for its advances regarding hundreds of the microfungi.

During the first three quarters of the nineteenth century new species were being recognized and named from all parts of the world. The descriptions appeared in journals, reports, and books many of which were not widely circulated. It is little wonder that investigators soon found it difficult to know whether or not a species under consideration was already described and named. It may be well said that this condition still exists. Thus it came about that species were named and renamed from several to many times. Little was known of the distribution of the fungi and workers in one region had no way of knowing of the probability of the existence elsewhere of the species which they were studying. Conceptions of the probable cosmopolitan distribution of the fungi were necessarily slow in developing. Many efforts were directed toward bringing together all species known to occur in certain regions or countries without attempts to determine their wider distribution. The flora-type of publication became common, especially in the European countries. Rabenhorst's "Kryptogamen Flora" of Germany, Austria, and Switzerland is a good example. Many other floras could be cited. These publications were valuable but they did not solve the problem for the workers who were located away from the European centers of mycological activity.

The assertion that many mycologists actually were deterred "from describing supposedly new species for fear of duplication" will doubtless not meet with credulity. An important step toward overcoming this situation was the plan for the "Sylloge Fungorum" inaugurated by Saccardo in 1882. The first volume appeared in that year. The effect was an immediate stimulation of systematic mycological activity. This great work developed into twenty-five volumes, the last appearing in 1931. During this period mycological journals were established in various countries and taxonomic work with the fungi went forward at a rapid rate.

Thus far we have given consideration chiefly to the describing, naming and classifying of the many and varied forms. The earlier workers naturally were concerned with these phases of study. It should not be concluded, however, that there were not some, even among the early workers, who were intrigued with the possibilities of studying the development and life-histories of the forms with which they worked. There were suggestions that relationships might exist between different forms which were found in close association. The impress left by De Bary on this phase of mycological work is well known. He began his work about the middle of the nineteenth century and the type of investigation which it stimulated has continued up to the present. He found time to work not only with fungi but also with algae, myxomycetes, bacteria, and higher plants. It is said that no less than 68 workers, afterwards distinguished in science, studied under him at Strassburg. According to Erwin F. Smith, "His work and that of his students put plant pathology on a new foundation, and he also, undoubtedly had much influence on human and animal pathology, since his very successful infection experiments with fungi on plants suggested many things to those who were trying to determine the cause of human and animal plagues." Yet we must agree that the primary interest of De Bary was in morphology rather than in pathology.

Using a good microscope and employing micro-chemical reagents De Bary made important advances in the knowledge of spores, infection, and mycelia. His cultural demonstration of heteroecism in *Puccinia graminis,* with proof that the aecidium on barberry was a stage in the life-cycle of wheat rust is well known. These results were announced in 1865. This work, and more which followed, ushered in a new phase of mycological endeavor. It is significant that he began these investigations not out of pure scientific interest, but in order to settle controversies between agriculturists and botanists regarding the relation between smuts and rusts and diseases. Agriculturists thought them to be the causes of disease while botanists were inclined to regard them as products of disease. De Bary had himself resisted the suggestion of a possible alternation of generations which required an alternation of hosts plants. When his experiments led to that conclusion, his naive statement that "one comes around, perhaps, in a way, to the ancient opinion according to which rusted wheat would be infected by the rust of barberry" is most interesting. His experiences should be heartening to many present-day investigators who are required to work on projects which are economic and agricultural in nature. Out of such problems may arise basic scientific discoveries as in the case of De Bary.

The next epoch in the study of the fungi after De Bary was ushered in by the study of the nucleus and its behavior. This gave a new direction to the study of fungi. As life-histories were important for taxonomic considerations so nuclear developments were eventually recognized as having a bearing on taxonomy. The application of cytological methods to the study of life-histories in the fungi began with the work of Dangeard in 1894 and was soon under way on a large scale. Other early workers in this field were Poirault, Sappin-Trouffy, Maire, Harper, Blackman, and Christman. It was soon evident that the nature of sexual reproduction in the fungi was of great value in determining relationships. We are indebted to such a host of investigators that it is impossible to mention them by name. Notable studies have been made in the Phycomycetes, Ascomycetes, Ustilaginales, Uredinales, and higher Basidiomycetes. In the last few years genetical studies have been made and highly important results are in the making.

Our account would not be complete if we did not make some reference to the possibility that the classification of the future may have a physiological basis. Much headway toward such a goal has been made by Mez and his associates. Many of you are familiar with the fact that Mez, using serological methods, has constructed a family tree of plants which corroborates in a remarkable manner the older tree based on morphological characters. Seifriz refers to this work in a recent book (The Physiology of Plants, 1938) with the remark, "It is of great significance to the field of evolution and phylogenetic relationship that a purely chemical basis of classification should so well support a purely anatomical one." Seifriz points out that the relationships between plants established thus far by serology hold well for families, not so well for genera, and not at all for species. He believes, however, that this is due to a lack of delicacy in technique. He is of the opinion species differences in proteins must also exist.

Our historical sketch which began with the early attempts to classify fungi led us rather inevitably to some consideration of morphological, cytological, genetical, and physiological studies. Certainly we must agree that knowledge gained in all these fields is essential for progress in taxonomy. E. A. Bessey in 1939 (A Textbook of Mycology) refers to the present-day activity of systematic mycologists and points out that, "Life histories are being studied in all groups, the sexual relations are being scrutinized from the lowest to the highest fungi and genetical studies are revealing results somewhat parallel, but on a vastly smaller scale as yet, to those attained by the study of *Zea mays* and *Drosophila*." "As never before," says Bessey, "is a knowledge of fungi themselves so necessary." Obviously right conceptions of fungi must be based upon many facts, and wrong conceptions can easily be the result of partial facts, and of ideas derived from other plants which may be inapplicable and misleading.

We have referred to the contribution which Darwin's theory of evolution made to biological classification. Phylogeny soon became the fundamental basis for classificatory endeavor. So far as the fungi are concerned we should not overlook the influence of the work of Hofmeister in 1851 on the bryophytes and pteridophytes. The recognition of an alternation of generations in these groups had its effect on studies of the algae and fungi.

Every student who has taken a course in general botany is familiar with the system of classification which places the algae and fungi together in the division Thallophyta. We have no thought of attempting to reach any conclusions about this broad question of the taxonomic disposition of the fungi. Whether the fungi are to be regarded as one of two subdivisions of the Thallophyta, the algae being the other, depends upon the origin of the fungi. We say this in spite of a recent assertion that the taxonomist "is not interested in the origin, but in the character of his plants." On the origin of the fungi, G. M. Smith, in his "Cryptogamic Botany," Vol. I, "Algae and Fungi" (1938) writes, "This is highly controversial and opinion is divided as to whether they arose from the protozoa or whether they had either a monophyletic or polyphyletic origin among the algae. If they arose from protozoa, they should be put in one or more divisions coordinate in rank with the various algal divisions; if they arose from the algae, they should be placed as classes of one or more of the algal divisions."

Smith reviews the algal and the protozoan theories of the origin of the fungi and concludes that "it seems more probable that the fungi evolved from protozoa rather than from algae." He bases his conclusion largely on metabolism and the type of flagellation in the Phycomycetes. There are some algal groups in which there occur chlorophyll-less forms which are so similar morphologically that they cannot be regarded as distinct from the green forms. It is pointed out that these saprophytic and parasitic algae accumulate reserve carbohydrates as starch just as do the green algae. In contrast the Phycomycetes are reported generally to accumulate carbohydrates as glycogen but never as starch. The zoospores and gametes of the green algae are never uniflagellate whereas the motile cells of certain Phycomycetes are regularly uniflagellate. It is admitted that the question of the origin of the Ascomycetes is a more difficult one. The similarity in the sex organs, and the structures developed subsequent to fertilization, in the Ascomycetes and in the red algae are striking and have caused many workers to assume a relationship between these groups. Smith argues that these distinctive reproductive structures may have evolved along independent phyletic lines. He thinks the Ascomycetes had their origin in the Phycomycetes and that the Basidiomycetes arose by modification from the Ascomycetes. In his classification he rejects the Thallophyta as a division of the plant kingdom and in its place substitutes nine divisions, of which the Myxothallophyta, or slime molds, constitute one and the

Eumycetae, or true fungi, constitute another. The other seven divisions include the algae. "Abandonment of the Algae as a subdivision of the plant kingdom," says Smith, "does not mean that the word *alga* must be abandoned." He believes that we can still use the term alga for designating simple green plants that have an independent mode of nutrition. We might add that we will likewise continue to use the term *fungus* although attempts to define it lead to difficulties.

Bessey in his "Textbook of Mycology" has attempted a definition of the term fungi that would not commit the definer to any system of classification. We quote: "Fungi are chlorophyll-less thallophytic organisms typically consisting of coenocytic or cellular filaments, but including also encysted or amoeboid one-celled organisms which reproduce by some type of motile or non-motile spore; excluding the Bacteria and such chlorophyll-less organisms, which, by their structure, are with definiteness assignable to recognized orders of algae." Bessey is of the opinion that the Mycetozoa are not related to the fungi; are not, indeed, plants. There are those who believe that the fungi should not be regarded as belonging to the Plant Kingdom. Herbert F. Copeland in a comparatively recent paper (Quarterly Review of Biology, December, 1938) has presented evidence and argument "to the effect that organisms can be arranged, naturally, and more conveniently than in the past, in four Kingdoms as follows":

Kingdom 1. Monera (Bacteria and Blue-green Algae)
Kingdom 2. Protista (Protozoa, Diatoms, Red and Brown Algae, Slimemolds, and Fungi)
Kingdom 3. Plantae (Green Algae, Liverworts and Mosses, Ferns and Allies, Seed plants)
Kingdom. 4. Animalia (Metazoa)

To those who have been accustomed to thinking that all living organisms must be either plants or animals the recognition of two new groups as Kingdoms may seem revolutionary. It is true, however, that the line between lower plants and lower animals has always been a difficult one to draw. It must be admitted that nomenclatorially there are difficulties in placing together in the Kingdom Protista organisms which have been previously in two different Kingdoms. The original proposal for a Kingdom to be called Protista was made by Haeckel in his "Generelle Morphologie" in 1866. He also established the group Monera but included it in Protista. According to Copeland other authors have expressed the opinion that the Monera should be treated as a separate Kingdom.

The comments presented here relative to the origin of the fungi form a very inadequate picture of the discussions and arguments that exist in the writings of many investigators. We have wished merely to call attention to the fact that there is no general agreement as to whether the fungi are monophyletic or polyphletic in origin or whether they have descended from the algae or from the protozoa. The algal theory appears to have been advocated by A. Braun in 1847, and was accepted by Cohn (1854), Pringsheim (1858), and Sachs (1874). De Bary in 1881 objected to the method of intercalating the fungi among the algae saying it led to an orderly arrangement of species but not to a natural system. The suggestion that the fungi arose from the protozoa is credited to Cornu (1872), and was developed by Gobi (1885) and Dangeard (1886). Atkinson (1907) was in favor of deriving the lower fungi from ancestral unicellular organisms, but was uncertain whether they were colorless or chlorophyll bearing. He was, however, certain that their origin was monophyletic. The algal origin of fungi was supported by Strasburger and C. E. Bessey. Gäuman (1925) presented the view that all true fungi were derived from the green algae in monophyletic line; he believes the lower Chytridiales (his class Archimycetes) along with the Myxomycetes may have arisen from the colorless Flagellatae. He does not regard either of these groups as fungi. Martin (Bot. Gaz. **93**: 421-435, 1932) has "suggested that the fungi be regarded as a phylum which has not definitely developed into either plants or animals, but may be grouped with the former as a matter of convenience, and in accordance with custom." He rejects the assumption that all living organisms are descended from a single primitive cell and points out that the assumption that life may have originated more than once and in different forms is more in accord with what we know of living organisms.

Clements and Shear (Genera of Fungi, 1931) enunciate a basic principle: "that the fungi do not constitute a natural group, and that all the phyletic lines lead sooner or later to holophytic origins." It should be noted that although they say they are not dealing with a *natural* group yet they claim to have approximated a *natural* system in several respects in their book. They believe that there is but one natural system and they maintain that any approach to it must be the result of the work of many minds. After their admonition that it is more or less inexact, even though convenient, to connect the name of an individual to any particular arrangement, one wonders whether he should not tear up his manuscript and begin anew. Clements and Shear do not agree that cytology can be the final arbiter on questions of origin and relationship among the fungi. They make a plea for experimentation "on the largest and broadest scale possible, in both field and laboratory."

This review which is concerned with the taxonomy of the fungi must provide reference to the specialists who publish papers or monographs on certain groups. Sometimes such authors are called experts. I like the way one writer who says he is no expert disposes of this matter. He says, "The standard taxonomic revision is the work of an expert in the group concerned; it cites all the present literature; it is received with respectful interest (never with complete acquiescence) by the author's fellow experts in the same group, and is more or less annoying to others who have to take it into account, as requiring revision of familiar ideas of the limits of groups and the application of names." The parenthetical phrase is not mine; it is in the original.

As with other groups of living organisms the fungi have had their devotees. Crowds of them have advanced to the expert stage. It is impossible to name them or to evaluate their contributions. They must be treated generically, as it were. The writer has thought it worth while to try to present some of the problems which such workers encounter. By this is meant not so much the problems inherent in taxonomic studies but rather the wider limitations which often operate to check individual progress and to break the continuity of advances for which a groundwork may have been well established. The difficulties which are to be discussed are not necessarily peculiar to systematic mycology. Taxonomic work in general as well as in mycology, has a checkered history. Its advances through the centuries have been piecemeal. Perhaps it will always be thus, and deploring the fact may not only be in vain but may not be fitting.

It seems likely that we must depend largely upon institutions to furnish the support for taxonomic mycology. Of course there have been numerous individuals who have done their work chiefly or wholly without institutional support. In this country we have only to think of such men as L. D. von Schweinitz, J. B. Ellis, C. E. Fairman, J. J. Davis, and Elam Bartholomew, to realize the debt we owe to individuals, and great credit is due them.

Even where universities, colleges, or other institutions or governmental agencies are involved it is still true that the ambition, industry, and perseverance of individuals are largely responsible for the advances that have been made. In these later days we have been hearing a good deal about institutional research. So far as taxonomic work with the fungi is concerned we delieve that an analysis would show that research in this line is mostly due to individual prosecution rather than to institutional initiation. It may happen that an institution will make an effort to continue the type of research that has been inaugurated and successfully carried on by one of its staff members and will then refer to the program as an institutional program. More often it happens that a real leader appears and develops successfully a line of work which is supported (more or less) during his years of activity but which is dropped by the institution afterwards. Such instances indicate the correctness of the conclusion that there is often no such thing as an institutional program. There are, of course, exceptions but we feel safe in saying that the exceptions prove the rule rather than make it. We have inserted the parenthetical phrase—more or less—because we are sure that institutional support even when forthcoming during the height of the program is often more apparent than real. Certainly it is true that many of our productive mycologists have had to earn their "bread and butter" with teaching and routine duties and have had left only a small percentage of their time and efforts for the kind of work which they were so well qualified to pursue.

Someone may well ask why these difficulties are raised in connection with taxonomic research when they exist in so many lines of research activity. There are several reasons for doing so. The source materials for taxonomic research are in large part not commercial commodities. They consist of rare books, separates, indexes, illustrations and specimens which are accumulated only with time, patience, correspondence, and exploration. When such collections have finally been put together in an institution they should be used by more than one generation of workers in that institution. Or if that is not possible some method should be worked out by which they become available to succeeding investigators in other institutions. There are now in existence some collections of microfungi where spore measurements and drawings accompany literally hundreds of specimens. Such aids are indispensable for taxonomic studies and when available not only save the time necessary to duplicate them elsewhere but help to prevent errors and misconceptions. There are also herbaria of fleshy fungi where great accumulations of photographs, drawings, and notes make them of the utmost importance to other workers. This is not a plea for the centralization of mycological taxonomy. It is rather to call attention to the fact that enormous resources are frequently accumulated and then not used nor made available for use. Since our modern concepts fix the application of names by types rather than by descriptions it is a fair question whether type specimens should ever be personal or institutional property. The difficulties may seem insurmountable but this may not be the case. Surely we will make no progress until the workers themselves reach a keener appreciation of the situation.

There are other factors which bear on the progress of taxonomic work with the fungi. Even though a staff member may have the ability and enthusiasm to carry on work of this sort it may be, as previously indicated, difficult for him to obtain the full cooperation of his institution. Projects which have more evident economic aspects have always elicited more favor with administrative officials in our agricultural institutions. This is true in spite of the obvious relation of taxonomic studies of the fungi to many phases of plant pathology. It is easy to comprehend why this attitude prevailed in the early days of the agricultural experiment stations but it is not so easy to see why the value of fundamental work of this sort should not eventually come to be recognized more generally. In very recent times approval of agricultural projects depends upon evidence that results are likely to be of direct benefit to farmers. And again, even though there may be institutional approval so far as the time of the worker is concerned, it is often difficult to secure the maintenance support which is essential. For a project requiring special apparatus, machinery, glassware, and chemicals, it is usually not difficult to secure funds. But to secure funds for the purchase of specimens, photographs, particular books, separates, periodicals, indexes, and exploration it may be difficult or well-nigh impossible. It is generally conceded that a research worker is not expected to get along with the equipment and supplies which are in general stock but is entitled to special expenditures for his project. Not so with library facilities. He may be expected to get along with what the institutional library provides. He may of course compete for more than his share of the general library funds but this is not always satisfactory even if partially successful. The use of research funds for special library facilities is much less common than for special material equipment. The problem of publication is a closely related one. Monographic treatises are often expensive to publish and the demand for them may be slight and slow. The fact that publication is difficult tends to discourage this type of work.

A few weeks ago I received a letter from a former associate in which he said, "I notice, with much interest, in the last issue of Science, that you are to have a part in the 'Symposium on Taxonomy,' June 23, in connection with the Seventy-fifth Anniversary Celebration of the Torrey Botanical Club . . . . I assume that you will *speak for the fungi*." Of course. Whether I have said, or still can say, anything which he would have me say is another matter. I assume that he expected me to make some reference to the problem of nomenclature and it seems impossible to close this discussion without bringing up this vexatious topic.

I propose to make comments of a general nature and to confine them to two aspects of the nomenclatorial situation: (1) on getting rules, and (2) on getting them into effect.

It is generally conceded that "Natural history can make no progress without a regular system of nomenclature, which is *recognized* and *used* by the great majority of naturalists in all countries." This is a quotation of the first article of the International Rules of Botanical Nomenclature; the italics are mine. The necessity of establishing international rules to govern the application of names of plants has been recognized by botanists for many years. But it is easier to recognize the problem than to solve it. The world well knows the difficulties of securing unanimity of action on any matters calling for international consideration.

One of the chief difficulties is to get together a group, the personnel of which is truly representative of the science and at the same time really international in standing. Institutions and governments have been willing to designate individuals as representatives to botanical congresses but for the most part they have been unwilling, or thought it unwise, to contribute toward the expense of attendance. The final assembly has been made up, therefore, not necessarily of those best qualified but of those individuals who have been willing to finance a trip in order to take part in the proceedings. The departments of our national government sometimes send "official delegates" to international congresses but they usually place restrictions on the activities of such delegates. I hope I am giving away no secret when I say that an employee of our federal government told me when we were in attendance at an International Botanical Congress that he was instructed before leaving this country that he might take part in the discussions but was not allowed to vote on the questions coming before the section on nomenclature. The conclusion seems to be justified that the advancement of this phase of natural history, of the greatest importance to mankind, has been too dependent upon voluntary contributions of the workers themselves.

It is also generally conceded that rules of nomenclature should not be arbitrary and that they cannot be imposed by authority—at least not by the authority of the makers of the rules. As an alternative the framers of the rules say, "They must be simple and founded on considerations clear and forcible enough for everyone to comprehend and be disposed to accept." Such a statement was made in the Rules as published in 1912 which were adopted in 1905 (Vienna) and supplemented in 1910 (Brussels). Perhaps rules of nomenclature are like a plant which grows slowly and requires a period of development before it comes to maturity. I do not know how many people did not comprehend the International Rules of Vienna and Brussels but I do know that in the following years many were disposed *not* to accept. There were individuals and groups of individuals who deplored the fact that certain fundamental principles of a basic nature in which they believed were not incorporated. They felt that once they accepted a code without these principles the chances for amendment would not be good. I have in mind chiefly the "type-concept" which was not a part of the original code. Reference to a more or less minor feature may serve to illustrate difficulties regarding adoption. The Vienna code provided that "On and after January 1, 1908, the publication of names of new groups of recent plants will be valid only when they are accompanied by a Latin diagnosis." Again I do not know how many names have since been published which are invalid, but I do recall taking part in a business session of a certain mycological society, at least 25 years after the Latin deadline, when the matter before the house was whether that rule should be enforced in its official journal.

It seems fair to say that cordial agreement was reached at the Cambridge Congress in 1930 on most of the disputed nomenclatorial problems and that the disposition to accept International rules was improved thereafter. Not long ago I was criticized by a colleague for such a conservative statement. He wanted me to say that these rules are, and have been for some time, actually in effect. Again it may be time which settles many problems. At any rate, it was in 1940 that the Secretary of the United States Department of Agriculture formally approved a recommendation of the Department Committee on Plant Names "to put the Department, botanically speaking, under the International Rules of Nomenclature." To me it is interesting that it took ten years for this department to come to an action making these rules official for "publications, reports, and correspondence involving scientific plant names." Perhaps one might be pardoned for calling attention to the anomaly of an agency finally finding it expedient to subscribe to the acts of an organization which it failed officially to aid. It is also interesting to note that two years after the official order they are still going through an adjustment period in getting nomenclatorial usage realigned according to International rules. When it becomes necessary to drop the name *Ustilago hordei* which, according to old usage, has been applied to the *covered* smut of barley and to take up the same name, according to International Rules, for *loose* smut of the same host it is little wonder that the workers talk about confusion. Personally, I believe that the confusion will be only temporary and that the advantage of getting on a world-usage basis will more than outweigh the disadvantages. It is desirable to avoid changes in names as far as possible, but changes cannot be entirely avoided if the rules of nomenclature are to put in order the old names as well as to be a guide for the creation of new names. There are those who believe that the procedure embodied in the present system of nomenclature leaves too much to expediency and personal preference and do not rest sufficiently upon foundamental principles. It has been pointed out that "there is no guarantee—if, indeed, there is any hope—that the system which may be adopted today will be accepted by the next generation." No, there is no guarantee that anything man devises will continue—not even democracy. We must not, however, look upon this or any other problem in such a futile manner. There are difficulties, to be sure, but they are not insurmountable. We are told in the Torrey Botanical Club Announcement and Field Schedule for 1942, "It is understood that there will be no mutilation of species at this session." That being the case, this seems to be the proper place to bring this discussion to an end.

THE PENNSYLVANIA STATE COLLEGE
STATE COLLEGE, PENNSYLVANIA

ACTIVITIES OF THE CLUB

January to May 1943

January 5. Annual Meeting.

The annual dinner meeting of the Torrey Botanical Club was held at the Men's Faculty Club, Columbia University, at 6:45 p.m. The President, Dr. C. Stuart Gager, presided, with 82 members and friends present. After the dinner the minutes of the preceding meeting were approved. The reports of the Treasurer, of the Chairman of the Field Committee, and of the Editor of Torreya were distributed in mimeographed form, and the combined report of the Editor and the Bibliographer was read by Dr. Matzke. These reports were accepted on a motion by Dr. Karling.
Dr. Gager addressed a few remarks to the Club and then announced that the following list of officers had been elected for the year 1943:

President: William J. Robbins
1st Vice-President: Fred J. Seaver
2nd Vice-President: Lela V. Barton
Corresponding Secretary: Edwin B. Matzke
Recording Secretary: Honor M. Hollinghurst
Treasurer: W. Gordon Whaley
Editor: Harold W. Rickett
Bibliographer: Lazella Schwarten
Business Manager: Michael Levine
Members of the Council: Charles A. Berger, Clyde Chandler, Albert E. Hitchcock, Roger P. Wodehouse
Delegate to the Council of the N. Y. Academy of Sciences: Bernard O. Dodge
Representative on the Board of Managers of the N. Y. Botanical Garden: Henry A. Gleason
Representatives on the Council of the American Association for the Advancement of Science: John H. Barnhart, Albert F. Blakeslee

Dr. Matzke then conducted a "Botanical Information Please" quiz with a board of experts comprised of Drs. Gager, Graves, Karling, Robbins, and Zimmerman, augmented at times by the guests at large. The meeting adjourned at 9:15 p.m.

Honor M. Hollinghurst, Recording Secretary.

January 20. Meeting at The New York Botanical Garden.

The meeting was called to order at 3:30 p.m. by the President, Dr. William J. Robbins. Attendance 25. The minutes of the preceding meeting were approved. The following new members were elected: 15 to Annual membership, 3 to Associate membership; 2 transfers to Annual membership and 4 transfers to Associate membership were approved. The resignations of 21 Annual and of 4 Associate members were accepted with regret.

A letter was read concerning the preservation of High Tor. Dr. Robbins suggested that a letter be sent to the sponsors of this movement, expressing the interest of the Torrey Botanical Club, and stating that the enterprise had been announced and discussed at our meeting, and suggesting that the Club send a notice concerning this with the field schedule to be issued in March, provided this date is not too late.

The scientific program consisted of two talks, the first by Dr. H. W. Rickett on "The Genus *Cornus* in North America."

The genus *Cornus* may readily be divided into 7 sections, 5 of which have often been treated as genera. The difference between these are chiefly in the inflorescences.

It is assumed that *Afrocrania,* with one species in East Africa is primitive. Closely related is the big section *Thelycrania,* which covers much of Europe, Asia, and North America, and is here typified by such species as *C. stolonifera* and *C. amomum.* Also from *Afrocrania* came *Tanycrania* (*C. mas, C. sessilis*), found now in southern Europe, China, western North America; *Disocrania,* with one species in Mexico; *Cynoxylon* and *Cephalocrania,* which include such species as *C. florida* and *C. kousa,* found in southern Asia and North America; and *Arctocrania,* the so-called herbaceous boreal species *C. canadensis* and *C. suecica.* The progression seems to have been from a primitive panicle subtended by bracts, by condensation to a "head" with either disappearance of the bracts (*Thelycrania*), or their development into more or less petaloid appendages; this often accompanied by the postponement of anthesis through a dormant period until the season following flower-formation, the bracts serving as bud scales. Most of the confusion in names and identities is in *Thelycrania.* This section falls readily into groups of two or three species each, in North America. A study of their distribution indicates that each of these groups seems to have once been present in the southern Appalachian region, and to have split as it migrated northward. When the segregated elements came again into contact we find integrading forms which cannot be accurately classified. One of the regions where this occurs is the Ohio Valley, where Rafinesque created numerous new "species." Another is the St. Lawrence Valley and northern New York.

This was followed by a presentation by Mr. F. R. Swift on "Treating Yeast Plants as Individuals," illustrated with splendid motion pictures.

This talk gave a short review of some of the methods used in developing yeast cultures, from the primitive method of merely exposing easily fermentable material to the air to the manipulator method developed at the Fleischmann Yeast Laboratory.

In the latter, glass cover-slips are pre-coated with a vegetable-mineral oil mixture, adjusted to fit the medium in use at the time. Small hanging drops are then distributed on the cover-slips and each one is seeded with one yeast cell. It was explained that by varying the proportions of the vegetable and mineral oil with the varying surface tension of different media being used, easily handled, uniform droplets, can be assured.

The development of yeast cultures growing and sporulating in such droplets was shown in a series of slides and by stopmotion photography, in a motion picture.

The discussion of these papers was continued after the meeting was formally adjourned at 5:05 p.m., while tea was generously provided by The New York Botanical Garden.

Edwin B. Matzke, Corresponding Secretary.

February 2. Meeting in The Museum of Natural History.

The meeting was called to order by the President, Dr. Robbins, at 8:15 p.m. Attendance 43. The minutes of the preceding meeting were accepted. Five new members were elected to Annual membership. Dr. Seaver reported that the Auditing Committee had found the Treasurer's books in excellent condition. The report was accepted. President Robbins then read the names of those appointed to the various standing committees of the Club. The scientific program was presented by Mr. G. L. Wittrock of The New York Botanical Garden who spoke on "Local Plants Used by the American Indians," and illustrated these with colored slides. After a discussion period the meeting adjourned at 9:40 p.m.

Honor M. Hollinghurst, Recording Secretary.

February 17. Meeting at The New York Botanical Garden.

The meeting was called to order at 3:30 p.m. by the President, Dr. Robbins. Attendance 22. The minutes of the preceding meeting were approved. Two new Annual members and one Associate member were elected. The first speaker on the scientific program was Dr. Frances E. Wynne who spoke on "Variability and Distribution of *Drepanocladus* in North America."

Drepanocladus, like many aquatic and semi-aquatic plants, is extremely variable. Field and herbarium studies have been made to determine which variations are hereditary and which are merely environmental fluctuations. Careful examination of leaves from different parts of the same plant shows that elongated leaves, costae, and cells are always produced when the plant grows submerged in water, whereas shorter leaves and cells are produced by stems which grow emergent. Many of the described varieties are merely seasonal phases produced by changes in the water level. The present monographic study has reduced the previously recognized 24 species and 30 varieties to 9 species, 1 subspecies, and 4 varieties. Hereditary factors determine the presence of an excurrent costa and secund leaves; therefore these characters are used as the basis for varieties in several species. The environmental fluctuations of the shape of the leaves, costae, and cells are not given taxonomic recognition.

The species of *Drepanocladus* may be classified geographically into two groups—arctic-alpine and boreal-montane. The arctic-alpine species are restricted in their range to the arctic regions; the boreal-montane species are widespread in the arctic but occur also in boreal and mountain bogs and swamps.

The species of *Drepanocladus* may be divided into two categories on the basis of fundamental variability. All the boreal-montane are extremely adaptable and variable and as a result of their toleration of a large variety of habitats have spread over a wide range. The arctic-alpine species are stable, clear-cut species limited to one region and one type of habitat.

Drepanocladus has a circumpolar distribution in both hemispheres. In North America its present range coincides with the maximum extent of continental and cordilleran glaciation during the Pleistocene. In eastern North America the distribution in partially glaciated states such as Pennsylvania, New Jersey, Ohio, Indiana, and Missouri is significant. In these states *Drepanocladus* does not occur south of the till sheets except in a few isolated stations. In western North America it is found in mountain bogs and alpine meadows.

Four types of localities may have provided refuges for plants such as *Drepanocladus* during the Pleistocene: (1) areas south of the Pleistocene ice (2) arctic areas north of the ice (3) unglaciated lowlands and (4) mountains or nunataks.

Two types of distribution result from the Pleistocene glaciation: (1) relic, static and (2) general, widespread. Any hypothesis, proposed to explain the post-Pleistocene dispersal of plants, must consider these two types of distribution found on glaciated areas. Of the numerous explanations which have been proposed, the most satisfactory is founded on the genetic constitution of the plants. Species may be plastic and adaptable or rigid and static. The boreal-montane species of *Drepanocladus* are adaptable because a large number of individuals survived the Pleistocene in a large variety of habitats on all of the possible refuges; therefore a large number of biotypes contributed to these plastic species. The arctic-alpine species are rigid because only a few individuals survived in a few habitats on only one of the refuges; the biotypes contributing to these species were depleted by the vicissitudes of the ice age leaving the species genetically rigid.

The second speaker was Dr. Morris Winokur who spoke on "Photosynthesis in Bacteria."

The attempt to interpret the metabolism of the green and sulfur bacteria has resulted in the development of a generalized concept of photosynthesis which is applicable to the green plant as well.

At the beginning of the twentieth century, there existed three conflicting theories concerning the physiology of the purple bacteria. Engelmann believed that the purple bacteria were able to photosynthesize much in the manner of the algae. Winogradsky postulated that the oxidation of hydrogen sulfide and sulfur represented a substitute for the respiration of organic substances, characteristic of the normal functioning of most organisms. Molisch developed the thesis that the purple bacteria cannot assimilate carbon dioxide, but they assimilate organic compounds in the light. The controversial nature of the results obtained by these three investigators was due to their use of different biological materials: Engelmann—purple sulfur bacteria; Molisch—purple non-sulfur bacteria; Winogradsky—colorless sulfur bacteria. Buder attempted to harmonize the diverse views by categorizing the organisms employed. The existence of an intimate connection between the photosynthetic activity of the purple sulfur bacteria and their respiratory phenomena was first clearly expressed by Kluyver and Donker.

Van Niel demonstrated conclusively the photosynthetic nature of the metabolism of the purple sulfur bacteria by devising methods for growing them in pure culture in strictly mineral media in the light. His data show that the photosynthetic carbon dioxide utilization depends quantitatively on the oxidation of sulfide and sulfur. He also disclosed a similar relationship for the green sulfur bacteria. Comparing these photosyntheses with that of the green plant, van Neil formulated the hypothesis that the several photosynthetic reactions are all examples of photochemical carbon dioxide reduction with a different hydrogen donor in each case. This generalized view of photosynthesis made possible the explanation of the photosynthesis of the non-sulfur purple bacteria as one in which the normal inorganic hydrogen donors for the reduction of carbon dioxide are replaced by organic molecules. A variety of indirect and direct experimental evidence has substantiated this interpretation.

Critical evaluation of the objections to the generalized concept of photosynthesis leaves unimpaired the viewpoint that photosynthesis is a photochemical carbon dioxide reduction in which organic compounds as well as inorganic substances or even molecular hydrogen can play the role of hydrogen donors.

The consequence of the acceptance of this broad generalization is that it renders untenable the classical Willstätter-Stoll theory of green plant photosynthesis.

After discussion of both papers, the meeting adjourned at 4:35 p.m., to be continued over the inviting tea and refreshments served by friends at the Garden.

Honor M. Hollinghurst, Recording Secretary.

March 2. Meeting in Schermerhorn Extension, Columbia University.

The meeting was called to order at 8:15 p.m. by Dr. Lela V. Barton, the second Vice-President. Despite the promise of a five siren air raid drill, 17 members attended. The minutes of the preceding meeting were approved. The scientific program was presented by Dr. Ray F. Dawson who spoke on "Some Aspects of Parasitism in the Mycorrhizae of Shortleaf Pine."

The fungus or fungi which induce mycorrhiza formation on the roots of shortleaf pine in the Missouri Ozarks area are apparently obligate parasites. The nature of the symbiotic relationship between fungus and tree roots is determined largely by environmental factors. When the trees are grown upon soils which are nutritionally poor or unbalanced or when light intensity is low, fungal invasion of the short roots readily occurs, and many well developed mycorrhizae are formed. Tree growth may vary from slow to negligible. When the trees are grown upon fertile soil mycorrhiza formation is difficult and slow and tree growth may be good, but if the soil contains appreciable amounts of organic matter the seedlings will most likey fall victim of damping-off fungi. When the trees are grown upon soils which contain relatively low amounts of the necessary nutrients but when these nutrients are present in physiologically balanced proportions on the soil colloids mycorrhizal development and tree growth are both favored. Under such circumstances the mechanism of the beneficial effect of mycorrhizae upon tree growth seems to be associated with an increased salt absorption which is conditioned by an increased rate of aerobic respiration and by a newly introduced mechanism for anaerobic respiration both of which serve to maintain the energy output necessary for the growth processes. Hydrogen ion excretion by the roots under such circumstances is increased several times thus making it possible for the root colloids to undergo more intensively base exchange reactions with the soil colloids in the initial phase of salt absorption. The enhanced absorption of salts may then bring about greater water absorption and resulting increases in both volume and mass of the plant tissues.

Following the discussion period, the meeting adjourned at 9:35 p.m.

Honor M. Hollinghurst, Recording Secretary.

MARCH 17. MEETING AT THE NEW YORK BOTANICAL GARDEN.

The meeting was called to order by the Vice-President, Dr. Seaver, at 3:30 p.m. Attendance 36. The minutes of the preceding meeting were accepted. Dr. Whaley announced the death of Dr. Tracy Hazen on March 16th, in Waterbury, Conn. On a motion by Dr. Stewart it was voted that the Secretary send the condolences of the Club to the family of Dr. Hazen. Dr. Matzke stated that he had received from Dr. Moulton, of the American Association for the Advancement of Science, a request for a summary of the history of the Torrey Botanical Club. Dr. Matzke said he would be willing to prepare this summary which is to be published in the Journal of the Association with the histories of other affiliated societies. The first scientific paper was presented by Dr. Ernest Naylor who spoke on "Problems of Cellular Behavior during Regeneration."

The author presents a brief discussion of some of the cell changes during early stages of shoot and root formation on isolated plant parts during regeneration. The multiplication and organization of cells during regeneration involves two fundamental types of cells morphologically. One is the meristematic type, which may or may not be definitely organized into recognizable growing points. Such cells may be variously located in leaf axils, nodal regions, leaf margins, woody structures, and in other places.

The other type is concerned with differentiated cells of the plant body which undergo structural changes and become actively meristematic to produce the new root and shoot primordia. Such de-differentiation of vacuolate cells is described in various tissues of a number of seed plants. The extent and limitations of such de-differentiations in plant cells is briefly considered and some of the theoretical implications pointed out.

Dr. Whaley was the second speaker on the scientific program, and his topic was "Inferiority Complexes in Plants."

Recent work of Dobzhansky and others indicates that in natural populations many detrimental recessive genes are accumulated. The number and relative potency of these genes is dependent upon the population structure, which is a function of the number of individuals and the type of reproductive mechanism. Under selection it is also possible for unfavorable dominants to accumulate. Heterosis is the result of masking of these deleterious recessives in some organisms, the result of heterozygosity in others. Suggestions as to the nature of some of these deleterious factors is found in excised root culture experiments. The roots of certain tomato lines show a deficiency in ability to synthesize pyridoxine, others in the ability to synthesize nicotinamide. Crosses between such lines produced vigorous hybrids under ordinary field conditions. Hybrid vigor represents a return to an "optimum" phenotype rather than any "super" phenotype.

After a discussion of both papers, the meeting adjourned at 4:35 p.m. Then tea and delicious refreshments, in keeping with the spirit of St. Patrick's Day, were served by friends at the Garden.

HONOR M. HOLLINGHURST, RECORDING SECRETARY.

MARCH 27. FIELD TRIP to The New York Zoological Park for the study of some animal habits. Leader, Miss Nellie L. Condon, Director, Reptile Study Society of America. Attendance 11.

MARCH 28. FIELD TRIP to Springdale, N. J., for limestone lichens. Leader, Mr. G. G. Nearing. Attendance 4. Unusual forms found were: *Acarospora murorum, Cyphelium tigillare*, and *Physcia venusta.* The last two were in fruit, and these fruiting forms appear to be rare.

APRIL 4. FIELD TRIP to Central Park, N. Y. to search for the trees mentioned in L. H. Peet's book "Trees and Shrubs of Central Park" (1903). Leader, Dr. E. B. Matzke, Columbia University. Attendance 25. Many of those present took an active part in the identification of the trees, and all of us profited by Mr. James Murphy's generous and genial contributions on the trees and shrubs as well as on the history and lore of Central Park. The following plants were found in flower: *Cornus mas, Lonicera fragrantissima, Ulmus americana, U. campestris,* and *Acer rubrum.* Most of the day was spent trying to locate trees mapped in Peet's book. The morning was devoted to the southern half of the park, and the afternoon to the northern end. A few tentative conclusions may be suggested, subject of course to correction after more careful study:

1. Changes in tree population have been much more pronounced in the southern end of the Park in the last forty years than in the northern end. Many of the trees listed by Peet for the northern end could easily be located; this was decidedly not true nearer 59th Street.
2. The conifers have not fared well. White pines and some other gymnosperms present in 1903 were not found; a young Douglas Fir, more recently planted, was distinctly the worse for wear. Some Austrian pines have survived, and they may or may not be an exception.
3. The Turkey Oak, *Quercus Cerris,* has grown and perhaps prospered; native oaks apparently do not thrive.
4. The English Elm, *Ulmus campestris,* seems to have done reasonably well, distinctly better than our native ones.
5. In the wetter habitats the red maple, *Acer rubrum,* seems to be pretty well established.
6. *Ailanthus* apparently "seeds in" in the park.

EDWIN B. MATZKE

APRIL 6. MEETING IN SCHERMERHORN HALL, COLUMBIA UNIVERSITY.

The meeting was called to order at 8:20 p.m. by the President, Dr. Robbins. Attendance 33. The minutes of the preceding meeting were approved. Eight new annual members and three associate members were elected, and one transfer from associate to annual membership was approved.

Dr. Matzke then read to the club the letter which he, as Corresponding Secretary, had sent to the family of the late Dr. Tracy E. Hazen:

New York City
March 23, 1943

DR. ROBERT HAZEN
Thomaston
Connecticut.

Dear Dr. Hazen:

At its meeting held on March 17, 1943, the Torrey Botanical Club directed its Secretary to extend sympathy and condolence to the family of the late Professor Tracy Elliot Hazen.

Its Editor for many years, its President for two terms, the Torrey Botanical Club was singularly fortunate in having profited by the sound scholarship, the meticulous labors, the faithful devotion to duty, and the kindness of heart of Professor Hazen. All its members admired him, all respected him as a thorough gentleman, and all who knew him intimately, loved him.

Your grief, and ours, may be assuaged by a knowledge of Professor Hazen's goodness, of his quiet nobility, and of his high attainments.

The Torrey Botanical Club realizes that a faithful officer, member, and friend has passed to his reward; it is grateful for having shared in the innate richness of his life.

In deep respect,
EDWIN B. MATZKE,
CORRESPONDING SECRETARY.

Dr. Robbins announced that he had appointed a committee to draft a biographical note on Dr. Hazen for the BULLETIN. The committee consists of Dr. Carey, chairman, Dr. Barnhart, and Dr. Bold.

The scientific program of the evening was presented by Dr. A. B. Stout of The New York Botanical Garden, who spoke on "Dichogamy in Relation to Reproduction," illustrated with lantern slides. After questions and discussion from the floor, the meeting adjourned at 9:40 p.m.

HONOR M. HOLLINGHURST, RECORDING SECRETARY.

APRIL 11. FIELD TRIP to The Brooklyn Botanic Garden and Conservatories for seasonal studies outside, and for observation of economic plants from other lands. Leaders, Dr. A. H. Graves and Dr. A. Gundersen of the Garden staff. Attendance: 3 members and 147 visitors in the Garden.

APRIL 17. FIELD TRIP to The New York Botanical Garden Conservatories, particularly the Easter exhibit in the Display House featuring trees of the Holy Land. Leader, Dr. H. A. Gleason of the Garden staff. Attendance 11.

APRIL 18. FIELD TRIP to the Lichen Trail in Palisades Interstate Park for lichens, fungi, and general botany of the season. Leader, Mr. G. G. Nearing. Attendance 4.

APRIL 21. MEETING AT THE BROOKLYN BOTANIC GARDEN.

The meeting was called to order at 3:30 p.m. by Dr. C. Stuart Gager, in the absence of the President and Vice-Presidents of the Club. Attendance 18. The minutes of the preceding meeting were approved. The program consisted of a talk by Dr. Henry K. Svenson on the "Plants of a Long Island Pond," illustrated with Kodachrome slides; and an inspection of the Local Flora Area of the Garden under the leadership of Dr. Svenson.

HONOR M. HOLLINGHURST, RECORDING SECRETARY.

APRIL 24. FIELD TRIP to Surprise Lake, Watchung Reservation, near Summit, N. J., for reptiles, amphibia, and spring plant life, all of which reflected the late season. Leader, Miss Nellie L. Condon. Attendance 11.

MAY 1. FIELD TRIP to Mertensia Island along Raritan River above Raritan, N. J., to see the profuse stand of *Mertensia, Dentaria, Erythronium,* etc. This was the ideal date for this season. Leader, Dr. John A. Small, New Jersey College for Women. Attendance 6.

MAY 2. FIELD TRIP to Silver Lake, White Plains, N. Y., for spring flowers and birds. The day was cold and windy. 25 bird species were seen, 4 violets and 10 other plant species were found in bloom. Leader, Miss Farida A. Wiley, American Museum of Natural History. Attendance 12.

MAY 8-9. WEEK END FIELD TRIP to Camp Thendara, Lake Tiorati, Palisades Interstate Park, N. Y., for study of birds and plants. Leader, Mrs. Richard M. Abbott. Attendance 32, of which at least 5 were from the Torrey Club. 69 bird speceis were recorded, including 19 warblers.

MAY 11. MEETING IN SCHERMERHORN HALL, COLUMBIA UNIVERSITY.

The meeting was called to order by the President, Dr. Robbins, at 8:15 p.m. Attendance 70. The minutes of the preceding meeting were approved. The scientific program was presented by Dr. Samuel Record, of the Yale School of Forestry, who told "How Woods Are Identified."

> The results already obtained from the systematic studies of woods indicate clearly that any wood sample is identifiable. The unit of classification is at present the genus, but well-defined species are frequently recognizable and their number

will increase with fuller knowledge of their range of variation. Ability to identify a wood is of practical value to timber dealers and users and an important aid to taxonomists in determining imperfect herbarium material and in preventing or correcting faulty classification.

The essentials for systematic study of woods are: 1. A comprehensive and representative collection of samples obtained with herbarium material determined by competent taxonomists. In the Yale collections there are 40,700 catalogued samples representing nearly 12,000 named species of 2,800 genera and 232 families. 2. A collection of slides with cross, radial, and tangential sections for examination under the microscope. The Yale slide collection contains about 19,500 slides of 11,072 specimens of 6,506 name species, 2,616 genera, and 218 families. 3. Careful examination of the slides by trained anatomists and the preparation of descriptions and tabulations of all essential features. The standards used are those approved by the International Association of Wood Anatomists after several years of cooperative effort. 4. The use of the assembled data for making keys or other aids to identification. Numerous keys to special groups have already been published and others are in preparation.

The task is very large, difficult, and costly and can only be carried out successfully through cooperative efforts. Ordinary taxonomists, though willing to accept the aid of the anatomist in a time of trouble, make no effort to secure material essential for anatomical study. Fortunately there are exceptions to this rule and The New York Botanical Garden is foremost among American institutions in encouraging its botanists to collect wood samples. Systematic wood anatomy has made its greatest progress during the past decade for the simple reason that during that time research workers in various parts of the world effected an organization and pooled their efforts and materials. The best incentive to further progress would be the addition of new and better material which botanical expeditions could so readily supply.

Because discussion of the talk was sharply curtailed at 9:30 p.m. by the sounding of sirens for an air raid drill, the meeting quickly adjourned to darkened halls, where by the light of a lantern, Dr. Record graciously identified wood specimens presented by members of the audience.

Honor M. Hollinghurst, Recording Secretary.

May 15. Field Trip to McLean Woods, The Bronx, N. Y., for spring study of the area. Species lists were prepared and filed with the Field Committee. Leader, Mrs. Mary Holtzoff. Attendance 14.

May 16. Field Trip to Point Pleasant, N. J., to search for Britton's Violet, of which a good stand was found, and in addition a large number of other plants. Leader, Mr. Louis Hand. Attendance 7.

May 21-23. Field Trip to Culvers Lake, N. J., for the Annual Branchville Nature Conference. In order to have the conference at the most desirable season and without increased expense to those participating it was necessary to change from THE PINES to THE HALTERE for accommodations. This proved satisfactory. Leaders: Mr. Wallace M. Husk, Professor Oliver P. Medsger, and Dr. Julius Johnson. Attendance 40.

May 22. Field Trip to Ridgewood, N. J., to see the Rhododendron seedbeds, nurseries, and stock of the leader, Mr. G. G. Nearing. Attendance 10.

May 29. Field Trip to Haskell, N. J., for fungi of the Chicohikie Falls region, especially *Fissipes acaulis,* of which there was plenty. Leader, Mr. F. R. Lewis. Attendance 5.

The Importance of Taxonomic Studies of the Fungi*

Frank D. Kern

The naming and classifying of living organisms has been going on for centuries. It has been well said that "a large part of our thinking about living things is bound up with some system of classification." Another writer has pointed out the fact that we depend much upon classification in our general experiences. "It is the innate propensity of active minds," he says, "to form species, *i.e.*, successively to make distinctions, to point out similarities, and then to assemble the things that are alike into their kinds. It applies to everything from chemical elements to college fraternities."

The recognition of the need of names for plants dates from the days of Pliny, the Roman naturalist, and Dioscorides, the Greek physician, in the first century of the Christian era. Plants could not be discussed without names. They could be named, however, without classification. They could be classified, also, without a conception of phylogeny. In other words, nomenclature deals with names which may or may not be arranged according to a system of classification; and classification deals with groups which may or may not indicate relationships. Many biologists, on the other hand, attempt to arrange groups on a basis of similarities, which they believe to be expressions of actual relationships. It is of particular interest today to note that the modern development of these aspects of botanical science has been made during the years since the founding of this Club. The first real progress in working out a universal system of nomenclature was made at an International Botanical Congress in Paris in 1867. A natural system of classification, although early recognized as desirable, has made its most progress since the theory of evolution provided a basis for phylogenetic interpretations. Darwin's Origin of Species, just a few years earlier, furnished the evolutionary concepts which soon became so significant in taxonomy.

Even a cursory examination of some of the early attempts to classify the fungi is sufficient to reveal that the results were most general in nature. Bauhin, in the days of the "herbals" purported to bring together all the plants known to him and to all those who preceded him (Pinax Theatri Botanici, 1623). The concept of the genus as a group of species had not then become definitely established. In the group which he called *Fungus* were included 81

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species which are now distributed to at least nine families. Tournefourt, in the latter part of the 17th century, made a considerable contribution to the genus concept. He recognized six genera of fungi and one of lichens. Dillenius and Vaillant added some genera and the latter published illustrations which were a real contribution to the study of the fungi. He maintained the genus *Fungus* in which were included most of the forms of the family Agaricaceae.

The foremost pre-Linnaean student of the fungi was Micheli. By the time of the publication of his "Nova plantera genera" in 1729 the microscope had become a working-aid and he made use of it. His work was excellent for the time. It included consideration of the genera of flowering plants, ferns, mosses, lichens, algae, and fungi. Both large and small forms of fungi were given consideration. He germinated and grew spores of the larger fungi and observed both mycelium and sporophores.

The early workers who studied the microfungi under the microscope rather naturally tried to interpret them in the light of their knowledge of the parts of flowering plants. In the case of the bread-molds the sporangia seemed like little fruiting pods containing seeds. By analogy rust spores were similarly interpreted although the situation there was not so easily demonstrated as with the molds. In 1807 DeCandolle, referring to the spores of *Uromyces* and *Uredo,* said that "with a microscope this powder seems composed of ovoid or globular spores . . . . filled with many small grains that are considered spores." He thought that a teliospore might contain at least 100 such "spores." This interpretation prevailed among such workers as Fries, Léveillé, and the Tulasne brothers, and persisted until the time of De Bary in the middle of the 19th century.

Linnaeus set himself the task of bringing together in his "Species Plantarum" (1753) all the known species of the plant world. He included the fungi in his class Cryptogamia but it cannot be said that he advanced the knowledge of them to any appreciable extent.

The first author to make a distinct advance in the classification of the fungi after the beginning of binomial nomenclature was Persoon. In a paper published in 1794 (Neuer Versuch einer Sytematischen Eintheilung der Schwämme, Romer's Neues Mag. Bot. **1**: 63-128) he recognized 77 genera of fungi, which he placed in two classes: Angiothecium and Gymnothecium. The three genera of rusts, which were included, were the first rust genera to be established after the solitary rust genus of Micheli 65 years before. Several authors of important works during the first quarter of the nineteenth century followed Persoon's classification in the main. Among these were Schumacher, Rebentish, Albertini and Schweinitz, De Candolle, and Brongniart. During the same period Link brought out a new classification which was accepted wholly or in part by Schlechtendal, S. F. Gray, and Wallroth.

During the middle of the nineteenth century great contributions to the knowledge of the larger fungi were made by Elias Fries. He had "not only a poor opinion of the parasitic fungi but an antiquated conception of their nature." In his third volume of "Systema Mycologicum" (1832) he used the name Hypodermii to include the rusts, smuts, and some other fungi and characterized them as having "No proper vegetative body; sporidia originating from the metamorphose of the cellular structure of living plants: an inferior kind of fungi." Nevertheless the work of Fries which extended over more than a half a century gave a great impetus to the study of fungi. His prestige was so great that there were many who accepted his leadership. Among these may be mentioned Endlicher, Léveillé, Corda, Rabenhorst, Strauss, Berkeley, and Cooke. Most of these authors made changes in the arrangement of the genera. Corda's extensive publication (Icones Fungorum) is notable not only for its contribution to the knowledge of the structure of the larger fungi but also for its advances regarding hundreds of the microfungi.

During the first three quarters of the nineteenth century new species were being recognized and named from all parts of the world. The descriptions appeared in journals, reports, and books many of which were not widely circulated. It is little wonder that investigators soon found it difficult to know whether or not a species under consideration was already described and named. It may be well said that this condition still exists. Thus it came about that species were named and renamed from several to many times. Little was known of the distribution of the fungi and workers in one region had no way of knowing of the probability of the existence elsewhere of the species which they were studying. Conceptions of the probable cosmopolitan distribution of the fungi were necessarily slow in developing. Many efforts were directed toward bringing together all species known to occur in certain regions or countries without attempts to determine their wider distribution. The flora-type of publication became common, especially in the European countries. Rabenhorst's "Kryptogamen Flora" of Germany, Austria, and Switzerland is a good example. Many other floras could be cited. These publications were valuable but they did not solve the problem for the workers who were located away from the European centers of mycological activity.

The assertion that many mycologists actually were deterred "from describing supposedly new species for fear of duplication" will doubtless not meet with credulity. An important step toward overcoming this situation was the plan for the "Sylloge Fungorum" inaugurated by Saccardo in 1882. The first volume appeared in that year. The effect was an immediate stimulation of systematic mycological activity. This great work developed into twenty-five volumes, the last appearing in 1931. During this period mycological journals were established in various countries and taxonomic work with the fungi went forward at a rapid rate.

Thus far we have given consideration chiefly to the describing, naming and classifying of the many and varied forms. The earlier workers naturally were concerned with these phases of study. It should not be concluded, however, that there were not some, even among the early workers, who were intrigued with the possibilities of studying the development and life-histories of the forms with which they worked. There were suggestions that relationships might exist between different forms which were found in close association. The impress left by De Bary on this phase of mycological work is well known. He began his work about the middle of the nineteenth century and the type of investigation which it stimulated has continued up to the present. He found time to work not only with fungi but also with algae, myxomycetes, bacteria, and higher plants. It is said that no less than 68 workers, afterwards distinguished in science, studied under him at Strassburg. According to Erwin F. Smith, "His work and that of his students put plant pathology on a new foundation, and he also, undoubtedly had much influence on human and animal pathology, since his very successful infection experiments with fungi on plants suggested many things to those who were trying to determine the cause of human and animal plagues." Yet we must agree that the primary interest of De Bary was in morphology rather than in pathology.

Using a good microscope and employing micro-chemical reagents De Bary made important advances in the knowledge of spores, infection, and mycelia. His cultural demonstration of heteroecism in *Puccinia graminis,* with proof that the aecidium on barberry was a stage in the life-cycle of wheat rust is well known. These results were announced in 1865. This work, and more which followed, ushered in a new phase of mycological endeavor. It is significant that he began these investigations not out of pure scientific interest, but in order to settle controversies between agriculturists and botanists regarding the relation between smuts and rusts and diseases. Agriculturists thought them to be the causes of disease while botanists were inclined to regard them as products of disease. De Bary had himself resisted the suggestion of a possible alternation of generations which required an alternation of hosts plants. When his experiments led to that conclusion, his naive statement that "one comes around, perhaps, in a way, to the ancient opinion according to which rusted wheat would be infected by the rust of barberry" is most interesting. His experiences should be heartening to many present-day investigators who are required to work on projects which are economic and agricultural in nature. Out of such problems may arise basic scientific discoveries as in the case of De Bary.

The next epoch in the study of the fungi after De Bary was ushered in by the study of the nucleus and its behavior. This gave a new direction to the study of fungi. As life-histories were important for taxonomic considerations so nuclear developments were eventually recognized as having a bearing on taxonomy. The application of cytological methods to the study of life-histories in the fungi began with the work of Dangeard in 1894 and was soon under way on a large scale. Other early workers in this field were Poirault, Sappin-Trouffy, Maire, Harper, Blackman, and Christman. It was soon evident that the nature of sexual reproduction in the fungi was of great value in determining relationships. We are indebted to such a host of investigators that it is impossible to mention them by name. Notable studies have been made in the Phycomycetes, Ascomycetes, Ustilaginales, Uredinales, and higher Basidiomycetes. In the last few years genetical studies have been made and highly important results are in the making.

Our account would not be complete if we did not make some reference to the possibility that the classification of the future may have a physiological basis. Much headway toward such a goal has been made by Mez and his associates. Many of you are familiar with the fact that Mez, using serological methods, has constructed a family tree of plants which corroborates in a remarkable manner the older tree based on morphological characters. Seifriz refers to this work in a recent book (The Physiology of Plants, 1938) with the remark, "It is of great significance to the field of evolution and phylogenetic relationship that a purely chemical basis of classification should so well support a purely anatomical one." Seifriz points out that the relationships between plants established thus far by serology hold well for families, not so well for genera, and not at all for species. He believes, however, that this is due to a lack of delicacy in technique. He is of the opinion species differences in proteins must also exist.

Our historical sketch which began with the early attempts to classify fungi led us rather inevitably to some consideration of morphological, cytological, genetical, and physiological studies. Certainly we must agree that knowledge gained in all these fields is essential for progress in taxonomy. E. A. Bessey in 1939 (A Textbook of Mycology) refers to the present-day activity of systematic mycologists and points out that, "Life histories are being studied in all groups, the sexual relations are being scrutinized from the lowest to the highest fungi and genetical studies are revealing results somewhat parallel, but on a vastly smaller scale as yet, to those attained by the study of *Zea mays* and *Drosophila*." "As never before," says Bessey, "is a knowledge of fungi themselves so necessary." Obviously right conceptions of fungi must be based upon many facts, and wrong conceptions can easily be the result of partial facts, and of ideas derived from other plants which may be inapplicable and misleading.

We have referred to the contribution which Darwin's theory of evolution made to biological classification. Phylogeny soon became the fundamental basis for classificatory endeavor. So far as the fungi are concerned we should not overlook the influence of the work of Hofmeister in 1851 on the bryophytes and pteridophytes. The recognition of an alternation of generations in these groups had its effect on studies of the algae and fungi.

Every student who has taken a course in general botany is familiar with the system of classification which places the algae and fungi together in the division Thallophyta. We have no thought of attempting to reach any conclusions about this broad question of the taxonomic disposition of the fungi. Whether the fungi are to be regarded as one of two subdivisions of the Thallophyta, the algae being the other, depends upon the origin of the fungi. We say this in spite of a recent assertion that the taxonomist "is not interested in the origin, but in the character of his plants." On the origin of the fungi, G. M. Smith, in his "Cryptogamic Botany," Vol. I, "Algae and Fungi" (1938) writes, "This is highly controversial and opinion is divided as to whether they arose from the protozoa or whether they had either a monophyletic or polyphyletic origin among the algae. If they arose from protozoa, they should be put in one or more divisions coordinate in rank with the various algal divisions; if they arose from the algae, they should be placed as classes of one or more of the algal divisions."

Smith reviews the algal and the protozoan theories of the origin of the fungi and concludes that "it seems more probable that the fungi evolved from protozoa rather than from algae." He bases his conclusion largely on metabolism and the type of flagellation in the Phycomycetes. There are some algal groups in which there occur chlorophyll-less forms which are so similar morphologically that they cannot be regarded as distinct from the green forms. It is pointed out that these saprophytic and parasitic algae accumulate reserve carbohydrates as starch just as do the green algae. In contrast the Phycomycetes are reported generally to accumulate carbohydrates as glycogen but never as starch. The zoospores and gametes of the green algae are never uniflagellate whereas the motile cells of certain Phycomycetes are regularly uniflagellate. It is admitted that the question of the origin of the Ascomycetes is a more difficult one. The similarity in the sex organs, and the structures developed subsequent to fertilization, in the Ascomycetes and in the red algae are striking and have caused many workers to assume a relationship between these groups. Smith argues that these distinctive reproductive structures may have evolved along independent phyletic lines. He thinks the Ascomycetes had their origin in the Phycomycetes and that the Basidiomycetes arose by modification from the Ascomycetes. In his classification he rejects the Thallophyta as a division of the plant kingdom and in its place substitutes nine divisions, of which the Myxothallophyta, or slime molds, constitute one and the

Eumycetae, or true fungi, constitute another. The other seven divisions include the algae. "Abandonment of the Algae as a subdivision of the plant kingdom," says Smith, "does not mean that the word *alga* must be abandoned." He believes that we can still use the term alga for designating simple green plants that have an independent mode of nutrition. We might add that we will likewise continue to use the term *fungus* although attempts to define it lead to difficulties.

Bessey in his "Textbook of Mycology" has attempted a definition of the term fungi that would not commit the definer to any system of classification. We quote: "Fungi are chlorophyll-less thallophytic organisms typically consisting of coenocytic or cellular filaments, but including also encysted or amoeboid one-celled organisms which reproduce by some type of motile or non-motile spore; excluding the Bacteria and such chlorophyll-less organisms, which, by their structure, are with definiteness assignable to recognized orders of algae." Bessey is of the opinion that the Mycetozoa are not related to the fungi; are not, indeed, plants. There are those who believe that the fungi should not be regarded as belonging to the Plant Kingdom. Herbert F. Copeland in a comparatively recent paper (Quarterly Review of Biology, December, 1938) has presented evidence and argument "to the effect that organisms can be arranged, naturally, and more conveniently than in the past, in four Kingdoms as follows":

Kingdom 1. Monera (Bacteria and Blue-green Algae)
Kingdom 2. Protista (Protozoa, Diatoms, Red and Brown Algae, Slimemolds, and Fungi)
Kingdom 3. Plantae (Green Algae, Liverworts and Mosses, Ferns and Allies, Seed plants)
Kingdom. 4. Animalia (Metazoa)

To those who have been accustomed to thinking that all living organisms must be either plants or animals the recognition of two new groups as Kingdoms may seem revolutionary. It is true, however, that the line between lower plants and lower animals has always been a difficult one to draw. It must be admitted that nomenclatorially there are difficulties in placing together in the Kingdom Protista organisms which have been previously in two different Kingdoms. The original proposal for a Kingdom to be called Protista was made by Haeckel in his "Generelle Morphologie" in 1866. He also established the group Monera but included it in Protista. According to Copeland other authors have expressed the opinion that the Monera should be treated as a separate Kingdom.

The comments presented here relative to the origin of the fungi form a very inadequate picture of the discussions and arguments that exist in the writings of many investigators. We have wished merely to call attention to the fact that there is no general agreement as to whether the fungi are monophyletic or polyphletic in origin or whether they have descended from the algae or from the protozoa. The algal theory appears to have been advocated by A. Braun in 1847, and was accepted by Cohn (1854), Pringsheim (1858), and Sachs (1874). De Bary in 1881 objected to the method of intercalating the fungi among the algae saying it led to an orderly arrangement of species but not to a natural system. The suggestion that the fungi arose from the protozoa is credited to Cornu (1872), and was developed by Gobi (1885) and Dangeard (1886). Atkinson (1907) was in favor of deriving the lower fungi from ancestral unicellular organisms, but was uncertain whether they were colorless or chlorophyll bearing. He was, however, certain that their origin was monophyletic. The algal origin of fungi was supported by Strasburger and C. E. Bessey. Gäuman (1925) presented the view that all true fungi were derived from the green algae in monophyletic line; he believes the lower Chytridiales (his class Archimycetes) along with the Myxomycetes may have arisen from the colorless Flagellatae. He does not regard either of these groups as fungi. Martin (Bot. Gaz. **93**: 421-435, 1932) has "suggested that the fungi be regarded as a phylum which has not definitely developed into either plants or animals, but may be grouped with the former as a matter of convenience, and in accordance with custom." He rejects the assumption that all living organisms are descended from a single primitive cell and points out that the assumption that life may have originated more than once and in different forms is more in accord with what we know of living organisms.

Clements and Shear (Genera of Fungi, 1931) enunciate a basic principle: "that the fungi do not constitute a natural group, and that all the phyletic lines lead sooner or later to holophytic origins." It should be noted that although they say they are not dealing with a *natural* group yet they claim to have approximated a *natural* system in several respects in their book. They believe that there is but one natural system and they maintain that any approach to it must be the result of the work of many minds. After their admonition that it is more or less inexact, even though convenient, to connect the name of an individual to any particular arrangement, one wonders whether he should not tear up his manuscript and begin anew. Clements and Shear do not agree that cytology can be the final arbiter on questions of origin and relationship among the fungi. They make a plea for experimentation "on the largest and broadest scale possible, in both field and laboratory."

This review which is concerned with the taxonomy of the fungi must provide reference to the specialists who publish papers or monographs on certain groups. Sometimes such authors are called experts. I like the way one writer who says he is no expert disposes of this matter. He says, "The standard taxonomic revision is the work of an expert in the group concerned; it cites all the present literature; it is received with respectful interest (never with complete acquiescence) by the author's fellow experts in the same group, and is more or less annoying to others who have to take it into account, as requiring revision of familiar ideas of the limits of groups and the application of names." The parenthetical phrase is not mine; it is in the original.

As with other groups of living organisms the fungi have had their devotees. Crowds of them have advanced to the expert stage. It is impossible to name them or to evaluate their contributions. They must be treated generically, as it were. The writer has thought it worth while to try to present some of the problems which such workers encounter. By this is meant not so much the problems inherent in taxonomic studies but rather the wider limitations which often operate to check individual progress and to break the continuity of advances for which a groundwork may have been well established. The difficulties which are to be discussed are not necessarily peculiar to systematic mycology. Taxonomic work in general as well as in mycology, has a checkered history. Its advances through the centuries have been piecemeal. Perhaps it will always be thus, and deploring the fact may not only be in vain but may not be fitting.

It seems likely that we must depend largely upon institutions to furnish the support for taxonomic mycology. Of course there have been numerous individuals who have done their work chiefly or wholly without institutional support. In this country we have only to think of such men as L. D. von Schweinitz, J. B. Ellis, C. E. Fairman, J. J. Davis, and Elam Bartholomew, to realize the debt we owe to individuals, and great credit is due them.

Even where universities, colleges, or other institutions or governmental agencies are involved it is still true that the ambition, industry, and perseverance of individuals are largely responsible for the advances that have been made. In these later days we have been hearing a good deal about institutional research. So far as taxonomic work with the fungi is concerned we delieve that an analysis would show that research in this line is mostly due to individual prosecution rather than to institutional initiation. It may happen that an institution will make an effort to continue the type of research that has been inaugurated and successfully carried on by one of its staff members and will then refer to the program as an institutional program. More often it happens that a real leader appears and develops successfully a line of work which is supported (more or less) during his years of activity but which is dropped by the institution afterwards. Such instances indicate the correctness of the conclusion that there is often no such thing as an institutional program. There are, of course, exceptions but we feel safe in saying that the exceptions prove the rule rather than make it. We have inserted the parenthetical phrase—more or less—because we are sure that institutional support even when forthcoming during the height of the program is often more apparent than real. Certainly it is true that many of our productive mycologists have had to earn their "bread and butter" with teaching and routine duties and have had left only a small percentage of their time and efforts for the kind of work which they were so well qualified to pursue.

Someone may well ask why these difficulties are raised in connection with taxonomic research when they exist in so many lines of research activity. There are several reasons for doing so. The source materials for taxonomic research are in large part not commercial commodities. They consist of rare books, separates, indexes, illustrations and specimens which are accumulated only with time, patience, correspondence, and exploration. When such collections have finally been put together in an institution they should be used by more than one generation of workers in that institution. Or if that is not possible some method should be worked out by which they become available to succeeding investigators in other institutions. There are now in existence some collections of microfungi where spore measurements and drawings accompany literally hundreds of specimens. Such aids are indispensable for taxonomic studies and when available not only save the time necessary to duplicate them elsewhere but help to prevent errors and misconceptions. There are also herbaria of fleshy fungi where great accumulations of photographs, drawings, and notes make them of the utmost importance to other workers. This is not a plea for the centralization of mycological taxonomy. It is rather to call attention to the fact that enormous resources are frequently accumulated and then not used nor made available for use. Since our modern concepts fix the application of names by types rather than by descriptions it is a fair question whether type specimens should ever be personal or institutional property. The difficulties may seem insurmountable but this may not be the case. Surely we will make no progress until the workers themselves reach a keener appreciation of the situation.

There are other factors which bear on the progress of taxonomic work with the fungi. Even though a staff member may have the ability and enthusiasm to carry on work of this sort it may be, as previously indicated, difficult for him to obtain the full cooperation of his institution. Projects which have more evident economic aspects have always elicited more favor with administrative officials in our agricultural institutions. This is true in spite of the obvious relation of taxonomic studies of the fungi to many phases of plant pathology. It is easy to comprehend why this attitude prevailed in the early days of the agricultural experiment stations but it is not so easy to see why the value of fundamental work of this sort should not eventually come to be recognized more generally. In very recent times approval of agricultural projects depends upon evidence that results are likely to be of direct benefit to farmers. And again, even though there may be institutional approval so far as the time of the worker is concerned, it is often difficult to secure the maintenance support which is essential. For a project requiring special apparatus, machinery, glassware, and chemicals, it is usually not difficult to secure funds. But to secure funds for the purchase of specimens, photographs, particular books, separates, periodicals, indexes, and exploration it may be difficult or well-nigh impossible. It is generally conceded that a research worker is not expected to get along with the equipment and supplies which are in general stock but is entitled to special expenditures for his project. Not so with library facilities. He may be expected to get along with what the institutional library provides. He may of course compete for more than his share of the general library funds but this is not always satisfactory even if partially successful. The use of research funds for special library facilities is much less common than for special material equipment. The problem of publication is a closely related one. Monographic treatises are often expensive to publish and the demand for them may be slight and slow. The fact that publication is difficult tends to discourage this type of work.

A few weeks ago I received a letter from a former associate in which he said, "I notice, with much interest, in the last issue of Science, that you are to have a part in the 'Symposium on Taxonomy,' June 23, in connection with the Seventy-fifth Anniversary Celebration of the Torrey Botanical Club . . . . I assume that you will *speak for the fungi.*" Of course. Whether I have said, or still can say, anything which he would have me say is another matter. I assume that he expected me to make some reference to the problem of nomenclature and it seems impossible to close this discussion without bringing up this vexatious topic.

I propose to make comments of a general nature and to confine them to two aspects of the nomenclatorial situation: (1) on getting rules, and (2) on getting them into effect.

It is generally conceded that "Natural history can make no progress without a regular system of nomenclature, which is *recognized* and *used* by the great majority of naturalists in all countries." This is a quotation of the first article of the International Rules of Botanical Nomenclature; the italics are mine. The necessity of establishing international rules to govern the application of names of plants has been recognized by botanists for many years. But it is easier to recognize the problem than to solve it. The world well knows the difficulties of securing unanimity of action on any matters calling for international consideration.

One of the chief difficulties is to get together a group, the personnel of which is truly representative of the science and at the same time really international in standing. Institutions and governments have been willing to designate individuals as representatives to botanical congresses but for the most part they have been unwilling, or thought it unwise, to contribute toward the expense of attendance. The final assembly has been made up, therefore, not necessarily of those best qualified but of those individuals who have been willing to finance a trip in order to take part in the proceedings. The departments of our national government sometimes send "official delegates" to international congresses but they usually place restrictions on the activities of such delegates. I hope I am giving away no secret when I say that an employee of our federal government told me when we were in attendance at an International Botanical Congress that he was instructed before leaving this country that he might take part in the discussions but was not allowed to vote on the questions coming before the section on nomenclature. The conclusion seems to be justified that the advancement of this phase of natural history, of the greatest importance to mankind, has been too dependent upon voluntary contributions of the workers themselves.

It is also generally conceded that rules of nomenclature should not be arbitrary and that they cannot be imposed by authority—at least not by the authority of the makers of the rules. As an alternative the framers of the rules say, "They must be simple and founded on considerations clear and forcible enough for everyone to comprehend and be disposed to accept." Such a statement was made in the Rules as published in 1912 which were adopted in 1905 (Vienna) and supplemented in 1910 (Brussels). Perhaps rules of nomenclature are like a plant which grows slowly and requires a period of development before it comes to maturity. I do not know how many people did not comprehend the International Rules of Vienna and Brussels but I do know that in the following years many were disposed *not* to accept. There were individuals and groups of individuals who deplored the fact that certain fundamental principles of a basic nature in which they believed were not incorporated. They felt that once they accepted a code without these principles the chances for amendment would not be good. I have in mind chiefly the "type-concept" which was not a part of the original code. Reference to a more or less minor feature may serve to illustrate difficulties regarding adoption. The Vienna code provided that "On and after January 1, 1908, the publication of names of new groups of recent plants will be valid only when they are accompanied by a Latin diagnosis." Again I do not know how many names have since been published which are invalid, but I do recall taking part in a business session of a certain mycological society, at least 25 years after the Latin deadline, when the matter before the house was whether that rule should be enforced in its official journal.

It seems fair to say that cordial agreement was reached at the Cambridge Congress in 1930 on most of the disputed nomenclatorial problems and that the disposition to accept International rules was improved thereafter. Not long ago I was criticized by a colleague for such a conservative statement. He wanted me to say that these rules are, and have been for some time, actually in effect. Again it may be time which settles many problems. At any rate, it was in 1940 that the Secretary of the United States Department of Agriculture formally approved a recommendation of the Department Committee on Plant Names "to put the Department, botanically speaking, under the International Rules of Nomenclature." To me it is interesting that it took ten years for this department to come to an action making these rules official for "publications, reports, and correspondence involving scientific plant names." Perhaps one might be pardoned for calling attention to the anomaly of an agency finally finding it expedient to subscribe to the acts of an organization which it failed officially to aid. It is also interesting to note that two years after the official order they are still going through an adjustment period in getting nomenclatorial usage realigned according to International rules. When it becomes necessary to drop the name *Ustilago hordei* which, according to old usage, has been applied to the *covered* smut of barley and to take up the same name, according to International Rules, for *loose* smut of the same host it is little wonder that the workers talk about confusion. Personally, I believe that the confusion will be only temporary and that the advantage of getting on a world-usage basis will more than outweigh the disadvantages. It is desirable to avoid changes in names as far as possible, but changes cannot be entirely avoided if the rules of nomenclature are to put in order the old names as well as to be a guide for the creation of new names. There are those who believe that the procedure embodied in the present system of nomenclature leaves too much to expediency and personal preference and do not rest sufficiently upon foundamental principles. It has been pointed out that "there is no guarantee—if, indeed, there is any hope—that the system which may be adopted today will be accepted by the next generation." No, there is no guarantee that anything man devises will continue—not even democracy. We must not, however, look upon this or any other problem in such a futile manner. There are difficulties, to be sure, but they are not insurmountable. We are told in the Torrey Botanical Club Announcement and Field Schedule for 1942, "It is understood that there will be no mutilation of species at this session." That being the case, this seems to be the proper place to bring this discussion to an end.

THE PENNSYLVANIA STATE COLLEGE
STATE COLLEGE, PENNSYLVANIA

ACTIVITIES OF THE CLUB

January to May 1943

January 5. Annual Meeting.

The annual dinner meeting of the Torrey Botanical Club was held at the Men's Faculty Club, Columbia University, at 6:45 p.m. The President, Dr. C. Stuart Gager, presided, with 82 members and friends present. After the dinner the minutes of the preceding meeting were approved. The reports of the Treasurer, of the Chairman of the Field Committee, and of the Editor of Torreya were distributed in mimeographed form, and the combined report of the Editor and the Bibliographer was read by Dr. Matzke. These reports were accepted on a motion by Dr. Karling.

Dr. Gager addressed a few remarks to the Club and then announced that the following list of officers had been elected for the year 1943:

President: William J. Robbins
1st Vice-President: Fred J. Seaver
2nd Vice-President: Lela V. Barton
Corresponding Secretary: Edwin B. Matzke
Recording Secretary: Honor M. Hollinghurst
Treasurer: W. Gordon Whaley
Editor: Harold W. Rickett
Bibliographer: Lazella Schwarten
Business Manager: Michael Levine
Members of the Council: Charles A. Berger, Clyde Chandler, Albert E. Hitchcock, Roger P. Wodehouse
Delegate to the Council of the N. Y. Academy of Sciences: Bernard O. Dodge
Representative on the Board of Managers of the N. Y. Botanical Garden: Henry A. Gleason
Representatives on the Council of the American Association for the Advancement of Science: John H. Barnhart, Albert F. Blakeslee

Dr. Matzke then conducted a "Botanical Information Please" quiz with a board of experts comprised of Drs. Gager, Graves, Karling, Robbins, and Zimmerman, augmented at times by the guests at large. The meeting adjourned at 9:15 p.m.

Honor M. Hollinghurst, Recording Secretary.

January 20. Meeting at The New York Botanical Garden.

The meeting was called to order at 3:30 p.m. by the President, Dr. William J. Robbins. Attendance 25. The minutes of the preceding meeting were approved. The following new members were elected: 15 to Annual membership, 3 to Associate membership; 2 transfers to Annual membership and 4 transfers to Associate membership were approved. The resignations of 21 Annual and of 4 Associate members were accepted with regret.

A letter was read concerning the preservation of High Tor. Dr. Robbins suggested that a letter be sent to the sponsors of this movement, expressing the interest of the Torrey Botanical Club, and stating that the enterprise had been announced and discussed at our meeting, and suggesting that the Club send a notice concerning this with the field schedule to be issued in March, provided this date is not too late.

The scientific program consisted of two talks, the first by Dr. H. W. Rickett on "The Genus *Cornus* in North America."

The genus *Cornus* may readily be divided into 7 sections, 5 of which have often been treated as genera. The difference between these are chiefly in the inflorescences.

It is assumed that *Afrocrania,* with one species in East Africa is primitive. Closely related is the big section *Thelycrania,* which covers much of Europe, Asia, and North America, and is here typified by such species as *C. stolonifera* and *C. amomum.* Also from *Afrocrania* came *Tanycrania* (*C. mas, C. sessilis*), found now in southern Europe, China, western North America; *Disocrania,* with one species in Mexico; *Cynoxylon* and *Cephalocrania,* which include such species as *C. florida* and *C. kousa,* found in southern Asia and North America; and *Arctocrania,* the so-called herbaceous boreal species *C. canadensis* and *C. suecica.* The progression seems to have been from a primitive panicle subtended by bracts, by condensation to a "head" with either disappearance of the bracts (*Thelycrania*), or their development into more or less petaloid appendages; this often accompanied by the postponement of anthesis through a dormant period until the season following flower-formation, the bracts serving as bud scales. Most of the confusion in names and identities is in *Thelycrania.* This section falls readily into groups of two or three species each, in North America. A study of their distribution indicates that each of these groups seems to have once been present in the southern Appalachian region, and to have split as it migrated northward. When the segregated elements came again into contact we find integrading forms which cannot be accurately classified. One of the regions where this occurs is the Ohio Valley, where Rafinesque created numerous new "species." Another is the St. Lawrence Valley and northern New York.

This was followed by a presentation by Mr. F. R. Swift on "Treating Yeast Plants as Individuals," illustrated with splendid motion pictures.

This talk gave a short review of some of the methods used in developing yeast cultures, from the primitive method of merely exposing easily fermentable material to the air to the manipulator method developed at the Fleischmann Yeast Laboratory.

In the latter, glass cover-slips are pre-coated with a vegetable-mineral oil mixture, adjusted to fit the medium in use at the time. Small hanging drops are then distributed on the cover-slips and each one is seeded with one yeast cell. It was explained that by varying the proportions of the vegetable and mineral oil with the varying surface tension of different media being used, easily handled, uniform droplets, can be assured.

The development of yeast cultures growing and sporulating in such droplets was shown in a series of slides and by stopmotion photography, in a motion picture.

The discussion of these papers was continued after the meeting was formally adjourned at 5:05 p.m., while tea was generously provided by The New York Botanical Garden.

Edwin B. Matzke, Corresponding Secretary.

February 2. Meeting in The Museum of Natural History.

The meeting was called to order by the President, Dr. Robbins, at 8:15 p.m. Attendance 43. The minutes of the preceding meeting were accepted. Five new members were elected to Annual membership. Dr. Seaver reported that the Auditing Committee had found the Treasurer's books in excellent condition. The report was accepted. President Robbins then read the names of those appointed to the various standing committees of the Club. The scientific program was presented by Mr. G. L. Wittrock of The New York Botanical Garden who spoke on "Local Plants Used by the American Indians," and illustrated these with colored slides. After a discussion period the meeting adjourned at 9:40 p.m.

Honor M. Hollinghurst, Recording Secretary.

February 17. Meeting at The New York Botanical Garden.

The meeting was called to order at 3:30 p.m. by the President, Dr. Robbins. Attendance 22. The minutes of the preceding meeting were approved. Two new Annual members and one Associate member were elected. The first speaker on the scientific program was Dr. Frances E. Wynne who spoke on "Variability and Distribution of *Drepanocladus* in North America."

Drepanocladus, like many aquatic and semi-aquatic plants, is extremely variable. Field and herbarium studies have been made to determine which variations are hereditary and which are merely environmental fluctuations. Careful examination of leaves from different parts of the same plant shows that elongated leaves, costae, and cells are always produced when the plant grows submerged in water, whereas shorter leaves and cells are produced by stems which grow emergent. Many of the described varieties are merely seasonal phases produced by changes in the water level. The present monographic study has reduced the previously recognized 24 species and 30 varieties to 9 species, 1 subspecies, and 4 varieties. Hereditary factors determine the presence of an excurrent costa and secund leaves; therefore these characters are used as the basis for varieties in several species. The environmental fluctuations of the shape of the leaves, costae, and cells are not given taxonomic recognition.

The species of *Drepanocladus* may be classified geographically into two groups—arctic-alpine and boreal-montane. The arctic-alpine species are restricted in their range to the arctic regions; the boreal-montane species are widespread in the arctic but occur also in boreal and mountain bogs and swamps.

The species of *Drepanocladus* may be divided into two categories on the basis of fundamental variability. All the boreal-montane are extremely adaptable and variable and as a result of their toleration of a large variety of habitats have spread over a wide range. The arctic-alpine species are stable, clear-cut species limited to one region and one type of habitat.

Drepanocladus has a circumpolar distribution in both hemispheres. In North America its present range coincides with the maximum extent of continental and cordilleran glaciation during the Pleistocene. In eastern North America the distribution in partially glaciated states such as Pennsylvania, New Jersey, Ohio, Indiana, and Missouri is significant. In these states *Drepanocladus* does not occur south of the till sheets except in a few isolated stations. In western North America it is found in mountain bogs and alpine meadows.

Four types of localities may have provided refuges for plants such as *Drepanocladus* during the Pleistocene: (1) areas south of the Pleistocene ice (2) arctic areas north of the ice (3) unglaciated lowlands and (4) mountains or nunataks.

Two types of distribution result from the Pleistocene glaciation: (1) relic, static and (2) general, widespread. Any hypothesis, proposed to explain the post-Pleistocene dispersal of plants, must consider these two types of distribution found on glaciated areas. Of the numerous explanations which have been proposed, the most satisfactory is founded on the genetic constitution of the plants. Species may be plastic and adaptable or rigid and static. The boreal-montane species of *Drepanocladus* are adaptable because a large number of individuals survived the Pleistocene in a large variety of habitats on all of the possible refuges; therefore a large number of biotypes contributed to these plastic species. The arctic-alpine species are rigid because only a few individuals survived in a few habitats on only one of the refuges; the biotypes contributing to these species were depleted by the vicissitudes of the ice age leaving the species genetically rigid.

The second speaker was Dr. Morris Winokur who spoke on "Photosynthesis in Bacteria."

The attempt to interpret the metabolism of the green and sulfur bacteria has resulted in the development of a generalized concept of photosynthesis which is applicable to the green plant as well.

At the beginning of the twentieth century, there existed three conflicting theories concerning the physiology of the purple bacteria. Engelmann believed that the purple bacteria were able to photosynthesize much in the manner of the algae. Winogradsky postulated that the oxidation of hydrogen sulfide and sulfur represented a substitute for the respiration of organic substances, characteristic of the normal functioning of most organisms. Molisch developed the thesis that the purple bacteria cannot assimilate carbon dioxide, but they assimilate organic compounds in the light. The controversial nature of the results obtained by these three investigators was due to their use of different biological materials: Engelmann—purple sulfur bacteria; Molisch—purple non-sulfur bacteria; Winogradsky—colorless sulfur bacteria. Buder attempted to harmonize the diverse views by categorizing the organisms employed. The existence of an intimate connection between the photosynthetic activity of the purple sulfur bacteria and their respiratory phenomena was first clearly expressed by Kluyver and Donker.

Van Niel demonstrated conclusively the photosynthetic nature of the metabolism of the purple sulfur bacteria by devising methods for growing them in pure culture in strictly mineral media in the light. His data show that the photosynthetic carbon dioxide utilization depends quantitatively on the oxidation of sulfide and sulfur. He also disclosed a similar relationship for the green sulfur bacteria. Comparing these photosyntheses with that of the green plant, van Neil formulated the hypothesis that the several photosynthetic reactions are all examples of photochemical carbon dioxide reduction with a different hydrogen donor in each case. This generalized view of photosynthesis made possible the explanation of the photosynthesis of the non-sulfur purple bacteria as one in which the normal inorganic hydrogen donors for the reduction of carbon dioxide are replaced by organic molecules. A variety of indirect and direct experimental evidence has substantiated this interpretation.

Critical evaluation of the objections to the generalized concept of photosynthesis leaves unimpaired the viewpoint that photosynthesis is a photochemical carbon dioxide reduction in which organic compounds as well as inorganic substances or even molecular hydrogen can play the role of hydrogen donors.

The consequence of the acceptance of this broad generalization is that it renders untenable the classical Willstätter-Stoll theory of green plant photosynthesis.

After discussion of both papers, the meeting adjourned at 4:35 p.m., to be continued over the inviting tea and refreshments served by friends at the Garden.

Honor M. Hollinghurst, Recording Secretary.

March 2. Meeting in Schermerhorn Extension, Columbia University.

The meeting was called to order at 8:15 p.m. by Dr. Lela V. Barton, the second Vice-President. Despite the promise of a five siren air raid drill, 17 members attended. The minutes of the preceding meeting were approved. The scientific program was presented by Dr. Ray F. Dawson who spoke on "Some Aspects of Parasitism in the Mycorrhizae of Shortleaf Pine."

The fungus or fungi which induce mycorrhiza formation on the roots of shortleaf pine in the Missouri Ozarks area are apparently obligate parasites. The nature of the symbiotic relationship between fungus and tree roots is determined largely by environmental factors. When the trees are grown upon soils which are nutritionally poor or unbalanced or when light intensity is low, fungal invasion of the short roots readily occurs, and many well developed mycorrhizae are formed. Tree growth may vary from slow to negligible. When the trees are grown upon fertile soil mycorrhiza formation is difficult and slow and tree growth may be good, but if the soil contains appreciable amounts of organic matter the seedlings will most likey fall victim of damping-off fungi. When the trees are grown upon soils which contain relatively low amounts of the necessary nutrients but when these nutrients are present in physiologically balanced proportions on the soil colloids mycorrhizal development and tree growth are both favored. Under such circumstances the mechanism of the beneficial effect of mycorrhizae upon tree growth seems to be associated with an increased salt absorption which is conditioned by an increased rate of aerobic respiration and by a newly introduced mechanism for anaerobic respiration both of which serve to maintain the energy output necessary for the growth processes. Hydrogen ion excretion by the roots under such circumstances is increased several times thus making it possible for the root colloids to undergo more intensively base exchange reactions with the soil colloids in the initial phase of salt absorption. The enhanced absorption of salts may then bring about greater water absorption and resulting increases in both volume and mass of the plant tissues.

Following the discussion period, the meeting adjourned at 9:35 p.m.

Honor M. Hollinghurst, Recording Secretary.

March 17. Meeting at The New York Botanical Garden.

The meeting was called to order by the Vice-President, Dr. Seaver, at 3:30 p.m. Attendance 36. The minutes of the preceding meeting were accepted. Dr. Whaley announced the death of Dr. Tracy Hazen on March 16th, in Waterbury, Conn. On a motion by Dr. Stewart it was voted that the Secretary send the condolences of the Club to the family of Dr. Hazen. Dr. Matzke stated that he had received from Dr. Moulton, of the American Association for the Advancement of Science, a request for a summary of the history of the Torrey Botanical Club. Dr. Matzke said he would be willing to prepare this summary which is to be published in the Journal of the Association with the histories of other affiliated societies. The first scientific paper was presented by Dr. Ernest Naylor who spoke on "Problems of Cellular Behavior during Regeneration."

The author presents a brief discussion of some of the cell changes during early stages of shoot and root formation on isolated plant parts during regeneration. The multiplication and organization of cells during regeneration involves two fundamental types of cells morphologically. One is the meristematic type, which may or may not be definitely organized into recognizable growing points. Such cells may be variously located in leaf axils, nodal regions, leaf margins, woody structures, and in other places.

The other type is concerned with differentiated cells of the plant body which undergo structural changes and become actively meristematic to produce the new root and shoot primordia. Such de-differentiation of vacuolate cells is described in various tissues of a number of seed plants. The extent and limitations of such de-differentiations in plant cells is briefly considered and some of the theoretical implications pointed out.

Dr. Whaley was the second speaker on the scientific program, and his topic was "Inferiority Complexes in Plants."

Recent work of Dobzhansky and others indicates that in natural populations many detrimental recessive genes are accumulated. The number and relative potency of these genes is dependent upon the population structure, which is a function of the number of individuals and the type of reproductive mechanism. Under selection it is also possible for unfavorable dominants to accumulate. Heterosis is the result of masking of these deleterious recessives in some organisms, the result of heterozygosity in others. Suggestions as to the nature of some of these deleterious factors is found in excised root culture experiments. The roots of certain tomato lines show a deficiency in ability to synthesize pyridoxine, others in the ability to synthesize nicotinamide. Crosses between such lines produced vigorous hybrids under ordinary field conditions. Hybrid vigor represents a return to an "optimum" phenotype rather than any "super" phenotype.

After a discussion of both papers, the meeting adjourned at 4:35 p.m. Then tea and delicious refreshments, in keeping with the spirit of St. Patrick's Day, were served by friends at the Garden.

Honor M. Hollinghurst, Recording Secretary.

March 27. Field Trip to The New York Zoological Park for the study of some animal habits. Leader, Miss Nellie L. Condon, Director, Reptile Study Society of America. Attendance 11.

March 28. Field Trip to Springdale, N. J., for limestone lichens. Leader, Mr. G. G. Nearing. Attendance 4. Unusual forms found were: *Acarospora murorum, Cyphelium tigillare*, and *Physcia venusta.* The last two were in fruit, and these fruiting forms appear to be rare.

April 4. Field Trip to Central Park, N. Y. to search for the trees mentioned in L. H. Peet's book "Trees and Shrubs of Central Park" (1903). Leader, Dr. E. B. Matzke, Columbia University. Attendance 25. Many of those present took an active part in the identification of the trees, and all of us profited by Mr. James Murphy's generous and genial contributions on the trees and shrubs as well as on the history and lore of Central Park. The following plants were found in flower: *Cornus mas, Lonicera fragrantissima, Ulmus americana, U. campestris,* and *Acer rubrum.* Most of the day was spent trying to locate trees mapped in Peet's book. The morning was devoted to the southern half of the park, and the afternoon to the northern end. A few tentative conclusions may be suggested, subject of course to correction after more careful study:

1. Changes in tree population have been much more pronounced in the southern end of the Park in the last forty years than in the northern end. Many of the trees listed by Peet for the northern end could easily be located; this was decidedly not true nearer 59th Street.
2. The conifers have not fared well. White pines and some other gymnosperms present in 1903 were not found; a young Douglas Fir, more recently planted, was distinctly the worse for wear. Some Austrian pines have survived, and they may or may not be an exception.
3. The Turkey Oak, *Quercus Cerris,* has grown and perhaps prospered; native oaks apparently do not thrive.
4. The English Elm, *Ulmus campestris,* seems to have done reasonably well, distinctly better than our native ones.
5. In the wetter habitats the red maple, *Acer rubrum,* seems to be pretty well established.
6. *Ailanthus* apparently "seeds in" in the park.

EDWIN B. MATZKE

APRIL 6. MEETING IN SCHERMERHORN HALL, COLUMBIA UNIVERSITY.

The meeting was called to order at 8:20 p.m. by the President, Dr. Robbins. Attendance 33. The minutes of the preceding meeting were approved. Eight new annual members and three associate members were elected, and one transfer from associate to annual membership was approved.

Dr. Matzke then read to the club the letter which he, as Corresponding Secretary, had sent to the family of the late Dr. Tracy E. Hazen:

New York City
March 23, 1943

DR. ROBERT HAZEN
Thomaston
Connecticut.

Dear Dr. Hazen:

At its meeting held on March 17, 1943, the Torrey Botanical Club directed its Secretary to extend sympathy and condolence to the family of the late Professor Tracy Elliot Hazen.

Its Editor for many years, its President for two terms, the Torrey Botanical Club was singularly fortunate in having profited by the sound scholarship, the meticulous labors, the faithful devotion to duty, and the kindness of heart of Professor Hazen. All its members admired him, all respected him as a thorough gentleman, and all who knew him intimately, loved him.

Your grief, and ours, may be assuaged by a knowledge of Professor Hazen's goodness, of his quiet nobility, and of his high attainments.

The Torrey Botanical Club realizes that a faithful officer, member, and friend has passed to his reward; it is grateful for having shared in the innate richness of his life.

In deep respect,
EDWIN B. MATZKE,
CORRESPONDING SECRETARY.

Dr. Robbins announced that he had appointed a committee to draft a biographical note on Dr. Hazen for the BULLETIN. The committee consists of Dr. Carey, chairman, Dr. Barnhart, and Dr. Bold.

The scientific program of the evening was presented by Dr. A. B. Stout of The New York Botanical Garden, who spoke on "Dichogamy in Relation to Reproduction," illustrated with lantern slides. After questions and discussion from the floor, the meeting adjourned at 9:40 p.m.

HONOR M. HOLLINGHURST, RECORDING SECRETARY.

APRIL 11. FIELD TRIP to The Brooklyn Botanic Garden and Conservatories for seasonal studies outside, and for observation of economic plants from other lands. Leaders, Dr. A. H. Graves and Dr. A. Gundersen of the Garden staff. Attendance: 3 members and 147 visitors in the Garden.

APRIL 17. FIELD TRIP to The New York Botanical Garden Conservatories, particularly the Easter exhibit in the Display House featuring trees of the Holy Land. Leader, Dr. H. A. Gleason of the Garden staff. Attendance 11.

APRIL 18. FIELD TRIP to the Lichen Trail in Palisades Interstate Park for lichens, fungi, and general botany of the season. Leader, Mr. G. G. Nearing. Attendance 4.

APRIL 21. MEETING AT THE BROOKLYN BOTANIC GARDEN.

The meeting was called to order at 3:30 p.m. by Dr. C. Stuart Gager, in the absence of the President and Vice-Presidents of the Club. Attendance 18. The minutes of the preceding meeting were approved. The program consisted of a talk by Dr. Henry K. Svenson on the "Plants of a Long Island Pond," illustrated with Kodachrome slides; and an inspection of the Local Flora Area of the Garden under the leadership of Dr. Svenson.

HONOR M. HOLLINGHURST, RECORDING SECRETARY.

APRIL 24. FIELD TRIP to Surprise Lake, Watchung Reservation, near Summit, N. J., for reptiles, amphibia, and spring plant life, all of which reflected the late season. Leader, Miss Nellie L. Condon. Attendance 11.

MAY 1. FIELD TRIP to Mertensia Island along Raritan River above Raritan, N. J., to see the profuse stand of *Mertensia, Dentaria, Erythronium,* etc. This was the ideal date for this season. Leader, Dr. John A. Small, New Jersey College for Women. Attendance 6.

MAY 2. FIELD TRIP to Silver Lake, White Plains, N. Y., for spring flowers and birds. The day was cold and windy. 25 bird species were seen, 4 violets and 10 other plant species were found in bloom. Leader, Miss Farida A. Wiley, American Museum of Natural History. Attendance 12.

MAY 8-9. WEEK END FIELD TRIP to Camp Thendara, Lake Tiorati, Palisades Interstate Park, N. Y., for study of birds and plants. Leader, Mrs. Richard M. Abbott. Attendance 32, of which at least 5 were from the Torrey Club. 69 bird speceis were recorded, including 19 warblers.

MAY 11. MEETING IN SCHERMERHORN HALL, COLUMBIA UNIVERSITY.

The meeting was called to order by the President, Dr. Robbins, at 8:15 p.m. Attendance 70. The minutes of the preceding meeting were approved. The scientific program was presented by Dr. Samuel Record, of the Yale School of Forestry, who told "How Woods Are Identified."

> The results already obtained from the systematic studies of woods indicate clearly that any wood sample is identifiable. The unit of classification is at present the genus, but well-defined species are frequently recognizable and their number

will increase with fuller knowledge of their range of variation. Ability to identify a wood is of practical value to timber dealers and users and an important aid to taxonomists in determining imperfect herbarium material and in preventing or correcting faulty classification.

The essentials for systematic study of woods are: 1. A comprehensive and representative collection of samples obtained with herbarium material determined by competent taxonomists. In the Yale collections there are 40,700 catalogued samples representing nearly 12,000 named species of 2,800 genera and 232 families. 2. A collection of slides with cross, radial, and tangential sections for examination under the microscope. The Yale slide collection contains about 19,500 slides of 11,072 specimens of 6,506 name species, 2,616 genera, and 218 families. 3. Careful examination of the slides by trained anatomists and the preparation of descriptions and tabulations of all essential features. The standards used are those approved by the International Association of Wood Anatomists after several years of cooperative effort. 4. The use of the assembled data for making keys or other aids to identification. Numerous keys to special groups have already been published and others are in preparation.

The task is very large, difficult, and costly and can only be carried out successfully through cooperative efforts. Ordinary taxonomists, though willing to accept the aid of the anatomist in a time of trouble, make no effort to secure material essential for anatomical study. Fortunately there are exceptions to this rule and The New York Botanical Garden is foremost among American institutions in encouraging its botanists to collect wood samples. Systematic wood anatomy has made its greatest progress during the past decade for the simple reason that during that time research workers in various parts of the world effected an organization and pooled their efforts and materials. The best incentive to further progress would be the addition of new and better material which botanical expeditions could so readily supply.

Because discussion of the talk was sharply curtailed at 9:30 p.m. by the sounding of sirens for an air raid drill, the meeting quickly adjourned to darkened halls, where by the light of a lantern, Dr. Record graciously identified wood specimens presented by members of the audience.

HONOR M. HOLLINGHURST, RECORDING SECRETARY.

MAY 15. FIELD TRIP to McLean Woods, The Bronx, N. Y., for spring study of the area. Species lists were prepared and filed with the Field Committee. Leader, Mrs. Mary Holtzoff. Attendance 14.

MAY 16. FIELD TRIP to Point Pleasant, N. J., to search for Britton's Violet, of which a good stand was found, and in addition a large number of other plants. Leader, Mr. Louis Hand. Attendance 7.

MAY 21-23. FIELD TRIP to Culvers Lake, N. J., for the Annual Branchville Nature Conference. In order to have the conference at the most desirable season and without increased expense to those participating it was necessary to change from THE PINES to THE HALTERE for accommodations. This proved satisfactory. Leaders: Mr. Wallace M. Husk, Professor Oliver P. Medsger, and Dr. Julius Johnson. Attendance 40.

MAY 22. FIELD TRIP to Ridgewood, N. J., to see the Rhododendron seedbeds, nurseries, and stock of the leader, Mr. G. G. Nearing. Attendance 10.

MAY 29. FIELD TRIP to Haskell, N. J., for fungi of the Chicohikie Falls region, especially *Fissipes acaulis,* of which there was plenty. Leader, Mr. F. R. Lewis. Attendance 5.

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OF THE

TORREY BOTANICAL CLUB

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A journal devoted to general botany, established in 1870 and published bi-monthly at present. Vol. 69, published in 1942, contained 711 pages of text and 44 full page plates. Price $6.00 per annum. For Europe, $6.25.

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Reprinted monthly on cards, and furnished to subscribers at three cents a card.

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W. GORDON WHALEY,
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Volume 43 December 1943 Number 2

TORREYA

EDITED FOR

THE TORREY BOTANICAL CLUB

BY

HAROLD H. CLUM

John Torrey, 1796-1873

CONTENTS

THE SEVENTY-FIFTH ANNIVERSARY CELEBRATION OF THE TORREY BOTANICAL CLUB, JUNE 22-27, 1942

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THE TORREY BOTANICAL CLUB

OFFICERS FOR 1943

MEMBERSHIP IN THE TORREY BOTANICAL CLUB

All persons interested in botany are invited to join the club. There are four classes of membership: *Sustaining,* at $15.00 a year; *Life,* at $100.00; *Annual,* at $5.00 a year and *Associate,* at $2.00 a year. The privileges of members, except *Associate,* are: (a) To attend all meetings of the club and to take part in the business, and (b) to receive its publications. *Associate* members have the privilege of attending meetings, field trips and of receiving the Schedule of the Field Trips and the Bulletin of the New York Academy of Sciences.

TORREYA

Torreya was established in 1901 as a monthly publication of the **Torrey Botanical Club** for shorter papers and interesting notes on the local flora range of the Club. It also contains the proceedings of the Club, reports of field trips, and some book reviews and news notes. The Council of the **Torrey Botanical Club** has decided to devote volume 43 of Torreya, 1943, to the publication of the papers presented in June 1942 at the 75th Anniversary Celebration of the Club, and to the Proceedings of the Club. This volume will be published in two numbers.

Torreya is furnished to subscribers in the United States and Canada for one dollar per year (January-December): single copies thirty cents. To subscribers elsewhere, twenty-five cents extra, or the equivalent thereof. Postal or express money orders, drafts, and personal checks are accepted in payment. Subscriptions are received only for full volumes.

Claims for missing numbers should be made within sixty days following their date of mailing. Missing numbers will be supplied free only when they have been lost in the mails. All subscriptions and requests for back numbers should be addressed to the treasurer, Dr. W. Gordon Whaley, Barnard College, Columbia University, New York, N. Y.

Of the annual membership dues of the **Torrey Botanical Club**, $.50 is for a year's subscription to **Torreya.**

Torreya is edited for the **Torrey Botanical Club** by

HAROLD H. CLUM
Hunter College, 695 Park Avenue
New York, N. Y.

TORREYA

Vol. 43 December 1943 No. 2

Viruses in Relation to the Growth of Plants*

L. O. Kunkel

About twenty-four years ago, Nishimura (10) reported that *Physalis alkekengi* allowed the tobacco mosaic virus to multiply within its tissues but showed no symptoms of disease. Since that time other masked carriers of plant viruses have been studied (2, 3, 9). We now know that practically all potatoes produced in this country carry the X virus but that, unless it occurs in combination with some other potato virus, no well defined symptoms are produced (3). We also know that some of the mutants of ordinary tobacco mosaic virus cause no obvious symptoms in tobacco (2). But, while it is true that some viruses multiply in some plants without causing symptoms by which a disease can be readily recognized, it is doubtful whether there are any really symptomless carriers. All viruses that become systemic and multiply within a plant probably cause some injury. However, the injury may be slight and easily overlooked unless control plants are available for comparison. Some virologists have gone so far as to suggest that there may be viruses capable of stimulating rate of growth in plants, but if such viruses exist they have not been discovered.

From viruses that cause exceedingly mild diseases, it is possible to pass by gradual steps to viruses that are lethal. We may, in fact, do this without going outside of the tobacco mosaic virus group. When masked strains of tobacco mosaic virus are propagated in tobacco, they are sooner or later replaced by mild mottling strains some of which approach ordinary tobacco mosaic virus in severity. Similarly, when severe strains are propagated in tobacco, they are replaced by milder strains some of which approach tobacco mosaic virus in mildness. All except the so-called masked virus strains cause marked stunting and other symptoms of disease. The masked virus strains cause stunting but no other well marked symptoms. Thus, the tobacco mosaic viruses and all other plant viruses may be classified as growth-depressing entities. This, however, does not mean that they depress rate of growth in all tissues.

The Fiji disease virus of sugarcane causes well marked galls in phloem tissues (4). The cranberry false blossom virus, with which the writer has

* Read at the 75th Anniversary Celebration of the Torrey Botanical Club at the Boyce Thompson Institute for Plant Research, Inc., Wednesday, June 24, 1942.

Torreya for December (Vol. 43, 87–183) was issued February 10, 1944.

been working recently, causes increased growth in flowers. It depresses growth in the plant as a whole but stimulates rate of growth in flowers. In a number of different plants to which it has been taken, it causes the production of giant blossoms. Its action on tomato flowers is shown in figure 1. In the truss on the left the flowers are normal, while in the other two they are diseased. The sepals of the diseased flowers are much larger than sepals of normal flowers. Instead of remaining separate as in healthy blossoms, the affected sepals have fused to form a sac-shaped structure. When the sac was torn open, it was found that the petals were green in color and borne at the end of a thick stalk which was about an inch in length. The petals were leaf-like in structure; some

FIG. 1. False blossom in tomato. The flowering truss at the left is healthy; the other two are diseased. (Photograph by J. A. Carlile.)

were simple and others compound. The anthers were usually small and green. In its effects on tomato flowers, false blossom resembles the big-bud disease which occurs in the western part of this country (1) and in Australia (11). Other effects of false blossom on flower trusses are shown in figures 2 and 3. The diseased truss pictured in figure 2 was about four times as long as the healthy truss. It terminated in two stem tips bearing leaves. The stem of the diseased truss also was thicker than that of the healthy truss. Figure 3 shows other variations in the deformation of enlarged flower trusses.

Some diseased trusses that had not elongated so much but were borne on thick stems are displayed in figure 4 beside a normal truss. This type of malformation was met with less often than the big-bud type. Apparently there are several different strains of false blossom virus prevalent in nature. From some diseased cranberry plants a strain was obtained that caused a severe check to longitudinal growth but stimulated transverse growth. Plants with this strain stopped producing flower buds soon after they were infected and did not stimulate the production of secondary shoots. From other false blossom cranberry

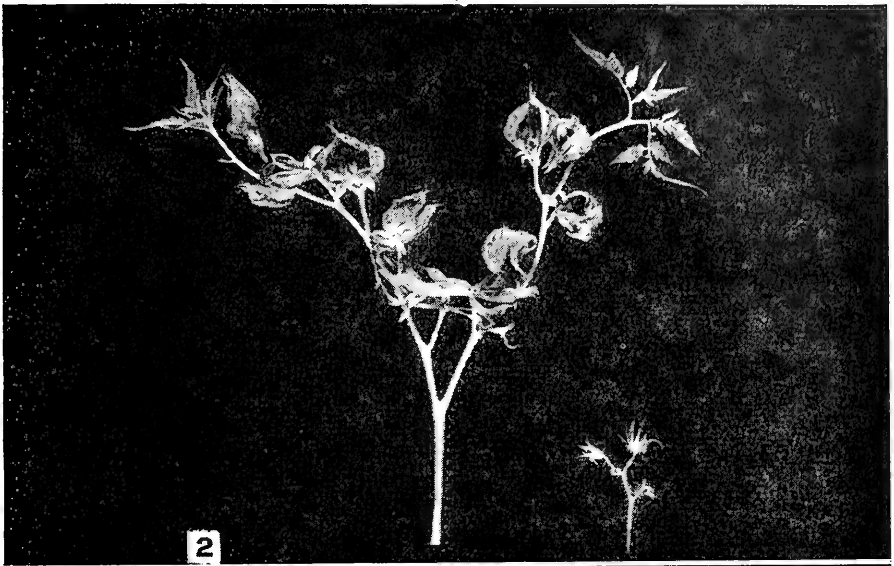


Fig. 2. False blossom in tomato. The flowering truss at the right is healthy; that at the left diseased. The picture shows the stimulating effect of the virus on flowering branches.

Fig. 3. False blossom in tomato. The three flowering trusses show different effects of the virus. (Photographs by J. A. Carlile.)

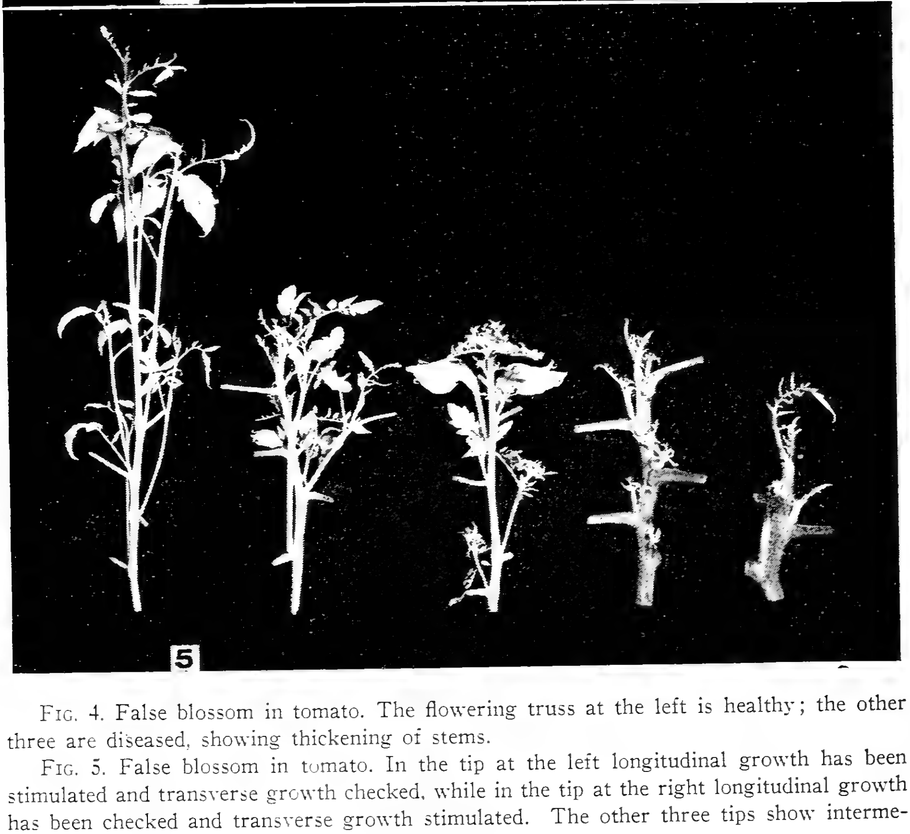


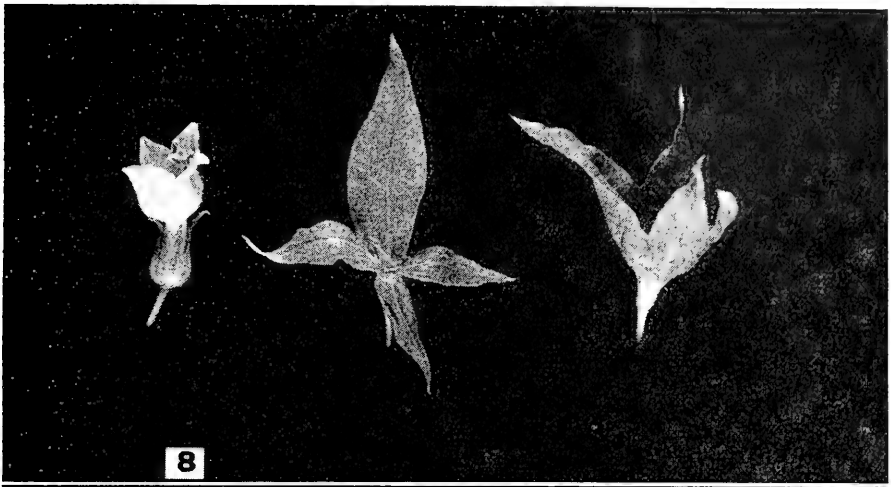
Fig. 4. False blossom in tomato. The flowering truss at the left is healthy; the other three are diseased, showing thickening of stems.

Fig. 5. False blossom in tomato. In the tip at the left longitudinal growth has been stimulated and transverse growth checked, while in the tip at the right longitudinal growth has been checked and transverse growth stimulated. The other three tips show intermediate effects. (Photographs by J. A. Carlile.)

plants a strain was obtained that stimulated longitudinal growth and checked transverse growth. This caused a spindling witches' broom type of growth. In tomatoes with the spindling strain no flower buds were produced except shortly after infection. The flowers that were produced usually were not more than two to three times the size of normal flowers. Between these extremes in which longitudinal growth was almost entirely stopped but transverse growth stimulated, on the one hand, and in which longitudinal growth was greatly stimulated but transverse growth severely checked, on the other hand, were strains that caused intermediate effects. Some of these are shown in figure 5 where tips from five different diseased tomato plants are pictured. The tip at the extreme right is greatly shortened and thickened; that on the extreme left is tall and spindly. The three types shown between these exhibited intermediate effects. The virus obtained from most diseased cranberry plants caused the symptoms shown by the tip in the center of the picture. This is the typical big-bud type of top where flowers are large and malformed and where considerable numbers of secondary shoots are produced. When scions from plants affected in this way and scions from plants showing the two extreme effects were grafted to healthy tomato plants, each came down with the type of disease characteristic of that shown by the plant from which the scion was taken. When the two extreme types were transmitted to periwinkle plants, they caused similar variations in symptoms. The virus that depressed longitudinal growth but stimulated transverse growth in the tomato caused the production of short thick tips but very little chlorosis or stunting of leaves when taken to periwinkles. The virus that stimulated longitudinal growth but depressed transverse growth in stems of the tomato produced similar effects in stems of periwinkles. In leaves it caused a marked chlorosis and narrowing. When the virus causing typical big-bud in tomato was taken to periwinkle, it caused the production of green malformed flowers such as are shown beside normal flowers in figure 6. When scions from periwinkles showing the different types of effects were grafted to healthy periwinkles, each transmitted the disease characteristic of the plant from which it was taken. While it has not been proved that these different types of disorders are caused by strains of the cranberry false blossom virus, this seems likely. When the common type of false blossom virus was transmitted to the composite, *Calendula,* it caused the production of malformed green flowers such as are pictured in figure 7 beside a healthy flower. Another plant in which false blossom virus caused gigantism in flowers was *Nicotiana glutinosa.* An early stage in the development of giant sepals is shown in figure 8, a late stage in figure 9. The blossoms at the left in both figures are normal; the others are diseased. Malformed leafy structures are shown protruding from some of the diseased flowers in figure 9. At the same time that the virus caused enlargement of flowers, it produced dwarfing of leaves.

FIG. 6. False blossom in *Vinca rosea*. The flowering branch at the left is healthy; that at the right is diseased. The diseased flowers are malformed and virescent.

FIG. 7. False blossom in *Calendula*. The flower at the left is healthy; the other two are diseased. Affected flowers are green in color. (Photographs by J. A. Carlile.)



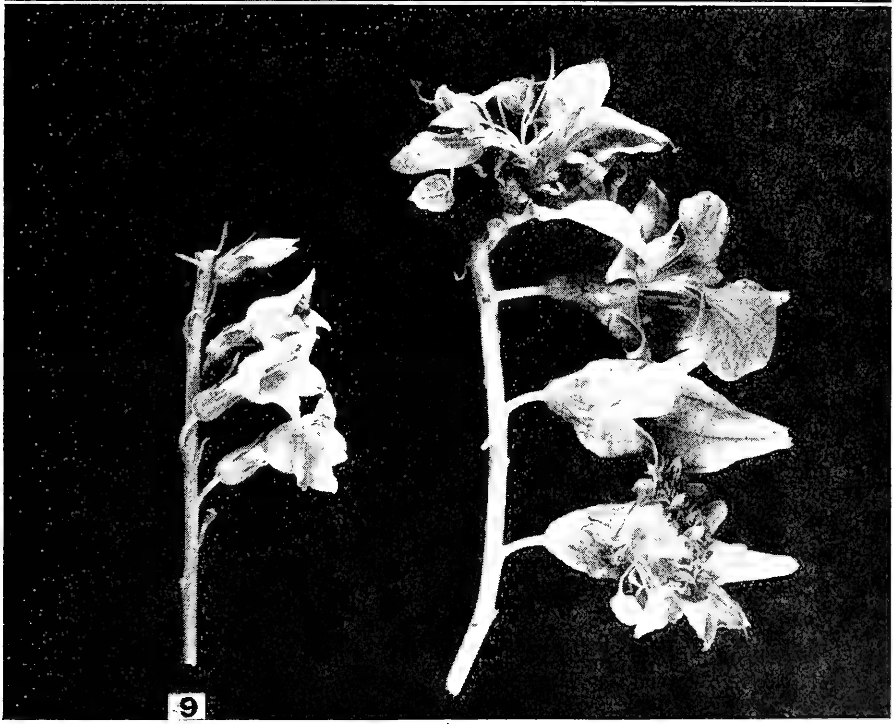


FIG. 8. False blossom in *Nicotiana glutinosa*. The flower at the left is healthy. The other two flowers have false blossom.

FIG. 9. False blossom in *Nicotiana glutinosa*. The flowering branch at the left is healthy; that at the right diseased, showing gigantism in flowers affected by the virus. (Photographs by J. A. Carlile.)

It would be possible to proceed at great length with the story of how false blossom virus upsets growth relationships, enlarges, distorts, and malforms flowers, and transforms plants of different species to such an extent that they can scarcely be recognized. But there would be no point in doing this, for the variability in the symptoms produced in different species is almost endless. It perhaps is sufficient to say that in all plants to which false blossom virus was taken it caused virescence and gigantism in flowers or parts of flowers, chlorosis and dwarfing in leaves, and an elongating or a shortening of internodes of stems.

Another effect of certain viruses on growth in plants that needs to be mentioned is repression of dormancy and maturity. Many biennial and perennial plants pass the winter in a dormant state. When brought into a greenhouse where good growing conditions are maintained and where they might be expected to grow continuously, they become dormant or semi-dormant as the winter season approaches. Many annual plants grow to maturity in a few months and then die. When affected by certain virus diseases, perennial plants fail to go into a dormant state regardless of environmental conditions. Peach trees affected by yellows disease do not stop growing as cold weather comes on but continue vegetative growth until the tender tips of branches are frozen and killed.

China aster plants set in the field late in May or early in June blossom in August and mature seeds in early autumn. By the time cold weather arrives, all healthy plants have died. The course of events is very different for plants that contract the aster yellows disease. They produce malformed virescent flowers and sterile seeds (5). It is true that some diseased plants produce viable seeds, but such seeds are borne only by flowers that have not been invaded by the virus. Instead of affected plants maturing and dying as cool weather approaches, they live and grow. They of course do not grow very fast and are eventually killed by low temperatures. But there is a period during which the only living plants in the field are those affected by the aster yellows disease. It is thus clear that the virus lengthens the life of the plant.

When healthy potato plants are grown in greenhouses, they produce tubers, mature, and die. If infected by the witches' broom virus, they produce tubers but they do not mature and die. Growth continues summer and winter for an indefinite period of time. There is a potted potato plant with witches' broom in one of our greenhouses that has been growing there for more than two years. Its healthy sister plants matured and died long ago. The witches' broom virus has had a favorable effect on the longevity of the plant.

Certain plant virus diseases are readily cured by heat. When affected plants are held at moderately high temperatures for appropriate periods of time, the viruses that cause these diseases are inactivated but the plants are not seriously injured. Peach yellows (6), aster yellows (7), and witches' broom of potato can be cured by heat in certain of the plants they affect. The false blossom disease also can be cured (8). When plants are cured, all of the bizarre effects produced by the viruses causing these diseases disappear. Cured peach trees become dormant when the season for dormancy arrives. Cured potato plants live no longer than healthy plants. The stimulating and stunting effects of cranberry false blossom virus in periwinkles subside and disappear when the plants are cured. It is apparent that these viruses affect growth only during the period in which they are present in the plants. The malformations that develop while plants are sick are of course not corrected by cure, but all new growth produced after plants are cured is normal. In this respect these viruses are like the growth-promoting substances. Their effects do not outlast the periods during which they are allowed to act but, unlike growth-promoting substances, viruses cause a retardation of growth in all plants in which they are permitted to multiply, although, as we have seen, they stimulate growth in certain tissues. They also are entirely unlike growth-promoting substances in that they infect, multiply, and cause disease.

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Literature Cited

1. Dana, B. F. Occurrence of big bud of tomato in the Pacific Northwest. Phytopath. **30**: 866-869. 1940.
2. Holmes, F. O. A masked strain of tobacco-mosaic virus. Phytopath. **24**: 845-873. 1934.
3. Jones, L. K., Anderson, E. J. & Burnett, G. The latent virus of potatoes. Phytopath. Zeitschr. **7**: 93-115. 1934.
4. Kunkel, L. O. Histological and cytological studies of the Fiji disease of sugar cane. Hawaiian Sugar Planters' Assoc., Exp. Bull., Bot. Ser., **3**: 99-107. 1924.
5. Kunkel, L. O. Sterility caused by the aster yellows disease. Mem. Hort. Soc. N. Y. **3**: 243-244. 1927.
6. Kunkel, L. O. Heat treatments for the cure of yellows and other virus diseases of peach. Phytopath. **26**: 809-830. 1936.
7. Kunkel, L. O. Heat cure of aster yellows in periwinkles. Am. Jour. Bot. **28**: 761-769. 1941.
8. Kunkel, L. O. False blossom in periwinkles and its cure by heat. Science **95**: 252. 1942.
9. McWhorter, F. P. A latent virus of lily. Science **86**: 179. 1937.
10. Nishimura, M. A carrier of the mosaic disease. Bull. Torrey Club **45**: 219-233. 1918.
11. Samuel, G., Bald, J. G. & Eardley, C. M. "Big bud," a virus disease of the tomato. Phytopath. **23**: 641-653. 1933.

Animal Hormones Affecting Growth and the Several Effects of Single Hormones*

Oscar Riddle

In higher vertebrate animals and man, the forms in which hormonal regulation is best known, several hormones act as stimulants to growth. In some cases this stimulus is fairly restricted or localized and only a single function or special tissue is affected. But advancing information indicates that many hormones affect a variety of functions and organs. For higher animals it has been learned during the past 15 years that the center of hormonal regulation resides in the anterior pituitary gland; its hormones may be called "trigger" hormones. In large measure these "trigger" hormones stimulate other hormone producing glands (thyroid, gonad, adrenal) whose products may thus in turn be called "target" hormones (thyroxine, estrone, testosterone, cortin). Growth processes are affected by both "trigger" and "target" hormones; one of the former, prolactin, and one of the latter, estrone (or estrogens), are here utilized as illustrations of hormones which are not only related to growth but which also exhibit a variety of actions.

Prolactin stimulates milk secretion in mammals and growth of crop-sacs and production of crop-milk in pigeons. It sometimes reduces or prevents the secretion of the "trigger" hormone, gonadotrophin. It releases broodiness (fowl, pigeon) and maternal behavior (rats). Perhaps it prolongs the life of corpus luteum cells, and stimulates their production of the hormone, progesterone. In pigeons, but not in rats, it seems to be the chief and best of hormones for the promotion of bodily growth. It assists growth in dwarf mice and there synergizes the action of thyrotrophin on growth. In pituitaryless pigeons prolactin can increase body weight and intestinal and liver tissue to an extraordinary degree, and likewise it can partially support the pancreas; but all these actions can be shared or augmented by hormone of the adrenal cortex (unpublished, Miller and Riddle), while still a third hormone, thyroxine, further assists in maintaining the weight of the intestine and pancreas. It is a moot question whether the pituitary gland produces a single "growth hormone" or whether bodily growth (probably somewhat differently stimulated in different species) is a summation of effects of various "trigger" and "target" hormones.

Estrone, or stable estrone-like substance, has been obtained from yeast, rape seed, potatoes and female willow catkins—even from petroleum and lig-

* Presented in more detail at the 75th Anniversary Celebration of the Torrey Botanical Club at the Boyce Thompson Institute for Plant Research, Inc. Wednesday, June 24, 1942. Only an abstract of the discussion is published here.

nite. Estrone produces localized growth in oviduct, mammary glands and uterus. It reduces or suppresses the output of the pituitary hormone, gonadotrophin. It affects bone development and general bodily form in some species. It has an action on the calcium, phosphorus and fat of the blood. In the mental sphere it affects sex behavior.

The past 15 years of study of the actions, interactions and automatic control of release of the pituitary hormones in the bodies of higher animals have provided a purely natural basis for some of the most mysterious performances and adjustments of our own bodies. Now, for the first time in the long history of man, human beings partly know a series of organs and substances which—acting in high degree as a self-regulating system—largely control the fuller expression of growth, the rhythms of reproduction, and some aspects of temperament and behavior. In short, we have come to recognize our anterior pituitary gland as the master or governing gland; also, the brain and this master gland are now marked as the two truly basic sources of the strength and competence of man. It should arouse biologist and layman alike to reflect that up to our own time mankind has made its whole history—its conquests, its arts, its literature, its laws, its religions, its philosophies—while wholly ignorant of one of the two physical sources from which the abilities of an individual human being are derived.

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The Formative Influences and Comparative Effectiveness of Various Plant Hormone-like Compounds*

P. W. Zimmerman

Plant physiology has gone a long way since Boysen-Jensen discovered that the stimulus which causes cell elongation and tropic curvatures in coleoptiles passed through a discontinuity of tissue and appeared to be of a chemical nature (1). Since that time many chemical compounds, natural and synthetic, have been found which when applied to plants act like hormones. In addition to cell elongation these substances cause cell division, induce new organs, prevent abscission, inhibit buds, modify the pattern of organs, and otherwise regulate the growth of plants. Such substances have been given various names as hormones, auxins, growth substances, growth promoters, growth regulators, etc. None of these designations is satisfactory because a single substance has the capacity to induce several varied responses. The word "formative" has often been used to describe the effects of hormone-like compounds on plants. This term did not seem significant until recently when it was found that some of these physiologically-active compounds have a decidedly regulating and "formative" effect on the new growths of the entire plant (5, 7, 3, 4). This is in contrast with locally induced cell elongation. The subject of this paper concerns especially formative influences and comparative activity of several hormone-like compounds which modify the pattern of leaves, flowers, and fruit and which change the correlation phenomena of organs.

METHODS AND MATERIAL

The activity of growth substances was usually detected by curvatures resulting from induced cell elongation or by formative effects on later growth. The former response occurred within a comparatively short period of time (20 to 60 minutes). Formative effects appeared in days or weeks after the plant had time to produce new organs. The first evidence of formative effects appeared on new leaves which were modified in size, shape, pattern, and texture. Later the effects appeared on flowers, fruit, growth habit, and correlation phenomena of organs.

The chemicals were applied to plants in water solution, as lanolin preparations, and as vapors. Various spreaders were used with water solutions but were generally considered not essential. Water solutions (10 to 300 mg./l.) were sprayed on the plants with a nasal atomizer, applied to the soil, and injected into the stem with a glass capillary tube. Lanolin (or other oily substance)

* Read at the 75th Anniversary Celebration of the Torrey Botanical Club at the Boyce Thompson Institute for Plant Research, Inc. Wednesday, June 24, 1942.

preparations were made up with a series of concentrations of the chemical, ranging from 0.005 to 20.0 mg./g. of lanolin. These preparations were applied to local parts of the plant with a glass rod. To induce epinasty the material was applied to the upper side of a young leaf petiole; to induce curvature of the stem the material was applied along one side of a young stem. Chemicals active for cell elongation caused negative (away from treated side) curvatures within a short time. The same treatment also served to determine whether the chemicals had a formative influence on new growth. Plants were exposed to vapors of the various compounds under bell jars, closed greenhouses, glass cages, or other closed containers which could be kept reasonably tight. The esters were more volatile than acids or amides and were considered best for vapor treatments. The ultimate effects, however, were the same for all. The amount of ester required under the bell jar was less than 1 milligram. When heat was required to volatilize the chemical, a small amount was placed on a watch glass which in turn was placed on a warm or hot inverted crucible under a bell jar. In the greenhouse a hot plate supplied the heat and an electric fan circulated the air.

Most of the chemical compounds used in the experiments and listed in the tables were synthesized in the Boyce Thompson Institute laboratories. A few were available from commercial supply houses.

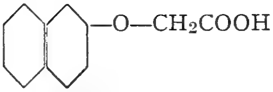
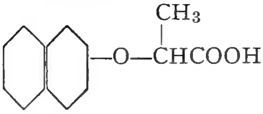
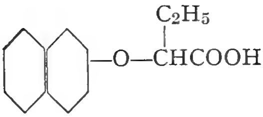
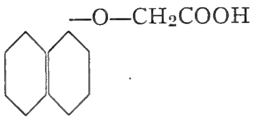
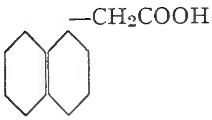
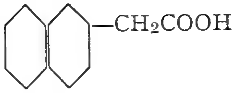
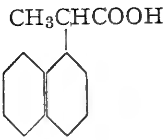
Results

For the study of formative influences three groups of compounds stand out above all others. They are β-naphthoxy acids, substituted phenoxy derivatives of the lower fatty acids, and substituted benzoic acids. The substituted groups were nitro, amino, methyl, or halogen radicals. These were used alone or in various combinations substituted in the naphthalene or benzene ring.

β-Naphthoxy compounds. β-Naphthoxyacetic acid and the higher homologs, propionic and butyric acids, were the first observed to have special formative influences (5). They were found to have in common with other plant hormone-like compounds the capacity to cause cell elongation, parthenocarpic development of ovaries, and to induce roots. Table 1 shows a list of naphthoxy and naphthalene compounds and their activity for cell elongation and formative influences.

It is interesting to note that for cell elongation naphthoxy compounds must have the chain of the molecule linked to the beta position in the ring while the alpha position is required for naphthaleneacetic acid. α-Naphthoxyacetic acid is inactive for cell elongation but has a slight formative influence. Neither α- nor β-naphthaleneacetic acid has a formative influence which modifies the pattern of leaves.

TABLE 1. MOLECULAR CONFIGURATION AND COMPARATIVE ACTIVITY OF NAPHTHOXY AND NAPHTHALENE COMPOUNDS

Substances	Cell elongation	Modification of tomato leaves
 β—Naphthoxyacetic acid	Active	Active
 α—(β-Naphthoxy) propionic acid	Active	Slightly Active
 α—(β-Naphthoxy)-*n*-butyric acid	Active	Active
 α—Naphthoxyacetic acid	Inactive	Slightly Active
 α—Naphthaleneacetic acid	Active	Inactive
 β—Naphthaleneacetic acid	Inactive	Inactive
 α—(α-Naphthalene) propionic acid	Inactive	Inactive

Attention has been called to the fact that though β-naphthoxyacetic acid and its higher homologs have a formative influence on growth, there are qualitative differences in responses induced with these compounds (6). It should be pointed out also that different species bring out further qualitative differences. β-Naphthoxyacetic acid, for example, modifies the leaves of Turkish tobacco (*Nicotiana tabacum*) while β-naphthoxypropionic acid has little or no effect on the pattern of leaves of this species.

Substituted phenoxy compounds. There are many active substituted phenoxy compounds. The activity appears to be related to the kind, number, and position of substituted groups in the benzene ring. In general, halogen substitutions bring about greater activity than methyl, amino, or nitro groups. With a single halogen group substitution the para position is more effective than the ortho. However, 2,4-dichlorophenoxyacetic acid is more effective than either *o*- or *p*-chloro phenoxyacetic acid (4, 7).

Nitro group substitutions do not activate the phenoxy molecule except in the meta position. The amino group activates the molecule when substituted in the para position. The chlorine atom in the ortho, meta, or para position activates the phenoxy molecule. These comparisons are shown in table 2.

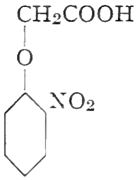
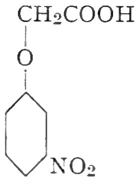
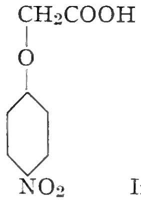
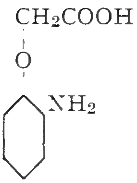
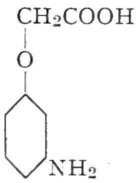
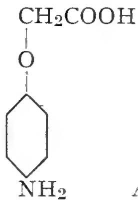
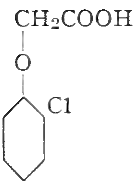
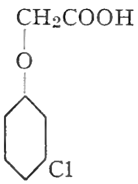
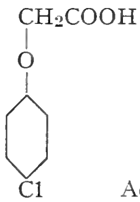
Table 3 shows the comparative activity of non-substituted and chloro-substituted phenoxy compounds. Phenoxyacetic acid does not modify the pattern of leaves though its propionic and butyric acid homologs do. This is in contrast with ortho, para, and 2,4-dichlorophenoxy compounds where the acetic acid form modifies leaves but the corresponding propionic and butyric acid homologs do not. These are in further contrast with *m*-chlorophenoxy and 2,4,5-trichlorophenoxy compounds where neither the acetic acid forms nor their higher homologs modify leaves though all are active for cell elongation. In all active phenoxy compounds the nucleus of the molecule was linked to the chain at the alpha carbon atom. Comparable beta linkages made inactive compounds.

2,4,6-Trichlorophenoxyacetic acid and the propionic acid homolog did not cause cell elongation but had a slight capacity to modify organs. 2,3,4,6-Tetrachlorophenoxyacetic acid and 2,3,4,5,6-pentachlorophenoxyacetic acid were inactive.

When the ortho and para positions were substituted with chlorine or a methyl group making 2,4-dichlorophenoxyacetic or 2,4-dimethylphenoxyacetic acids, the compounds were active for cell elongation and for modification of leaves. The higher homologs, however, were different. α-(2,4-Dichlorophenoxy) propionic and butyric acid were not active for modification of organs while the corresponding methyl-substituted compounds were active. This peculiarity is illustrated in table 4.

The formative influence of 2,4-dichlorophenoxyacetic acid is illustrated in figure 1 B and C. When the *Nicandra physalodes* plant on the right was ap-

TABLE 2. The Dependence for Activity upon the Position of Substituted Groups

 Inactive	 Active	 Inactive
 Inactive	 Inactive	 Active
 Active	 Active	 Active

proximately five inches high, it was sprayed with a water solution containing 12.5 mg. of the chemical per liter of water. All new growth thereafter produced modified organs. The change in the pattern of leaves can be seen by comparing the three old leaves near the base of the stem which were nearly mature when the plant was treated with those of the new growth. Also the flowers of the new growth were modified as shown in figure 1 B and C. Stems and leaves sometimes became fasciated and flowers appeared to arise from leaves (Fig. 1 C). Calyx tubes often remain closed and prevented the corolla from emerging. The veins of the leaves often crowded toward the midrib making a narrow leaf with only a ruffle of blade around the edge. The veins became nearly transparent and the plants appeared to have a virus disease.

Substituted benzoic acids. Considered from the standpoint of a plant growth substance, benzoic acid is an inactive compound. When, however, the nucleus is substituted, the molecule may be activated. The degree of activity depends upon the kind, number, and the position of substituted groups. Amino, nitro,

TABLE 3. Molecular Configuration and Comparative Activity of Phenoxy and Substituted Phenoxy Compounds

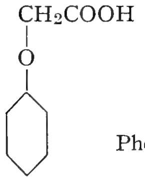
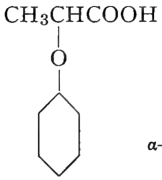
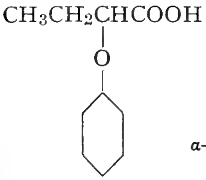
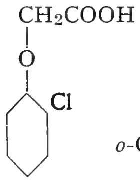
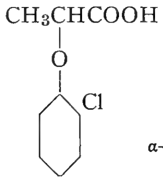
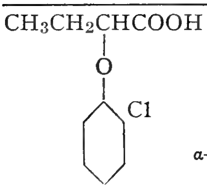
Substances	Cell elongation (epinasty) threshold conc. mg./g.	Modification of tomato leaves threshold conc. mg./g.
 Phenoxyacetic acid	20	Inactive
 *a*—(Phenoxy)propionic acid	5	5
 *a*—(Phenoxy)-*n*-butyric acid	5	5
 *o*-Chlorophenoxyacetic acid	1	0.25
 *a*—(2-Chlorophenoxy)propionic acid	1	Inactive
 *a*—(2-Chlorophenoxy)-*n*-butyric acid	1	Inactive

TABLE 3. (*Continued*)

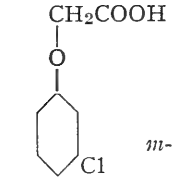
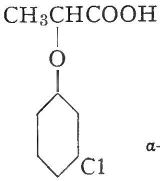
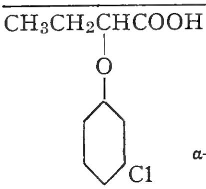
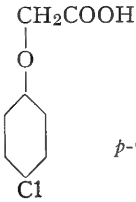
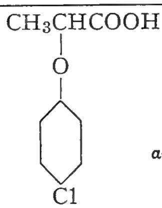
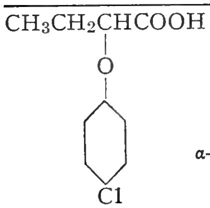
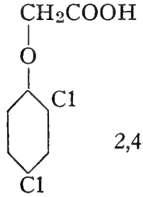
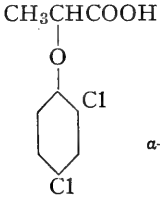
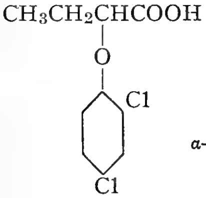
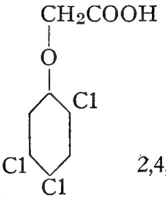
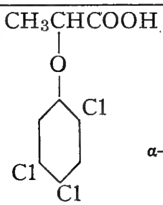
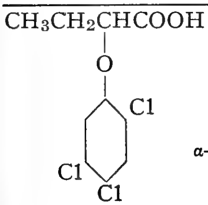
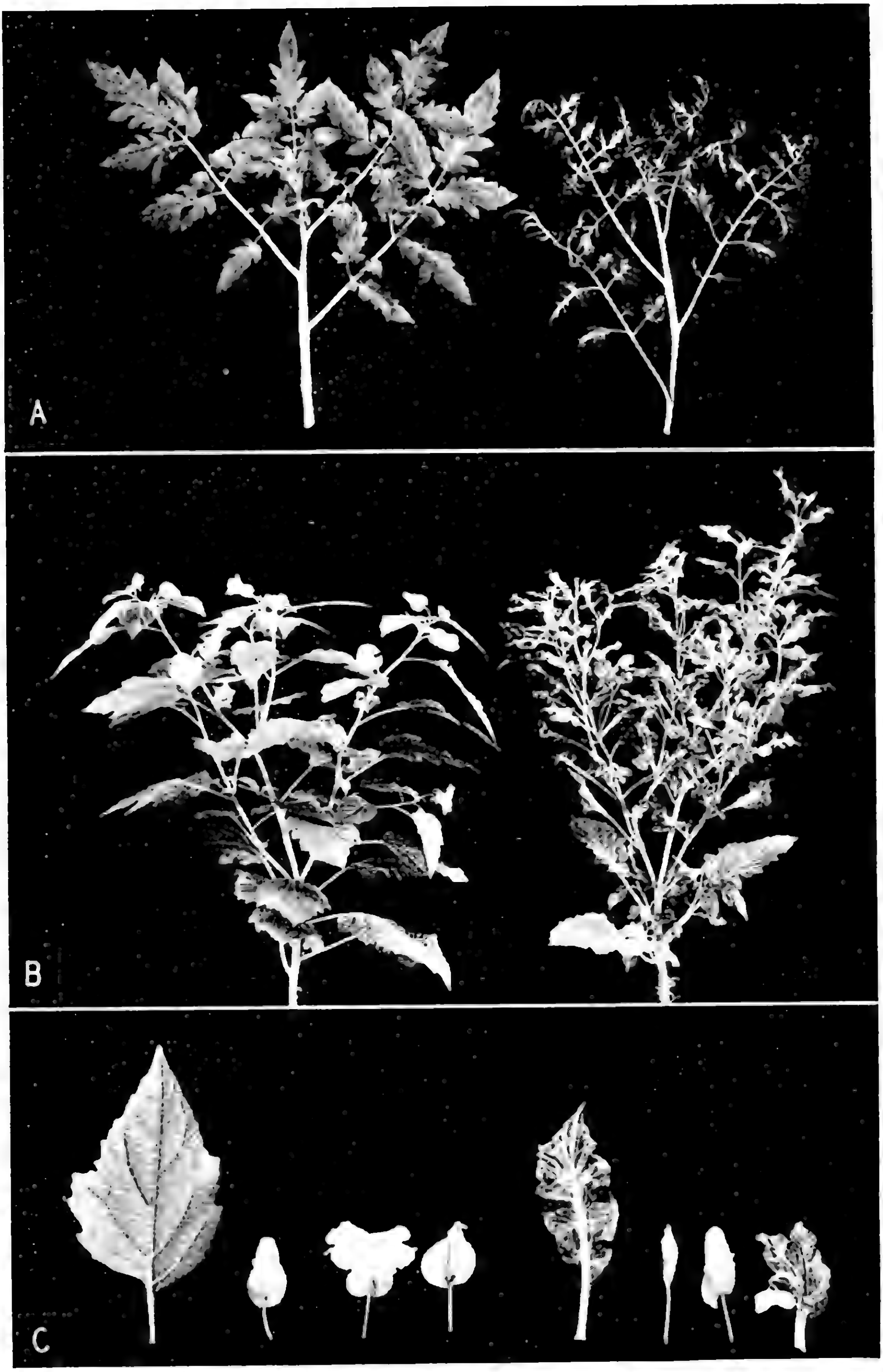
	Substances	Cell elongation (epinasty) threshold conc. mg./g.	Modification of tomato leaves threshold conc. mg./g.
	*m*-Chlorophenoxyacetic acid	0.5	Inactive
	*a*—(3-Chlorophenoxy) propionic acid	0.5	Inactive
	*a*—(3-Chlorophenoxy)-*n*-butyric acid	0.5	Inactive
	*p*-Chlorophenoxyacetic acid	0.25	0.06
	*a*—(4-Chlorophenoxy) propionic acid	0.5	Inactive
	*a*—(4-Chlorophenoxy)-*n*-butyric acid	1	Inactive

TABLE 3. (*Concluded*)

Substances		Cell elongation (epinasty) threshold conc. mg./g.	Modification of tomato leaves threshold conc. mg./g.
	2,4-Dichlorophenoxyacetic acid	0.015	0.003
	α—(2,4-Dichlorophenoxy)propionic acid	0.5	Inactive
	α—(2,4-Dichlorophenoxy)-*n*-butyric acid	0.5	Inactive
	2,4,5-Trichlorophenoxyacetic acid	0.06	Inactive
	α—(2,4,5-Trichlorophenoxy) propionic acid	0.03	Inactive
	α—(2,4,5-Trichlorophenoxy)-*n*-butyric acid	0.1	Inactive


A
B
C

and halogen groups appear to be the most important. Some substituted benzoic acids have a pronounced formative influence on plants but have little or no effect on cell elongation. One compound of the group, however, induced both cell elongation and modification of leaves (3, 7). Table 5 shows a list of active and inactive compounds.

Positions 2, 3, and 5 in the nucleus appeared to be the most important for substitutions. For example, 2,3,5-triiodobenzoic acid and 2-chloro-3,5-diiodobenzoic acid had the most pronounced formative influence of any of the compounds listed. In addition to modifying the pattern of leaves, they influence flowering habit and correlation of organs (8). One to 5 mg. of triiodobenzoic acid added to the soil of a 4-inch pot in which a tomato plant was growing was sufficient to cause modification of growth of the stem, leaves, and flowers, to cause axillary buds to grow flower clusters instead of the normal leafy shoots, and to induce the terminal bud to terminate with a flower cluster instead of continuing with a leafy shoot (Fig. 2 A and B). Similar results were obtained by other methods of applying the chemical. It is effective as a lanolin preparation (1 to 10 mg./g. of lanolin), as a vapor applied in a closed container, and as a water solution applied as a spray (25 to 100 mg./l.).

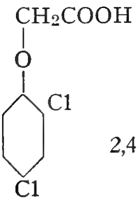
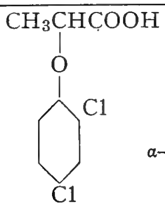
The results obtained with 2-chloro-3,5-diiodobenzoic acid were similar to but even more striking than those described for triiodobenzoic acid. Both compounds caused the terminal bud and axillary buds of tomatoes to grow flower clusters instead of leafy shoots, but the individual flowers were different. Those which grew under the influence of 2-chloro-3,5-diiodobenzoic acid were small with inconspicuous petals and sepals supported with an abnormally stout peduncle (Fig. 3 A). As the chemical influence became weaker and the plants began to recover, large single flowers instead of clusters were produced irregularly along the stem. The small flowers did not set fruit but the large ones functioned as normal flowers (Fig. 3 A and B).

Another active substituted benzoic acid, 2-bromo-3-nitrobenzoic acid, is of special interest since it caused both cell elongation (epinasty) and modified leaves of tomato plants (7). It was not as active for cell elongation as some of the phenoxy compounds but had a pronounced formative influence on growth. 2-Chloro-5-nitrobenzoic acid has a formative influence but does not cause cell elongation. Judging from active benzoic acids listed in table 5 it would appear

Explanation of figure 1

Modification of organs induced with substituted phenoxy compounds. A. Tomato shoots: left, control; right, response to spray with solution of β-(2,4,6-trichlorophenoxy)-β'-chlorodiethyl ether. B. *Nicandra* plants: left, control; right, modifications induced with 2,4-dichlorophenoxyacetic acid (12.5 mg./l.). Solution applied at tip with nasal atomizer when plant was 5 inches in height. Note non-modified leaves at base which were present when treated. C. Enlarged leaves, buds, and flowers taken from plants in B.

TABLE 4. VARIATION IN ACTIVITY ACCORDING TO THE POSITION OF CHLORO AND METHYL SUBSTITUTED GROUPS

<table>
<tr><th></th><th>Substances</th><th>Cell elongation</th><th>Formative effects</th></tr>
<tr><td>
</td><td>2,4-Dichlorophenoxyacetic acid</td><td>Active</td><td>Active</td></tr>
<tr><td>
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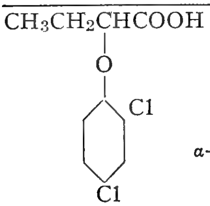
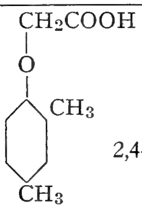
<tr><td>
</td><td>α-(2,4-Dichlorophenoxy)-*n*-butyric acid</td><td>Active</td><td>Inactive</td></tr>
<tr><td>
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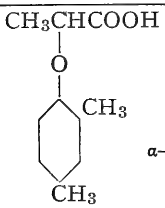
<tr><td>
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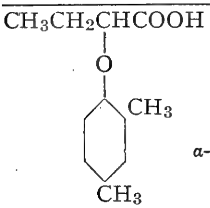
<tr><td>
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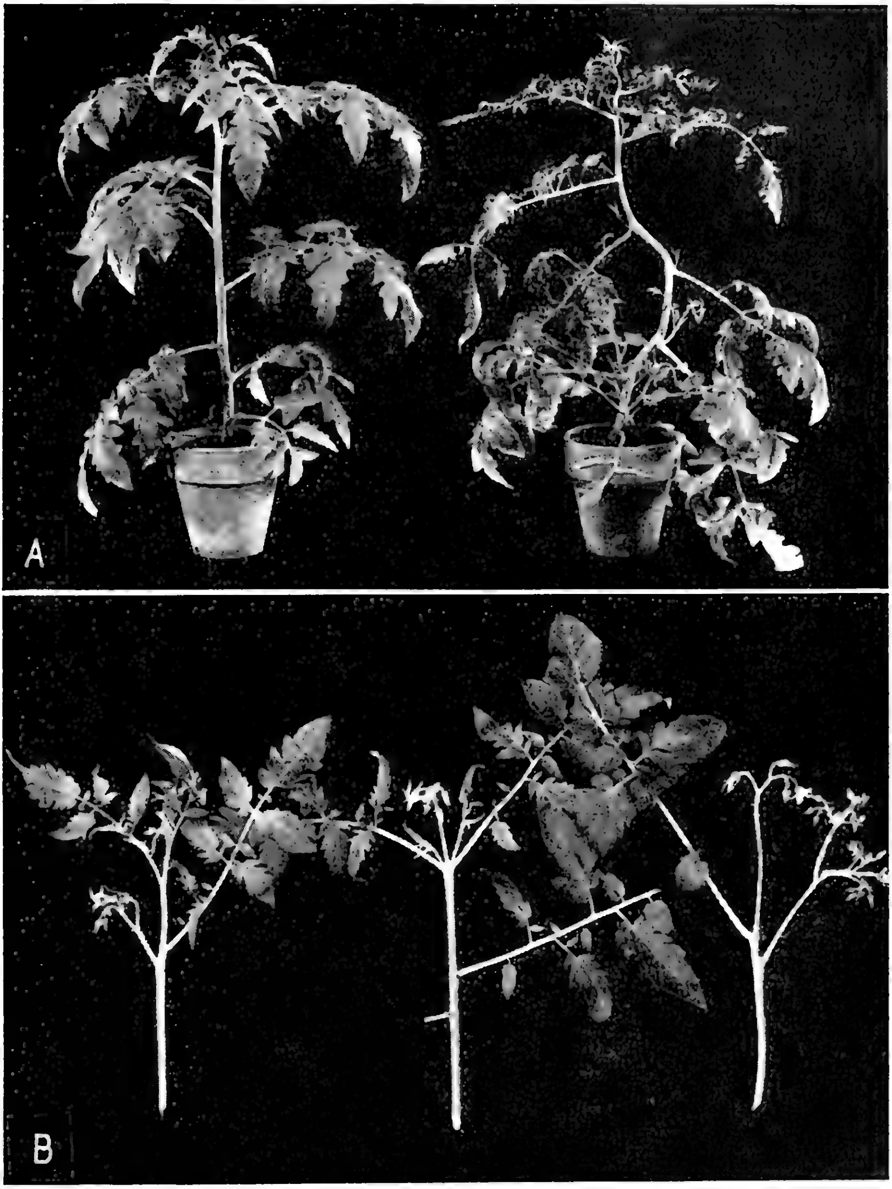


Fig. 2. Formative influence of 2,3,5-triiodobenzoic acid on tomato plants. A. Left, control; right, treated with 2 mg. of the chemical in 50 cc. of water applied to the soil when the plant was approximately 5 inches in height. B. Left, control; middle and right, terminal shoots showing modified flowering habit and correlation of organs after the main shoot had been treated with triiodobenzoic acid in lanolin (5 mg./g. [middle], and 10 mg./g.). Photographs taken 30 days after treatment.

TABLE 5. Molecular Configuration of Some Active and Inactive Benzoic Acids

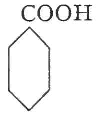
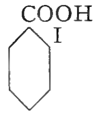
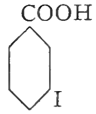
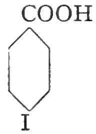
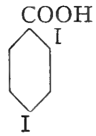
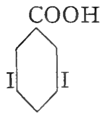
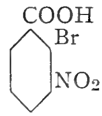
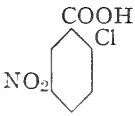
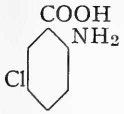
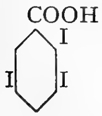
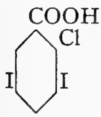
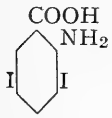
	Substances	Cell elongation	Formative effects
	Benzoic acid	Inactive	Inactive
	2-Iodobenzoic acid	Inactive	Inactive
	3-Iodobenzoic acid	Inactive	Inactive
	4-Iodobenzoic acid	Inactive	Inactive
	2,4-Diiodobenzoic acid	Inactive	Inactive
	3,5-Diiodobenzoic acid	Inactive	Active
	2-Bromo-3-nitrobenzoic acid	Active	Active
	2-Chloro-5-nitrobenzoic acid	Inactive	Active

TABLE 5. (*Concluded*)

	Substances	Cell elongation	Formative effects
	2-Amino-5-chlorobenzoic acid	Inactive	Inactive
	2,3,5-Triiodobenzoic acid	Inactive	Active
	2-Chloro-3,5-diiodobenzoic acid	Inactive	Active
	2-Amino-3,5-diiodobenzoic acid	Inactive	Inactive

that activity is dependent upon substitutions in the 2, 3, and 5 positions. None of the mono-substituted benzoic acids were active. Also 2,3,5-triiodobenzoic acid was more active than 3,5-diiodobenzoic acid. There are many possibilities for substituting a given radical and combinations of various groups in the nucleus of benzoic acids. Comparative activity cannot be predicted from the appearance of structural formulae. They must be synthesized and tested for comparative degrees of activity. That is to say, at the present time activity can be determined only by actual biological tests.

DISCUSSION

Formative influences described under the heading of "Results" are comparatively new in the study of growth substances. The meaning of the word "formative" could be extended to include local cell elongation and other short time responses which do not involve modification of size, shape, or pattern of organs produced by new growth. As intended in this paper, "formative" involves the growth of new organs immediately following the application of the active substance. The result is a systemic effect rather than local. It could be compared to the effect of a systemic virus disease in contrast to a local fungus disease. In fact the responses induced by some of the active compounds have been mistaken for virus diseases. As the character of the responses varies with


A
B

different strains of virus so do they vary with the different active growth substances. A characteristic virus-like type of response is illustrated in figure 4 for three different compounds applied to two different species of plants. The chemically induced responses have the characteristic modifications of leaves showing clearing of the veins, irregular shape, light and dark portions of tissue, etc. The present results appear to lend support to the claim that virus diseases result from natural chemical influences.

The mechanism in the plant through which these chemicals act is not well understood. It is fairly certain that living protoplasm has many potentialities for expressing itself and that environment determines which of these can develop. The so-called "normal" characters of a plant are but a partial expression of the range of possibilities of which the protoplasm is capable. Natural variations in the pattern of leaves of certain species of plants growing in different environments lend support to this theory. The influences which regulate growth must deal with undifferentiated meristems made up of uniform cells and in some way cause them to give rise to specialized cells which in turn give rise to new tissues and new organs of plants. Sinnott (2) is of the opinion that the cytoplasm plays an important rôle in "the *construction* of a pattern." It seems reasonable to assume that modified organs result from the influence of the chemicals acting upon the cytoplasm rather than upon the more stable nucleus. Each chemical constitutes a different environment and, therefore, permits different potentialities of the protoplasm to develop. This, at best, is only an assumption but may in time help us to interpret the qualitative differences in responses resulting from treatment with different growth substances.

The molecular configuration as a whole rather than any part of the molecule appears to determine physiological activity. A slight shift in the position of a substituted group, a change from chlorine to an amino group, or a shift in the linkage of the chain to the nucleus may activate or inactivate a molecule.

In addition to the exact nature of the molecule, the constitution of the receptor tissue in the plant is important. First, the genetic constitution of the tissue plays an important part, and second, the location in the organ and the age of the tissue are determining factors.

Explanation of figure 3

Formative influence of 2-chloro-3,5-diiodobenzoic acid. A. Left, control; middle, terminal portion of tomato plant after stem had been treated with a lanolin preparation (20 mg./g.). Note miniature flower. Right, two abnormally large individual flowers (instead of clusters) formed after one axillary shoot began to recover from the effects of the chemical influence. B. Left, control; right, terminal portion of the plant which had been given soil treatment of 2-chloro-3,5-diiodobenzoic acid (4 mg. per pot applied in 50 cc. of water). Note abnormally small flowers on 2 clusters and recovery of axillary shoot with abnormal flower cluster.

Though in the same family group, tomato and potato tissues do not respond alike to a given substance, due, perhaps to the difference in their genetic constitution. Apple and lilac stem cuttings can be induced through chemical treatment to produce adventitious roots in the spring of the year but not in autumn or winter. Though the tissue is receptive at an early age, the capacity to respond to the chemicals is soon lost.

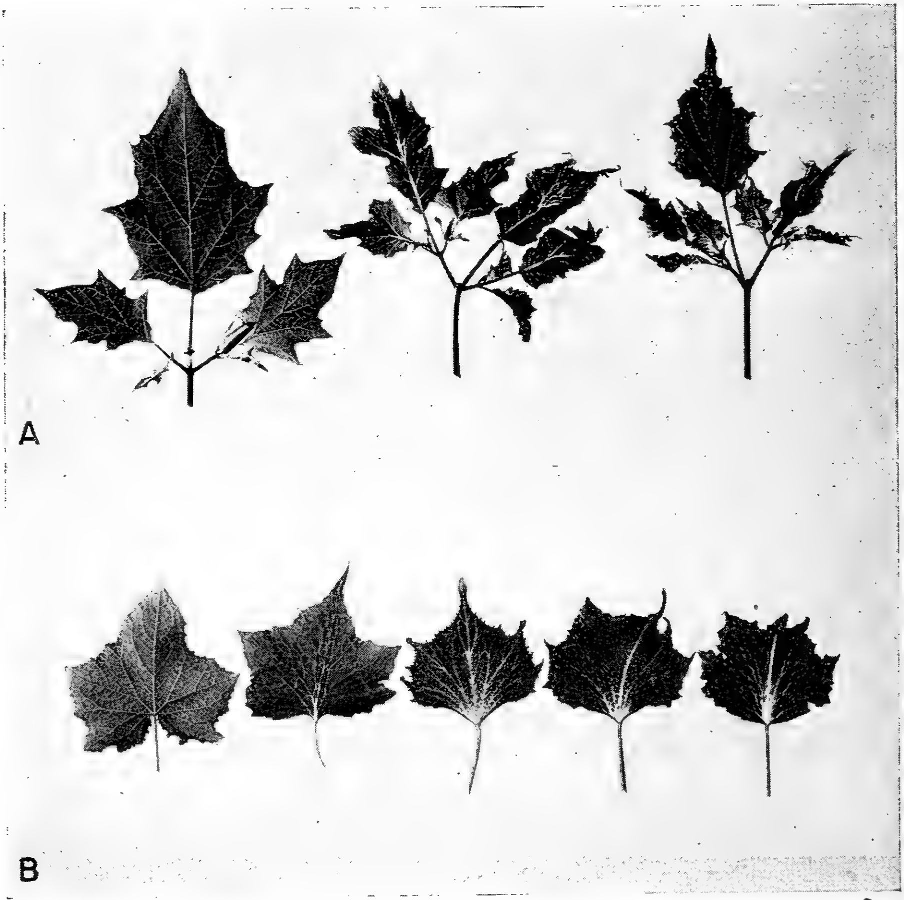


Fig. 4. Shoots and leaves showing formative influence of growth substances. A. *Datura stramonium:* left, control; middle, sprayed with a solution of 2,4-dibromophenoxyacetic acid (50 mg./1.); right, sprayed with a solution of *p*-aminophenoxyacetic acid (500 mg./1.). B. Cucumber (*Cucumis sativus*) leaves: left, control leaf; right, 4 leaves taken from one plant after the terminal bud had been sprayed with a solution of β-naphthoxyacetic acid (100 mg./1.).

With still other species young tissue does not respond to chemical treatment whereas older tissue is susceptible. Many other illustrations could be given to indicate that there are complex internal and external influences playing upon the living protoplasm and that the sum total of these regulates the growth and development of the plant.

SUMMARY

"Formative influence" as used in this report is defined and distinguished from other hormone-like influences.

For the study of formative influences three groups of compounds, β-naphthoxy, substituted phenoxy derivatives of the lower fatty acids, and substituted benzoic acids, stand out above all others. Substitutions in the nucleus of the molecule may be made with halogens, amino, nitro, or methyl groups. These may be used separately or in combination. Physiological activity depends upon the kind, number, and position of the substituted groups. The molecular configuration as a whole rather than any one part of the molecule appeared to determine the activity.

Characteristic responses induced with these growth regulators are illustrated in four different figures. Attention is called to the similarities between responses induced with synthetic growth regulators and naturally occurring virus diseases.

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Literature Cited

1. Boysen-Jensen, P. La transmission de l'irritation phototropique dans *l'Avena*. Kgl. Danske Videnskab. Selskabs. Forhandl. **1911** (1): 3-24.
2. Sinnott, E. W. The problem of internal differentiation in plants. Amer. Nat. **76**: 253-268. 1942.
3. Zimmerman, P. W. Formative influences of growth substances on plants. Cold Spring Harbor Symposia on Quan. Biol. **10**: 152-157. 1942.
4. ———. Present status of "plant hormones." Indus. & Eng. Chem. **35**: 596-601. 1943. (*Also in* Boyce Thompson Inst. Prof. Pap. **1** (35): 307-320. 1943.)
5. Zimmerman, P. W., and A. E. Hitchcock. Formative effects induced with β-naphthoxyacetic acid. Contrib. Boyce Thompson Inst. **12**: 1-14. 1941.
6. ———. Qualitative differences in capacity of growth substances to induce formative effects. Amer. Jour. Bot. **28**: 14s. 1941.
7. ———. Substituted phenoxy and benzoic acid growth substances and the relation of structure to physiological activity. Contrib. Boyce Thompson Inst. **12**: 321-343. 1942.
8. ———. Flowering habit and correlation of organs modified by triiodobenzoic acid. Contrib. Boyce Thompson Inst. **12**: 491-496. 1942.

Plants Need Vitamins Too*

William J. Robbins

Thirty years ago when I first became interested in the nutrition of the fungi the failure of a fungus to grow or grow well in a medium of known composition was ascribed to a variety of causes, none accounting satisfactorily for the results. Mycologists recognized that many fungi required special media containing some material of natural origin; and oatmeal, corn meal, potatoes, bean pods, extract of malt, peptone, wood, dung and many other natural products were frequently used as such or incorporated in the material upon which these organisms were grown. Generally speaking, an effort was made to supply as food the material on which the organism grew in nature.

The advantage of such natural media was not understood. Some suggested that it was because of the suitability of the minerals in the natural product, or its favorable acidity or alkalinity, to the presence of a particular carbohydrate or some unique source of organic nitrogen, to the special water relations afforded by the material or to some physical property. We know now that the growth of many fungi is conditioned by the presence in the medium of minute traces of specific organic compounds, some of them identical with the known vitamins; and the presence of these growth substances in products of natural origin frequently accounts for their advantages as culture media. This was a possibility seriously considered by few, if any, of those concerned with the cultivation of fungi thirty years ago. In fact, the very word vitamin was unknown at that time; it was coined by Casimir Funk in 1912 and up to eight years ago not a single completely convincing example of the importance of a vitamin for a plant could be cited.

During the period from 1912-1934 the animal physiologist proceeded to demonstrate the importance of vitamins for the growth and well-being of animals and to explore their multiplicity, functions, sources and chemistry. It was generally agreed that plants were the sources from which animals in the last analysis obtained their vitamins, or in other words, that plants made vitamins and animals used them, a fortunate circumstance for us and a sort of philanthropic activity on the part of plants. But the possibility that vitamins were important in the metabolism of the plant itself was regarded by the majority of plant physiologists with concealed or open scepticism. In fact, a complete and satisfactory demonstration of the importance of vitamins for plants waited, as so frequently happens in science, on advances in another field, on the isolation of a vitamin in chemically pure form. Crystalline thiamine (vita-

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min B_1) was isolated by Jansen and Donath in 1926 and became generally available in 1934. In that year Schopfer showed that the bread mold *Phycomyces* would not grow unless it was furnished with minute traces of this vitamin. With this convincing demonstration as a basis and the isolation of additional vitamins in chemically pure form our knowledge advanced rapidly.

Now we realize that plants are not so philanthropic as they once seemed. We know they too need vitamins, but more provident than animals, most plants make their own vitamins. Only the minority, and these chiefly the lower plants, suffer from vitamin deficiencies; that is, they cannot develop unless the material upon which they grow contains some of the necessary vitamins which, of course, must come from some other kind of plant or from an animal which has obtained them from a plant. Some bacteria, yeasts and molds need to be supplied with vitamins. Few, if any, of the trees, vegetables, flowers and other green plants benefit from having vitamins supplied them. To the best of our knowledge they make all they need.

You may ask whether this means, in spite of the considerable publicity on this subject, that supplying green plants with vitamin B_1 or other vitamins is not beneficial? I would answer this question in this way. The application of vitamins to trees, flowers, vegetables and other green plants is still in an experimental stage. Some investigators have reported beneficial results on some kinds of plants and not on others. Many have obtained negative results. We must conclude either that the conditions under which vitamins are beneficial to green plants are poorly understood or that their application does not bring favorable results. Certainly the use of vitamins in horticultural practice does not accomplish the miracles some would have us believe, and no reputable horticulturist on the basis of the evidence now at hand would recommend their use under normal garden and greenhouse practice.

In discussing the relation of vitamins to plans there are a good many questions we might ask. For example, what is a vitamin, how were they discovered, how do we know plants need vitamins and how many vitamins do plants need, what plants must be supplied vitamins and what do the vitamins do in the plant, how much of a vitamin is needed and is there a substitute for a particular vitamin—something just as good? I can't answer all these questions for any one vitamin, but some of them can be answered by discussing a particular vitamin, and I have selected three, thiamine or vitamin B_1, pyridoxine or vitamin B_6 and biotin or vitamin H.

Thiamine. Thiamine or vitamin B_1 is a white crystalline substance containing carbon, hydrogen, nitrogen, oxygen and sulfur. Its empirical formula is $C_{12}H_{16}ON_4S$. Its structure is known and between 25 and 30 tons are now made annually in chemical laboratories in this country. In 1935 thiamine cost $300 per gram which is at the rate of $135,000 per pound. With the discovery of methods of making it synthetically and the development of mass production its price dropped to $.53 per gram or about $238 per pound. Thiamine is used in the treatment and prevention of beri beri, of lack of appetite in children and of various types of neuritis and in the enrichment of flour. It is perhaps the best known and most widely advertised of all the vitamins.

The history of our acquaintance with this vitamin begins with attempts to cure a disease common in the far east, recognized by the Chinese as early as 2697 B.C. and known as beri beri. In the 19th Century it was found that beri beri could be cured by controlling the diet; for example, Takaki, Surgeon General of the Japanese Navy, about 1885, substituted meat and legumes for part of the rice in the diet of sailors and reduced the incidence of beri beri from between 30 and 40 percent to less than ½ percent. Takaki believed that this was because of the increased protein furnished. In 1912 Casimir Funk, a Polish scientist, suggested that beri beri was the result of the lack of a specific organic substance in the food. This new dietary essential he called a vitamin. It was found that pigeons and other animals fed on polished rice developed a type of beri beri which could be cured by feeding rice polishings or extracts made for them. The next step in logic was to assume that if vitamins were really present in rice polishings and not merely in the minds of Funk and those who believed as he did vitamins could be isolated and their chemical nature determined. Many made the attempt. Two Dutch investigators in Java, Jansen and Donath, succeeded in isolating a small quantity of vitamin B_1 in 1926, but its isolation in quantity and its synthesis in the laboratory were not accomplished until 1934. Since 1934 many yeasts, bacteria, filamentous fungi, and the excised roots of a number of higher plants have been found to suffer from thiamine deficiencies. It has been found further that those plants which grow without an external supply of thiamine make it, and the conclusion has been reached that all living organisms need thiamine. Some make it from simpler substances, others must be supplied with it. It is as essential and as necessary as water or minerals or any other indispensable item in the nutrition of an organism. Its absence means death, its presence, life.

Pyridoxine. Pyridoxine or vitamin B_6 is also a white crystalline compound. Its empirical formula is $C_8H_{11}O_3N$. It is a derivative of an ill-smelling liquid known as pyridine. In 1939 pyridoxine cost $12.00 per gram. It can be purchased now for $3.00 per gram or about $1350 per pound. The medical value of pyridoxine is ill-defined. It may be of value in the treatment of certain muscular rigidities, of paralysis agitans and perhaps of other conditions.

In 1915 Goldberger, a United States Public Health Official, recognized that dietary deficiencies might play an important part in the development of pellagra, a condition affecting between 400,000 and 500,000 people annually. In 1937 Elvehjem at the University of Wisconsin demonstrated that nicotinic acid would cure a pellagra-like condition in the dog known as "black tongue" and in 1938 Spies and coworkers reported that nicotinic acid was effective in the treatment of human pellagra. During the course of Goldberger's work he was able to produce a syndrome in rats which he called "rat pellagra." However, György (1934 and 1935) at the Babies and Children's Hospital in Cleveland determined that this condition was not cured by the pellagra-preventing factor, by thiamine or by vitamin B_2. It could be cured by particular extracts of rice polishings, and he proposed that the deficiency in the food causing this peculiar type of dermatitis was a new vitamin which he called vitamin B_6. In 1938 vitamin B_6, later named pyridoxine, was isolated and identified by Kuhn in Germany, Ichiba and Michi in Japan, Lepovsky in California, György in Ohio and Keresztesy and Stevens in New Jersey. It was synthesized in 1939 by Harris and Folkers. Partial or complete deficiencies for pyridoxine have been found for some bacteria, some yeasts and a good many fungi. It too appears to be a vitamin needed by all living organisms.

Biotin. Biotin is a white crystalline substance which in the form of its methyl ester has the empirical formula $C_{11}H_{18}N_2O_3S$. Its structural formula is not yet known, and it has not been synthesized from simpler substances. It may be obtained by a long and costly process of purification from natural products such as egg yolk or liver and for $10.00 you may purchase 75 micrograms of pure biotin which is at the rate of about $62,400,000 per pound. It was first isolated by Kögl and Tönnis of Utrecht in 1936 from the yolk of eggs and has proved to be the most potent of all the vitamins. Kögl and Fries were able to detect the effect on the growth of a fungus of 0.0001 of a microgram of biotin methyl ester. Biotin is widely distributed in products of natural origin. We have found it in such unexpected places as cow manure and cotton. In fact, a bale of cotton contains about $1000 worth of biotin. It is made by green plants and many bacteria, yeasts and filamentous fungi. There are, however, a good many of the lower organisms which lack the ability to make biotin; some cog is missing in their machinery, or it works slowly, and these organisms grow poorly or not at all in media from which this vitamin is absent. It is probably essential for animal growth and from recent pronouncements in various journals may be intimately associated with the development of cancer.

The discovery of biotin has a long and interesting history. In 1860 Pasteur published an important memoir on alcoholic fermentation in which he came to the conclusion that yeast grew if supplied with yeast ash, ammonium salts and a fermentable sugar. He observed that the fermentative power of yeast was increased by the addition of extracts from natural products, for example, grape juice, sugar beet juice or yeast juice but all the essentials for growth were included, according to Pasteur, in a solution of yeast ash, ammonium salts and glucose. However, in 1869 the famous German chemist, Justus von Liebig, stated that yeast neither grew nor fermented sugar under the conditions defined by Pasteur. This criticism was so keenly felt that in 1872 Pasteur declared he was so sure of his results that he was prepared to perform the experiment in the presence of Liebig himself. The demonstration never took place, Liebig died in 1873, and the nutritional requirements of yeast as defined by Pasteur remained unchallenged for many years.

In 1901 Wildiers of Belgium reported that yeast would not grow under the conditions defined by Pasteur if the amount of yeast used in the seeding was small. He found that small amounts of a thermostable organic material were necessary for the growth of yeast and gave to this chemically undefined material the name, bios. Bios was a concentrate prepared from the yeast itself. Wildiers suggested that Pasteur obtained his results because he had used a large quantity of yeast for the seeding, and this large seeding had carried with it sufficient bios to permit growth.

Wildiers' proposal that minute traces of organic material in addition to minerals, ammonium salts and sugar were necessary for yeast growth was roughly handled by some of his contemporaries, including Fernbach (1902) Windisch (1902) and Pringsheim (1906). Various students in Wildiers's laboratory supported his proposal but since no one could identify bios chemically, it remained for 20 years before the bar of science with the verdict, proposed but unproven.

In 1921 MacDonald and McCollum reported that yeast would grow in a solution of cane sugar and inorganic salts, but 2 years later Funk and Friedman demonstrated that ordinary cane sugar may contain a growth activator of organic character which required for its removal three crystallizations of the sugar from alcohol. And so after 60 years the dispute between Pasteur and Liebig was still unsettled. However, a decision was rapidly approaching. In 1921 Copping reported that wild yeasts would grow in a solution of minerals and sugar while cultivated yeasts required the addition of bios for normal growth, and in 1924 Lash Miller and Lucas of Toronto showed that there was a difference between races of yeast in their response to bios. It seems reasonable now to suggest that the conflict in the results obtained 60 years before by Pasteur and Liebig may have been the result of differences in the strains of yeast they used.

However, although the burden of evidence seemed tipping the scales in favor of the reality of bios its chemical nature remained unknown. From 1919-1928 various unsuccessful attempts were made to identify bios with the antiberi beri vitamin of Eijkman and with the coenzyme of Harden and Young and to isolate it in crystalline form. However, Fulmer in 1923 demonstrated that bios was not a single substance, and Lash-Miller's laboratory in Toronto separated it into two fractions, Bios I and Bios II. In 1928 Eastcott showed that bios I was mesoinositol, a substance which more than ten years later was found to be necessary in the diet of chicks and of rats as well as in that of yeasts. R. J. Williams and associates separated a bios fraction which was demonstrated to be thiamine and later a fraction which proved to be a new vitamin, pantothenic acid; but a portion of bios still remained unidentified.

Kögl in Utrecht began his work in 1932 and devoted his attention to that part of the bios complex which was adsorbed on charcoal and which he called biotin. Four years later he announced the isolation of crystalline biotin. He had obtained 1.1 milligrams of the crystalline material from 250 kilograms of dried egg yolk and estimated that this amount of material originally contained a total of 80 milligrams. On this basis it would take more than 125,000 tons of dry egg yolk to yield 1 pound of biotin or, to put it another way, about 1,500,000 hens would have to work for a full year to produce the eggs necessary to yield 1 pound of pure biotin.

But this does not end the story of biotin. About 1933 it was reported that rats fed a diet high in raw egg white developed a peculiar and impressive skin injury which was accompanied by emaciation and eventually terminated fatally. This was called egg white injury. Cooked egg white did not have this effect. It was found further that egg white injury could be cured by injections of liver extract, and it was suggested that this was because of the presence in the liver extract of a new vitamin which was labelled, vitamin H. In the meantime a group of investigators in the United States Department of Agriculture had become interested in a factor which caused increased growth of the bacteria which produce nitrogen-fixing nodules on legumes. They named this factor coenzyme R. In 1940 György, Melville, Burk and du Vigneaud proved that biotin, coenzyme R and vitamin H were identical.

In the same year R. J. Williams and his associates isolated from uncooked egg white a peculiar protein, which they named avidin. Avidin it was found combines with biotin so strongly that it renders the vitamin unavailable to the organism. Egg white injury is, therefore, the result of a vitamin deficiency, a deficiency of biotin and now—biotin is suspected of having an intimate relation to cancer.

Effective quantities of the vitamins. I have spoken from time to time of effective quantities of thiamine, pyridoxine or biotin in terms of 0.01, 0.001 or even 0.0001 of a microgram, and a microgram is one millionth of a gram. This quantity of material cannot be seen, even with the most powerful microscope, and it cannot be weighed, even on the most sensitive balance. It is invisible and imponderable. If I had two dishes before me, one containing 0.001 microgram of biotin, and the other empty you could see nothing in either dish. Yet a little water rinsed in one dish and added to the proper medium would enable the proper fungus to grow while wash water from the other dish would be of no benefit.

To the uninitiated such results border on magic, and such small quantities are meaningless. What is 0.001 of a microgram? I will try to tell you. A teaspoonful of biotin weighs about 3 grams. Take one third of it and in your imagination divide it into 1000 parts. Each part would be a milligram. Take one milligram and divide it into 1000 parts. One of these is a microgram. It is only necessary to think of one microgram divided into 1000 parts to obtain 0.001 of a microgram or one trillionth of a gram. Easy to do isn't it, in your mind's eye?

But if such a small amount cannot be seen or weighed how can it be measured—anywhere else, that is, than in one's imagination. This is a simple laboratory procedure, based on the principle of dilution. If we dissolve 1 gram of biotin in a liter of pure water it is clear that one milliliter of the solution will contain 1 milligram of biotin. A milliliter can be readily and accurately measured by means of a suitable pipette. If we transfer a milliliter of solution containing a milligram of biotin to another flask of a liter of pure water and distribute it there, then one milliliter in the second flask will contain one thousandth part of a milligram, or one microgram. A third transfer of this sort will yield a solution containing per milliliter 0.001 microgram or one trillionth of a gram. To obtain such small quantities is easy, if one knows how.

How vitamins work. Such small quantities of the vitamins are effective in determining the growth of an organism, like a fungus, in comparison with the amount of some other food, such as sugar or nitrogen, that our curiosity as to how vitamins function is sure to be aroused. It appears that they are parts of enzyme systems, and enzymes are those substances found in the body which make possible the chemical changes continuously occurring in a living organism and synonymous with life itself. Much as a bit of oil speeds a huge machine, an enzyme makes chemical reactions go on which otherwise would take place very slowly indeed. Sugar dissolved in sterile water will remain unchanged indefinitely but in the presence of the proper enzyme it is broken into its parts and yields its products. Most enzymes, perhaps all, are made up of two parts, an enzyme protein and a coenzyme, neither of which is effective by itself.

Some of the vitamins are known to be precursors of coenzymes. A deficiency of one of these vitamins interferes with the activity of an enzyme system and prevents the normal metabolic changes accomplished through the agency of that system. For example, cocarboxylase is the pyrophosphate of thiamine. The enzyme, carboxylase, catalyzes the decarboxylation of pyruvic acid, one of the intermediates in the metabolism of glucose; but carboxylase is only effective in the presence of its coenzyme, cocarboxylase. When thiamine is deficient and cocarboxylase is not formed, carboxylase does not function; and the normal utilization of sugar does not occur.

How specific are the vitamins? Vitamins are highly specific; that is, nearly related compounds will not substitute for a particular vitamin. A small change in the molecular structure of a vitamin reduces its effectiveness, may eliminate its activity entirely or even change it into a harmful compound. These results are probably because of their function as coenzymes.

What vitamins are important for plants? A dozen or more chemically pure vitamins and similar substances are now available. Not all of these have been demonstrated to be important for plants because usually a plant must be discovered which is deficient for a vitamin before the need for it can be clearly demonstrated. Nevertheless, deficiencies have been found for pantothenic acid and para amino benzoic acid, the anti gray hair factors, for riboflavin, m-inositol, thiamine, biotin, pyridoxine and ascorbic acid. In the development of any plant all these vitamins are probably essential, and others too, some of which are still unidentified. Most plants, including all green plants and many of the bacteria, yeasts and fungi, construct from sugar, minerals and a source of nitrogen all the vitamins they require in amounts adequate for normal and perhaps maximum development. Furnishing these plants with vitamins does not improve their growth.

Others suffer from one or more vitamin deficiencies: that is, they do not develop satisfactorily in a medium which lacks vitamins. Some plants have a *complete* deficiency for one or more vitamins. They are unable to synthesize any of the vitamin (or vitamins) in question, and in its absence do not grow. This is true of *Phycomyces* for thiamine. Others suffer from *partial* deficiencies; that is, they grow slowly in the absence of the particular vitamin, but more rapidly if it is present in the medium. Apparently they are able to make some of the vitamin, but not enough for maximum growth. Both complete and partial deficiencies may be *single* (for one vitamin) or *multiple* (for more than one vitamin). The deficiency may be *absolute,* or it may be *conditioned.* By an absolute deficiency I mean that no known environmental conditions enable the organism to synthesize the vitamin from the simple foods and nutrients in a vitamin-free medium. This appears to be true of *Phycomyces* in its relation to thiamine. *Pythium butleri,* on the other hand, suffers from a thiamine deficiency in a concentrated mineral solution which is relieved by diluting the solution. Its deficiency is conditioned by the medium in which it is grown.

The synthetic ability of a plant for a particular vitamin may be *complete, incomplete, or none;* that is, some plants are able to construct the vitamin from simple food and nutrients; others are capable of making the vitamin if supplied one or all of its intermediates; and still others are incapable of constructing any portion of the vitamin. For example, *Aspergillus niger* has complete synthetic power for thiamine; it can make this substance if supplied with sugar and minerals including nitrates. On the other hand, *Phytophthora cinnamomi* must be supplied with thiamine as such. It apparently lacks the ability to synthesize any portion of the thiamine molecule, resembling the animal in this respect. Between the two extremes of no synthetic power and complete synthetic ability, there exist many types of incomplete synthetic power. For example, *Mucor ramannianus* can make the pyrimidine half of the thiamine molecule but not the thiazole portion; *Sclerotium rolfsii* can make the thiazole but not the pyrimidine part; *Phycomyces* can combine the two intermediates into the thiamine molecule but is incapable of making either.

The importance of studies on vitamins in relation to plants. By this time you may be willing to admit that plants need vitamins, but you may still question the importance of such knowledge, particularly when you remember what I have said on the negative results of applying vitamins to green plants in field or garden. If most plants make all the vitamins they need, why should we study the subject?

There are many reasons. Even though vitamin B_1 seems at present to exist in sufficient amounts in green plants to permit them to develop satisfactorily without giving them more of it, there are many other vitamins, some as yet unidentified, and we know relatively little of their relations to the growth of green plants. If we search further, we may *perhaps* find a vitamin not made by green plants in large enough quantity for their maximum development—one which when fed to the plant will actually perform part of the miracles our commercially-minded friends have told us could be accomplished with vitamin B_1; but, at present, this seems like a rather long chance.

However, it is quite necessary for us to understand the nutrition of bacteria, yeasts and molds, a good many of which suffer from vitamin deficiencies. These lower plants are most important in causing disease and decay as well as bringing benefits through their relation to fermentation, cheese making and many similar processes. If we wish to control these lower plants—limit their detrimental activities and encourage their beneficial properties—we must understand how they live. For example, the edible morel is one of the most delicious of fungi, far superior to the mushroom we buy in the markets. Yet no one has ever cultivated it. Why? Perhaps it suffers from vitamin deficiencies which have never been properly satisfied by the materials upon which men have tried to grow it.

But even if further research should show that the use of vitamins on plants is of no practical significance, the study of the relation of vitamins to plants is important because of the light it may throw on their uses for animals. Plants have been found to be valuable tools in determining the presence and in estimating the quantity of various vitamins, in indicating how vitamins work in the animal and in leading investigators to the discovery of new vitamins. Pantothenic acid, paraamino-benzoic acid, inositol and biotin were all discovered through their effects on plants before they were known to have any influence on animals.

Entirely aside from the practical importance of using plants to increase our knowledge of a class of substances so important for animals, or of using the substances themselves to influence and modify the development of plants, it should help to reëstablish self-respect in the human race at the present moment in world history, to learn that in certain fundamental ways we resemble the innocent and harmless yeast plant. The same vitamins are concerned in the development of yeast as in the growth of man and they probably perform the same functions in both organisms.

And so science weaves a magic carpet of Bagdad which can carry us over the mountains and through the jungles which once impeded and entangled the footsteps of the seeker for knowledge. Threads from far off China, a bit of material from Java, some from all the world are woven in its woof. There are times when it is necessary to unravel a bit of the weaving unsuited to the pattern, but in the end the carpet is woven, and with its aid you can scale heights which neither Liebig nor Pasteur could surmount.

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Genetics, the Unifying Science in Biology*

George H. Shull

One may be excused for opening a paper on a subject of this kind by several propositions of such obvious validity that their statement is immediately recognized as platitudinous:

There is no wholly unrelated fact; all truth forms a connected fabric of inconceivably vast, indeed of infinite extent. A single observation or any number of single observations between which no connection is recognized may each and all be true, but they do not constitute science. Science consists of a body of knowledge which rests on recognizedly related observations. The relationships between observed facts are so numerous withal, and of so many different kinds that it is utterly impossible for any single individual to apprehend and comprehend more than a minute fraction of all that it is possible to know.

It has been inevitable that the curiosity, that has led men to make systematic observations in order to add new facts related to those in which their interest has been already aroused, has resulted in the sampling of many different parts of the network of observable phenomena and ascertainable relationships. Nature presents many different kinds of objects on which observations can be made, and among which relationships may be obviously present or may be discovered if sufficient attention be given to them. With so many different kinds of objects and different directions of approach there has arisen a bewildering multiplicity of scientific disciplines, which, notwithstanding their obvious overlapping and marginal merging with one another, have tended inevitably to obscure the congruity of all facts and relationships in a limitless universe.

Of the observations, cogitations, inductive and deductive reasoning in prehistoric times we know nothing but there is no reason to doubt that the human mind exercised itself in all these ways just as it does today. The history of biological science usually starts with the marvelously comprehensive work of Aristotle, but there must have been many pre-Aristotelians of exceptional intellectual capacity, whose intellectual acumen and keener-than-average powers of observation gave them high quality as individual "natural philosophers," but who, because of the lack of ready means of record and of intercommunication, made no permanent impression on subsequent progress of human knowledge and whose very existence can be only a matter of conjecture; they were the "mute, inglorious Miltons" of biological science, of whom only a few fragmentary records, if any, remain.

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With the rise of recorded science came also authoritarianism,—the establishment of *"schools"* consisting of the students and followers of individual observers, thinkers and teachers. Such groups of disciples did not as a rule become independent observers, nor independent thinkers. Rather were they simple protagonists of the theories of their leaders and disputatious opponents of the divergent views of other leaders.

Not until the coming of the Renaissance, and the development of the printing-press, cheapening and making more effective the process of permanent record and of intercommunication, could there be the accumulation of the observations and of philosophical concepts and theories of many individuals which gradually built up the diversification of knowledge which characterizes the field of science as we know it today. Along with this accumulation of recorded fact and theory, arose the competitive spirit, the checking and rechecking of hypotheses by new observation, the winnowing of truth from the chaff of fallacy.

The scientific field has been enlarged by bringing new objects under observation, through exploration and importation of materials from geographical areas of ever increasing extent. Also the invention of new instruments of research—the microscope, microtome, centrifuge, galvanometer, potentiometer, Crooks tube, cyclotron, electron microscope,—and the discovery of new effective chemicals, such as indole acetic acid, thiamin, colchicine, etc., have made possible new analyses and the perception of new relationships not previously recognized. Similar expansion has come from the discovery of exceptionally favorable research organisms and structures, as, for example, the mutation phenomena, the chromosome circles, and lethal factors of *Oenothera;* the regenerative capacity and tolerance of transplantation in Amphibians; the almost limitless genetical and cytological advantages of *Drosophila* for studies on the relations between genes and chromosomes; the effectiveness of the coleoptiles of *Avena* for the recognition of growth-promoting substances; and many others. All of these have brought about so great an expansion of the field of biological science that ever closer specialization is required in order to make further progress. This situation has been long recognized and jokingly referred to as "learning more and more about less and less."

So much for the expansion and diversification of biological science. As a result the science of biology has been divided into a very large number of separate branches, now commonly referred to as the plant sciences and the animal sciences, plus those which relate about equally to both plants and animals, such as general or cellular biology, ecology, and genetics.

The specialists working in each of these biological fields have found it advantageous to organize special societies for the holding of periodical meetings and for the support of adequate means of record and publication of their discoveries.

The simplest type of scientific activity is the naming and classification of natural objects, and the first taxonomist of whom we have record was Adam, who, according to the Biblical account, had all the plants and animals of the Garden of Eden brought before him to receive their names. How natural that the reawakening of human intelligence in the Renaissance should have been characterized by the rise of taxonomy, the "mother" of all the biological sciences! A very substantial contribution to the unification of the biological sciences was the adoption of the binomial system of nomenclature and its very extensive applications to both plants and animals by Carl Linné in the middle of the 18th century.

The more philosophical phases of classification which came to recognize natural relationships between genera, between families, and between groups of still higher order developed more gradually and at the hands of an ever increasing number of workers, both zoologists and botanists. On both sides it was soon recognized that in one important corner of the taxonomic field plant taxonomy and animal taxonomy overlap each other, so that *Euglena,* the Myxomycetes *alias* Mycetozoa, and the Volvocineae, for example, have been equally claimed by both plant and animal taxonomists.

Another discovery of the greatest importance for the unification of biological science was the recognition, independently and then jointly arrived at by Schleiden and Schwann in 1839, that both plant and animal bodies are made up of cells and substances and structures secreted by cells. This great generalization grew rapidly in importance as refined microscopical technique brought to light ever finer details of intra-cellular organization without finding a single consistent difference between plant and animal cells, either in the structures they contain or in their physiological activities.

These discoveries gave rise to the concept of biology as a single discipline, especially through the writings and teachings of Thomas Huxley, Herbert Spencer, John Tyndall and others. These writers emphasized the many common features of plants and animals, which made possible the stratification of biological knowledge in fields at right angles to the taxonomic line of division between the two Kingdoms; thus tying them together by bonds more natural than the divisions themselves between the Kingdoms. The principles of organography, tissue-differentiations, competition and cooperation of parts, specialization of tissues and the accompanying division of labor are equally applicable to and derivable from plants and animals, as are all the fundamental physiological processes, like nutrition, assimilation, growth, respiration, excretion and reproduction.

With the development of the evolution hypothesis in the first half of the last century and its gradual acceptance by all biologists, the fact that so many major fields of biology could bring supporting evidence, gave a still stronger bond of unity among the several branches of biological science. Taxonomy, comparative anatomy, embryology and paleontology were the chief sources of this supporting evidence.

It remained to secure convincing evidence of the evolutionary processes from actual experimentation, and here we can not over-stress the indebtedness of the entire biological world to that great genius of simplicity, philosophical outlook, penetrating vision and energetic persistent labor, Hugo de Vries, whose work more than that of any other individual ushered in a new era in biological science and philosophy. Thus was born the new experimental science appropriately called for a time "experimental evolution," but felicitously christened by William Bateson in 1906, the science of "Genetics." Inter-relationships of plant groups and of animal groups took on a new and more fundamental meaning when analyzed by the simple means provided by the experiments of Mendel and De Vries. There came in this way a clarification of concepts, and the possibility of brushing aside fallacious doctrines and their replacement by experimentally tested facts.

From another direction came independently another fundamental element of genetical technology. Contemporaneous with the work of Mendel and of De Vries was the statistical attack on problems of evolution, brilliantly conceived and put into practice by Sir Francis Galton, a cousin of Charles Darwin. This was the technique of the mathematical analysis of populations later denominated "Biometry."

Although Galton's conclusions seemed at first to be at variance with the discoveries of Mendel, the work of the genial and brilliant Danish plant physiologist, W. Johannsen, on pure-lines and populations in beans disclosed the nature of the discrepancy and brought complete harmony between the observations of Galton and those of Mendel and thus helped to establish biometry as one of the fundamental biological techniques. The tool thus developed for the handling of population problems may be considered not the least of the contributions which genetics has made to the other sciences, most of which tend to become more and more statistical as their stores of basic materials grow in magnitude and diversity.

One of the most important discoveries which resulted from the experiments of De Vries was the demonstration that variations, which Darwin had taken for granted and had assumed to be more or less generally transmitted from parents to offspring, are of two kinds. Some are completely inherited and remain permanent elements of organization in subsequent generations while others are non-inheritable and promptly disappear from subsequent generations. This important differentiation of variations into inherited and non-inherited, respectively designated "mutations" and "fluctuations," was beautifully and convincingly confirmed by Johannsen, whose keen analytical mind gave the new science of genetics its sharply accurate terminology. Inherited variations involve permanent changes in the genotype while the impermanent ones involve changes in reaction of this permanent genotype under changed environmental experiences. Only genotypic changes can have immediate and direct importance for evolutionary progress, although the capacity of a single genotype to react in different ways in response to changed environments may be of crucial importance in determining the survival of the genotype in question in relation to its competitors in the "struggle for existence."

Because of certain technical advantages of plants for genetical studies, especially the facility they have for self-fertilization, Mendel's laws were worked out with garden peas, and all of the three nearly simultaneously published papers of De Vries, Correns and Tschermak were based on experiments with plants; but work by L. Cuenot with mice, of Bateson and his distinguished coterie of collaborators with poultry and canaries, of Long with snails, of Castle with guinea-pigs, rats and rabbits and Davenport with poultry, canaries and with studies of human families, quickly showed that animals as well as plants follow identical patterns of genetical behavior.

The simplicity of the pedigree-culture methods and the fundamental importance of the facts and principles to be derived from the utilization of these methods, resulted in a very prompt participation of many investigators who in many cases abandoned for the time being the important fields of their previous interest to become the founders of the science of Genetics as we know it today. I have already mentioned in this connection the plant physiologist Johannsen and the animal morphologist and comparative anatomist Bateson. To these should be added the statisticians, Galton, Pearson and Davenport, embryologists such as Morgan and Conklin, and cytologists like E. B. Wilson, C. E. McClung and Calvin Bridges, to mention only a few of the more outstanding examples.

In this way there has grown a body of knowledge of plant and animal organization of astounding magnitude in the brief period of four decades. There has also been demonstrated a meticulous consistency of all of the phenomena which have been brought to light by these methods applied to both plants and animals. This consistency stresses a closeness of kinship of all living things, which hardly could have been dreamed of before the demonstration of the genes as the elements of organization of living matter.

The genetical approach has served to bring into harmony many phenomena of plant and animal organization and behavior which previously had had seemingly few points in common. For example the whole field of sex relationship has been greatly clarified through recognition of its basic relationship to genetical phenomena. Mendelian heredity was soon recognized as the product of the two critical phenomena which lie at the base of all sex, namely, the phenomena of diploidization through the union of egg and sperm, and haploidization brought about by meiosis, the "reduction division." The unfortunate confusion of terminology in botanical and zoological literature in relation to sex phenomena is still only partially resolved but there can be little doubt that a common and concordant terminology will be ultimately achieved through the influence of genetical considerations. The confusion began when botanists took over the sex terms which had been long applied by zoologists and by laymen,—by the botanists themselves,—in regard to diploid animals and applied them to the haploid generation in plants which has no counterpart in animals.

To achieve complete harmony it is necessary only to limit the concept of sex-homologies between plants and animals, to the diploid generation of plants, since it is the "sporophyte" of the higher plants that manifests Mendelian phenomena in exact agreement with those exhibited by the bodies of animals. The situation becomès clear if we take as the starting point for a comparison of the life-cycle of plants and animals the moment of union between egg and sperm. This brings the diploid resting-spore of the Chlorophyceae into a position of homology with the body of an animal, and leads to recognition of the fact that the fundamental difference between embryophytes and animals is the fact that in the former, the ootids (megaspores) and the spermatids (microspores) develop parthenogenetically to form respectively the female and male gametophyte generations, whereas in animals they are converted as a rule directly into eggs and sperms.

The closest relationship of genetics with the other biological disciplines is that between genetics and cytology. Before the birth of genetics, cytology had its major outlook directed toward comparative embryology. With the specific recognition of the chromosomes as the determining mechanism of the Mendelian phenomena, it has become obvious that cytology and genetics jointly constitute the biology of the chromosome. Cytology represents the morphological phase and genetics the physiological phase of the inheriting mechanism, but the relationship is so close that it is frequently indicated by the use of the term "cytogenetics" for this very fundamental scientific discipline.

In all other branches of biological science,—taxonomical, morphological, physiological, sociological, psychological,—the fact is of fundamental significance that genes constitute the basic material with which the researches in these several fields must deal. The origin and distribution of genes generally follow a pattern of very great simplicity which must be taken into account in laying out programs of experimentation, in analyzing the results of such experiments, and in drawing tenable conclusions from them. Genetics, the science of kinship, thus knits together, even to the most intimate details of basic organization, the organisms with which every phase of biological science deals, and strongly emphasizes the inherent kinship of all branches of biology.

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Criteria for the Indication of Center of Origin in Plant Geographical Studies*

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When the flora or fauna of any region is considered taxonomically or geographically, it becames apparent that it bears relationships with surrounding regions. The taxonomist, phylogeneticist (if he be different from a taxonomist), and the geographer are inevitably confronted by problems of origin and migration.

Forty years ago Charles C. Adams published a pioneer series of papers on postglacial dispersal of biota in North America (Adams, 1902a, 1902b, 1905, etc.), outstanding in their conception of process in biogeography. In one of these papers Adams (1902a) listed 10 criteria for the determination of centers of origin, and they were later reiterated (Adams, 1909) with further comments. Insofar as I know, these criteria have never been critically analyzed, although the concept of center of origin has been attacked by Kinsey (1936). Rather, they have been largely accepted without question, despite the lack of substantiating data in some cases, and have been variously and somewhat loosely employed. It is time for an appraisal: thus it is the purpose of this paper to review these criteria in the light of more recent contributions to the science of plant geography. Findings in the field of genetics, in particular, and in the study of wild populations supply reasons why certain of the criteria can not be tacitly accepted.

The concept of center itself should be broken down into its various implications. (1) *Center of origin* refers only to the region in which a population or a phyletic stock had its origin in an evolutionary sense. (2) *Center of dispersal* coincides with the center of origin only for the original members of a group. (3) *Center of variation* is the region where there is the largest number of biotypes within a species, species within a section, etc. (4) *Center of frequency* refers to the area with the densest population of the kind or kinds under consideration. (5) *Center of preservation* is an area where, usually, several species of a flora have survived a generally unfavorable change of environment. These are the epibiotic or relic members of the flora of a region. The differences among these centers are not always apparent in the literature.

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This paper has been shortened due to the space limitations of the Journal. A fuller treatment of these problems may be sought in the author's "Foundations of Plant Geography," to be published by Harper and Brothers.

The literature of plant and animal geography, taxonomy, and evolution is replete with statements concerning the center of origin of certain species, species groups, genera, etc. For example, Babcock and Stebbins (1937) say, "The distribution of the genus *Youngia* taken as a whole is entirely consistent with the conception that it is a natural group which had its origin in southeastern Asia and that evolution has been accompanied by extension of the geographic range." On the other hand, some species, as recognized by taxonomists, may not have had a center of origin in the sense of a restricted geographic spot where they arose. For example, Gleason (1923) states:

" . . . Probably if a complete series of specimens were at hand, showing comprehensively the maples of the eastern states, for example, from the Pliocene to the present time, it would be seen that some of the earlier forms are absolutely continuous with our present species and that the slight morphological distinctions between them are only the result of continuous slow variations throughout the centuries. According to this view, many modern species had no localized origin and are not the off shoot of any parent, but represent the mass development of a species, which, under our present taxonomic ideas, came to a stop at the beginning of a break in our geological record of it and reappeared as a new species at the beginning of our next experience with it."

A different situation is emphasized by Kinsey (1936), who denies both the usefulness and the truth of the concept of center of origin. He demonstrates through his taxonomic work with the gall wasps that species differ by many genic factors that have been added gradually to the population as it has migrated. Some of the characters of a species have been added in one place, and others in other places, and certain gene frequencies have increased with isolation resulting from migration. Where, then, is the center of origin? I think it would be begging the question to say that the center of origin of a species is where the genic factor or factors causing reproductive isolation arose.

Two other situations can be mentioned in which, in the strictest sense, there is no single center of origin. Chromosome (genom) doubling may happen many times in many places in a diploid population. The resulting autotetraploids, which may be a good species, do not necessarily have a center of origin other than the area of the entire progenitor diploid population. The map of Baldwin (1941) showing the chromosome races at *Galax aphylla* is of interest in this connection. Also, it is becoming increasingly apparent that many plant species are of hybrid origin. Sometimes a swarm of diploid hybrids, segregates, and backcrosses have attained a sufficiently distinct character and area that their population has been given specific status, distinct from the original species. At other times polyploid complexes develop. Stebbins (1940) says, "Dissolution of genetic barriers and exchange of genes between genetic systems that are completely isolated from each other in the diploid condition are made possible by the synthesis of polyploid complexes through allopolyploidy between three, four or more species, following the introduction of genes from all the species concerned." (See also Babcock and Cameron, 1934; Goodspeed and Bradley, 1942.) For example, according to the studies of Camp (1942), *Vaccinium corymbosum* is a tetraploid hybrid complex that has no center of origin in the usual sense. One contributing tetraploid was originally Ozarkian (*V. arkansanum*), one was in the Appalachian upland (*V. simulatum*), and one was of the eastern coastal plain (*V. australe*).

With these qualifications concerning types of centers and with the realization that under certain circumstances there may not be a center of origin, there follows a consideration of the criteria proposed four decades ago by Adams.[1]

Criterion 1. Location of Greatest Differentiation of a Type

With reference to this criterion of center of origin, Adams (1902a) says, "It is a very fundamental law that most forms of life are confined to restricted areas and only a small number have extensive distribution. Thus, from the center of origin there is a constant decrease, or attenuation in the number of forms which have been able to depart far from the original home."

This criterion is legitimate and applicable if we make two assumptions. In the first place, the basic assumption underlying the whole thesis is that there is a center of origin for a phyletic stock. This has already been discussed in the introduction. The other assumption is that there is a time relationship in evolution, that polymorphism increases with time; and that there is an age-and-area relationship, that with age the population of a species or other group tends to increase and occupy a wider area. In this connection see Willis (1922, 1940) and the numerous expert criticisms of his hypothesis. If we can accept these assumptions, it is clear that there will tend to be more polymorphism in the region of origin of a phyletic stock than away from this center. In such a region there will be more forms (biotypes, subspecies, species, sections, etc.) because of the longer time in which evolution has been occurring in the steadily increasing numbers of different kinds. With time, some of the forms originating in the central region will attain wider areas. They, in turn, may give rise to new forms away from the center, but in the nature of the relationship, the original area will tend to exceed any derived peripheral area in the number of kinds represented.

[1] I wish it understood that the evaluation of them is in no way a specific attack on Adams' paper, which was breaking new ground at that time, but is rather a criticism of the present day employment of these rules without evaluation of them in the light of more modern knowledge, and recognition of their limitations. As a matter of fact, by 1909 Adams was careful to point out that he understood the criteria to be only "convenient classes of evidence to which we may turn . . . It should be clearly emphasized that it is the convergence of evidence from many criteria which must be the final test in the determination of origins . . . "

A few quotations will illustrate this point. Payson (1922) says, "There is much evidence for believing that *Lesquerella* originated at some point in Central Texas and from this point as a center has spread over the large area that it now occupies . . . From purely theoretical standpoints also, the greatest number of species might be expected to occur in the vicinity of the point of origin, since there the genus would have existed for the longest period of time." In a recent publication on *Ceanothus,* Mason (1942) says, "The occurrence of many isolated local species along the coast as against a few widespread species of the interior would indicate that the direction of the *Ceanothus* migration was from the coast to the interior."

Another example of the use of this criterion, which also is admirably supported by phylogenetic and geological data, is the study of *Gaylussacia* by Camp (1941). He says, "it becomes apparent that the genus arose in South America for there, today, we find it as a series of interlocked species-groups still differentiating out of a common plexus, only three of which have given representative members to North America." The work of Szymkiewicz (1937) indicates a concentration of Mediterranean species of various genera, especially endemic species, in western Mediterranean regions. One example of this type will be sufficient. Širjaev (1934) has carefully mapped the distribution of the members of the Mediterranean genus *Ononis* and makes the following statement concerning center of origin: "Das Entstehungszentrum der Gattung (*Ononis*) war wahrscheinlich auf der Iberischen Halbinsel und im nordwestlichen. Mediterranen Afrika, wo jetzt noch alle Subsektionen und viele endemische und fast alle älteren Arten sich konzentrieren, während im ostlichen Teile des Mediterraneums keine eigene Subsektion und nur drei endemische Arten anzutreffen sind . . . Die Migration aus dem Entstehungszentrum fand in verschiedenen Epochen auf verschiedenen Wegen Statt." The investigations of Van Steenis (1934-1936) on isoflors (lines connecting regions of equal numbers of species in a genus) offer another method in which a strong indication of center of origin is obtained. Perhaps the most intensive studies of plants and their centers ever made are those of Vavilov (1940) and his colleagues. The following quotation is pertinent:

"Cultivated species as well as their closely allied wild relatives in their evolution, during the course of their distribution from the primary centers of species-formation, have been differentiated into definite ecological and geographical groups . . . Primary regions are at present characterized, as a rule, by the presence of many different species (in the sense of Linnaeus). They reveal practically the entire systems of genera."

It is necessary, however, to recognize that this criterion can not be accepted as universal, for it only describes a tendency that, under certain conditions, is counteracted by the operation of other factors, as is also true of age-and-area. A few of these conditions will be described.

Requirements for the development of many species are either that the forms are allopatric and have geographic isolation or, if sympatric, that they have some form of genetic (internal) reproductive isolation. Regions in which there are many closely related species are usually regions of habitat diversity, as noted by Vavilov (1940). It is entirely possible then that a phyletic stock that has had its origin elsewhere may, through migration, encounter a region in which there are numerous available ecological niches that are unsaturated—that is, in which competition pressure is low. Such a region may provide a variety of habitats with at least partial isolation. Under these conditions a phyletic stock may show a "burst" of evolutionary radiation. It is apparent that such a region of polymorphism is not necessarily indicative of the original center of origin nor of dispersal, but is a fortuitously derived secondary center of differentiation. Two more examples of this general type can be taken from Fernald's (1926) criticism of age-and-area. He uses the conclusions of Schonland (1924) concerning *Erica,* which has nearly one thousand species in South Africa. There is not a single known fact that indicates that the genus arose in South Africa where there are the most endemics and the greatest diversity (species and sections). Furthermore, Willis had concluded that the number of endemics in any genus would rise gradually to a maximum at or near the point where the genus entered a land area, or where a genus had its center of origin. Of this corollary of age-and-area Schonland (1924) says, "Applying this prediction to the genus *Erica* in South Africa, this point would be a part of Southwest Cape Colony west of George, where not only a large number of endemics are massed, but where, moreover, the greatest diversity owing to formation of subgenera and derived genera is to be found; but I fear no contradiction when I assert that it is certainly not the place where the genus *Erica* entered South Africa, or where it originated."

Further evidence as to the care required in arriving at conclusions concerning geographic problems is illustrated by *Senecio.* J. Small (In Willis, 1922) localizes the evolution of the Composites through *Senecio* in the northern Andes in Upper Cretaceous time, because of the present great expansion of that large genus in the Andean region. *Senecio* in the mountains of tropical America is in the most active stage of maturity, according to Greenman (1925), not because it originated there, but because it is a region geologically young and diversified. Small's and Willis' conclusion regarding *Senecio* rest on what Fernald (1926) gleefully calls a "colossal geological error," because the present great elevation of the Andes, where *Senecio* now has its magnificent development, did not occur until the close of the Tertiary (Pliocene) and the beginning of the Pleistocene. From Schuchert's (1935) recent historical geology, however, it appears that the Cordillera Occidental and the still more western and low Cordillera de Choco of northern South America are more ancient elevated land masses than the central and eastern Andes on which pre-Cenozoric plant developments might well have occurred, and from which much of the modern Andean flora must have been derived.

Another exception to the center of origin being where the greatest differentiation of a type exists is that resulting from polyploid complexes. Polyploidy tends to break down genetic barriers between species with a resultant production of a large number of varieties and species (Stebbins, 1940). Examples of such complexes include *Crepis, Zauschneria, Rosa, Rubus,* and sections of *Potentilla, Antennaria,* and *Taraxacum,* and dysploidy may increase the intricacy of the complex. Goodspeed and Bradley (1942) note the conclusion of Kostoff (1938) that amphidiploids from F_1 hybrids may give rise to monomorphic species, but in other cases, if a series of segregated forms can survive, a polymorphic species is produced. Inconstant amphidiploidy may originate a series of adaptable forms and provide suitable material for natural selection. In every case, according to Stebbins, the majority of the basic diploids are relatively restricted in area, while most of the widespread types are polyploid. He says, "The center of distribution of the diploid species of a polyploid complex is naturally the center of variation of the complex as a whole . . . the diploids tend to occupy the older, more stable habitats. This makes the study of polyploid complexes very important from the standpoint of plant geography." Such centers of variation as are due to hybridization and polyploidy may develop at the center of origin of a genus, but that is not necessarily the case. The American species of *Crepis* have such a center in the Pacific Northwest, but the stock immigrated from the Asiatic center of the genus (Babcock and Stebbins, 1938).

A third type of exception to the criterion consists of such phylogenetic stocks as have developed a center of variation at the center of origin, in the orthodox manner, but which have suffered a decimation of the group at the center as a result of physiographic and climatic changes. Through emigration and extinction due to climatic and physiographic changes the variety of types may be reduced in one region so that a secondary center comes to contain more variety.

Hultén (1937) has also come to the conclusion that "it must . . . be unsafe to assume that a plant originates in the place where it has its most numerous relatives. In most cases such a consideration will perhaps be correct, but in others it must be misleading." He illustrates this point by reference to old, widespread, arctic-montane species. "It is natural therefore that in different parts of the area of a Linnaean species considerably differentiated races should be found. The area has repeatedly been split up, during the glacials under the influence of a cold climate in the north and a pluvial one in the south, and during the interglacials under the influence of drought and heat. Each of these agencies must have caused a selection of biotypes in its particular direction . . .

The idea is current that a district in which a plant shows much variation or has many closely related species must be its original home. According to the above point of view this would only mean that the plant has been present within the district for a comparatively long time and has developed in different directions under the pressure of varying conditions there . . . The similarity or dissimilarity of two types alone will hardly be able to settle discussions concerning relationship between them." This latter conclusion is arrived at by Hultén because of the complication resulting from "parallel selection" of biotypes by separated but climatically similar regions.

We have seen that the location of greatest differentiation of a type may be at the center of origin of the group and, also, that the criterion can not be uncritically applied for a number of reasons.

Criterion 2. Location of Dominance or Greatest Abundance of Individuals

In connection with this criterion it first is necessary to note that dominance is a matter of the control of a community through reaction and coaction, and abundance is only a matter of numbers of individuals. It is true that certain forms may exert dominance through mere numbers, and that is possibly more frequent among plants than animals, but often it is true that less abundant forms are dominants by virtue of their life-form or strong actions.

Species that are dominants in a certain community (and there are usually not very many such species relative to the floristic composition of the community as a whole) usually range more widely than the area of the community. For example, beech, sugar maple, hemlock, and yellow birch all range more widely than the northern hardwood climax association in which they are codominants. It seems to me that dominance for a species can have no meaning except in terms of community dynamics. If, however, we consider a genus, there may be some instances in which the regions where certain species are community dominants or codominants are also the regions where there is a large concentration of species of the genus. This appears to be true for *Quercus* and *Hicoria* in the Ozark and Cumberland regions. Even here, however, a different interpretation is likely. These are ancient land areas in which evolution has long been going on and the numbers of species and their dominance may be unrelated phenomena, and also unrelated to center of origin.

The center of greatest abundance of individuals, center of frequency, has a special meaning only in connection with the distribution of the members of a population, a subspecies, a species, etc. The assumption that the center of abundance is also the center of origin for the type has to be based, it seems to me, on an hypothesis that the species arose in the habitat where it is best capable of abundant reproduction and establishment. This is a gratuitous assumption.

It is reasonable that, with migration from the center of origin, a species population may encounter more favorable conditions than those that prevailed where it arose. Hultén (1937) says concerning the "mass center" hypothesis, "Christ and other authors considered that a plant is likely to have originated in a district where its most numerous individuals are now found. Heer already opposed this view. It is natural that if a plant at the border of its perhaps wide original area should find favourable conditions and multiply freely, so that numerous individuals are developed, such a phenomenon will afford no indication of the earlier history of the species." Such cases are apparently found in certain weedy species of *Tradescantia* that have obtained wide areas and relatively high abundance in the eastern grassland and agricultural areas (Anderson and Woodson, 1935). Also, as with criterion 1, we can conceive of climatic deterioriation causing a reduction in numbers of individuals at the center of origin.

Shreve (1937) has pointed out that shrubs of the Sonoran desert with hard wood, sparse branching, and determinate growth (*Cassia, Mimosa, Acacia, Croton, Karwinskia, Caesalpinia, Lysiloma, Bauhinia, Acalypha,* etc.) belong to genera which are well represented in the thorn-forest, both with respect to numbers of species and abundance of individuals. Furthermore, distributional data indicate that this type has spread from the thorn-forest into the desert. However, Shreve (1934) has clearly shown for *Larrea tridentata* and *Franseria dumosa* what is probably a widespread relationship—that variations in plant size and abundance, and degree of dominance are correlated with environmental conditions, and not with the center of origin.

It is of interest to inquire further into certain characteristics of the distribution of individual plants. Gleason (1925) has studied this matter statistically and concluded that environmental differences are not of sufficient magnitude to affect the distribution of the species within an association, and that the number of individuals of a species, other things being equal, is an index to its adaptation to the environment. But what, we may ask, is the behavior of the species outside its native association, or at the margin of its range? When the area of a population of a new species or subspecies is expanding from its center of origin, and when natural barriers have not yet established a boundary, there will naturally be a centrifugal decrease of density. This would seem to be an inevitable result of numbers and random dispersal, and to provide a case in which the criterion is true. Let us assume, however, that a species population has extended its area to its maximum, having met barriers of one sort or another on all sides. Under these conditions it would seem that there would be a tendency for a greater density of individuals to exist toward the center of area because of a central harmony between ecological requirements and ecological conditions. Everywhere outside of this central "typical" climatic region to which the species is adapted there will be, for it, a progressive deterioriation of the climatic type. That is, in marginal regions of the climatic type where it begins to grade into another climatic type, there will be fewer and fewer suitable spots for the species. Of necessity, if this picture be true, the density of the species will tend to decrease toward the periphery. Some interesting data concerning the behavior of species at the margin of range have been published by Griggs (1914) on the Sugar Grove district of southern Ohio. He says, "It is clear . . . that in this region the species in which the individuals become scarcer and scarcer until it fails altogether is exceptional." Certain species are approximately continuous up to the margins of their range, but others are increasingly discontinuous until they are characteristically disjunct, and sometimes widely so, in the peripheral portion of their areas.

In the light of these data, it would seem that the criterion of species dominance and density is by no means an infallible guide to center of origin. Dominance and density are frequently highly irrelevant in this respect.

Criterion 3. Location of Synthetic or Closely Related Forms

From the context and through correspondence I find that by "synthetic" is meant generalized or primitive forms of a phyletic group. With this half of the criterion we can have no quarrel this far: the most primitive form or forms of a group certainly arose somewhere, and wherever that was, there is the center of origin of the group. To ascertain that center, after a group has had a long history, is, however, another matter.

It is frequently claimed that the center of origin for a group is where the earliest fossil forms have been found, whether or not the group is represented there today. For example, it has been claimed that the shell family Pleuroceridae had a western origin because its earliest record is from the Laramie formation (Colorado, etc.). Adams (1915), however, concluded that the family, and especially *Io,* had a southeastern origin centering in eastern Tennessee despite the absence of substantiating fossils.

There are two diametrically opposed views. The most widely accepted view is that the most primitive members of a group are still to be found at or near the center of origin of the group. This is frequently true because most of our temperate genera date back to the Cretaceous or early Tertiary and their primitive forms are frequently found concentrated in the old land areas. In the United States, for example, such ancient land masses with primitive species (Gleason, 1923) include the Southern Appalachian center, the Cumberland and Ozark center, the prairie center of Nebraska, Kansas, and eastern Colorado, the southwestern desert center, etc. In a study of *Lesquerella,* Payson (1922) concluded that the center of origin of the genus was in the old land area of central Texas where "not only are these species primitive, but in no other locality may be found anything like an equal display of what have been considered ancestral characteristics for purely morphological reasons . . . The periphery in general is bounded by highly specialized members of the genus."

The opposite view concerning the location of primitive species of a group is that the primitive forms are to be found at the periphery of area because they have been crowded from the center by the younger and more aggressive members of the group. The employment of such a criterion as this depends in part upon the validity of taxonomic criteria for the indication of primitiveness. Many of these criteria (as enunciated for botanists by Bessey, and others) themselves deserve critical analysis.

One of the most skillful proponents of the view that primitive forms are peripheral is Matthew (1939). The following quotations from "Climate and Evolution" (pp. 10, 11, 31, 32) reveal his hypothesis which is extensively documented by vertebrate paleontology and phylogenetics, but not universally accepted.

"Whatever agencies may be assigned as the cause of evolution of a race, it should be at first most progressive at its point of original dispersal, and it will continue this progress at that point in response to whatever stimulus originally caused it and spread out in successive waves of migration, each wave a stage higher than the previous one. At any one time, therefore, the most advanced stages should be nearest the center of dispersal (original), the most conservative stages farthest from it . . . to assume that the present habitat of the most generalized members of a group, or the region where it is now most abundant, is the center from which its migrations took place in former times appears to me wholly illogical and, if applied to the higher animals as it has been to fishes and invertebrates, it would lead to results absolutely at variance with the known facts of the geological record . . . The successive steps in the progress must appear first in some comparatively limited region, and from that region the new forms must spread out, displacing the old and driving them before them into more distant regions. Whatever be the causes of evolution, we must expect them to act with maximum force in some one region; and so long as the evolution is progressing steadily in one direction, we should expect them to continue to act with maximum force in that region. This point will be the center of dispersal of the race. At any period, the most advanced and progressive species of the race will be those inhabiting that region; the most primitive and unprogressive species will be those remote from this center."

Cytogenetics is providing a body of information for several groups that points undeniably toward the forms that are primitive in a group. One example of this type will be sufficient. Anderson (1937) says, "In those species which have both diploid and tetraploid races we . . . know that the tetraploids must have originated from the diploids." Tetraploid *Tradescantia occidentalis* ranges throughout the Great Plains and the eastern Rocky Mountains, and has a small diploid area in central and eastern Texas. Tetraploid *T. canaliculata* occupies a wide area in the Mississippi Valley, and is diploid in the same territory in

Texas. Also, *T. hirsutiflora* and *T. ozarkana* exhibit the same tendency. The combination of cytology with geological history and taxonomy suggests very strongly that the Edwards Plateau area of central Texas was the immediate center from which the American tradescantias have developed in comparatively recent times.

With respect to the other point of the criterion, it can be said that closely related forms can come to be located almost anywhere within the generic area. The nearest relative of any form, however, will tend to be near by, at least at first, because of the filial relationship between them. According to Kinsey (1936), the picture of evolution is that of a simple or infrequently branching chain. In this chain each species is a derivative of a previously existing species, usually without extermination of the parental species.

When one looks at a large family of plants, it is apparent that it is not everywhere equally well developed or rich. A certain tribe composing, say, 10 per cent of the family, may in one region constitute 30 or 40 per cent or more of the family. This phenomenon is likely true for the other tribes. Such regions of differentiation are likely regions of speciation or origin, except where, for historical reasons, they are known to be regions of preservation. I can not see, however, that closeness of relationship among species can ever be employed as a criterion to indicate the geographic center of origin of a group without the aid of other facts. We can only say that primitive and closely related forms may or may not be at the center of origin.

Criterion 4. Location of Maximum Size of Individuals

In a discussion of evolution of species through climatic conditions, Allen (1905) reiterates some "laws" stated by him in 1882: (1) the maximum physical development of the individual is attained where the conditions of environment are most favorable to the life of the species; (2) the largest species of a group (genus, sub-family, or family) are found where the group to which they severally belong reaches its highest development, or where it has what may be termed its center of distribution.

These conclusions were reached from the observation that "in the northern hemisphere, in nearly all types of both birds and mammals of obviously northern origin, there is a gradual decrease in the general size from the north southward in the representatives of a conspecific group . . . " Later on he says, "The variation in size from north southward is as gradual and continuous as the transition in climatic conditions."

It seems to me that within these statements, employed by Adams and others, the "cat is out of the bag." In the first place, size is a specific character that may not be related to environment. Size differences may be due to biotype selection across a climatic gradient, or to phenotypic expression. Allen's statements concerning size and favorableness of environment are generally correct, but there is no necessary relationship between size and center of origin or center of distribution. It would seem that geographic trends in adaptive characters are usually nothing more than the *clines* of Huxley (1940). Allen's statements were questioned by Cockerell (1906) who said, "I found in that genus (*Hymenoxys chrysanthemoides*) a case which seemed to me to exactly agree with those postulated by Dr. Allen, except that the large form was southern, the small one northern." To take another case, it is a common observation among botanists that plants on oceanic islands, such as the Azores, Canaries, and the Galapagos, are frequently of larger stature than their relatives on the mainlands from which they were derived. This larger size of herbs, shrubs, and trees would seem to be related to the long growing season, rather than to any hypothetical indication of their island origin.

I have tried to find an authentic case among plants either in favor of the criterion or opposed to it in which the data are adequate, but have failed to do so. The following notes are only suggestive. *Prosopis,* for example, attains its largest size (height of about 50 ft.) in the Rio Grande valley, where the genus is near its periphery. Shreve (1936) says, "It is only in the most favorable situations that the mesquite is found as a tree. In less favorable ones it is merely a shrub." The genus, however, is taxonomically complicated (Benson, 1941) and has had a long and obscure history as indicated by its split range, being in the South American deserts as well as in Mexico and our Southwest. It is therefore impossible to be very certain concerning the history of its area. The Southern Appalachians are becoming famous for their large trees as the region is better known. The largest single specimens known of *Picea rubens, Tsuga canadensis, Aesculus octandra, Tulipastrum acuminatum,* and several others, are found localized in the Great Smoky Mountains, but there is no evidence to indicate the origin of these species in that region.

One situation in which the tendency is opposite to the criterion has been shown by cytology. Autotetraploids, and sometimes allotetraploids, are larger than their progenitor diploids. Furthermore, they have a strong tendency to extend the range of the group and to occupy peripheral positions relative to the diploids. (Anderson and Sax, 1936; Babcock and Stebbins, 1938.)

Criterion 5. Location of Greatest Productiveness and its Relative Stability in Crops

From Adams' comments, it appears that he considers productiveness to be closely related to size and numbers, and essentially a matter of growth and reproduction. According to Adams, Hyde (1898) concluded that crop production, whether it averages high or low, will tend to be more uniform from year to year in the region where the crop is indigenous, and that the variability from year to year increases with departure from that center.[2] In the first place, note that Hyde indicates that the crop production is not necessarily high at the region of center, or where the crop is indigenous, but only that it is uniform from year to year. This does not fit well with criteria two and four. Furthermore, it does not appear that the term "indigenous" is employed in its strict meaning of being "native," but in a more general meaning of being "at home" in the sense of being well adapted. It is, of course, well known that crop production shows the greatest stability from year to year in climatic areas to which it is best adapted. This phenomenon appears to have nothing to do with center of origin of the crop (Vavilov, 1928, 1940), but is explained by weather and the operation of limiting factors (Taylor, 1934).

Criterion 6. Continuity and Convergence of Lines of Dispersal

When the species of a genus or higher category are distributed along natural highways of migration, and when these highways converge on a certain area, the distributional pattern suggests that the region of convergence of these routes is the center of origin and dispersal. This suggestion is even stronger when, as is usually the case, unrelated organisms show the same pattern. There is, however, no *a priori* reason considering dispersal lines alone why migrations need have been divergent from the apparent center rather than convergent on it. It is usually not difficult, however, to obtain evidence (see criterion eight) as to which direction the migrations took. Such evidence is largely obtained from comparative morphology and relationships. Sometimes paleontological evidence helps indicate the direction of migration. In other cases cytogenetical analysis of the related forms reveals without doubt the direction which the movement has taken. Migratory tracts are merely lines (however broad) of frequent, suitable habitats, and are not necessarily one-way routes. As expressed, and by itself, the criterion is not valid.

Criterion 7. Location of Least Dependence upon a Restricted Habitat

The use of this criterion for the indication of center of origin depends upon a species being more polymorphic at the center of origin (Criterion 1) or upon more primitive forms having wider tolerances than derived forms. Both of these conditions may not be true. A wide species contains a very large number of biotypes, perhaps many thousands (Turesson, 1925, 1932; DuRietz, 1930). Progressively from the center of origin, and especially along narrow migratory tracts extending from the main area, there is a biotype depauperization. This can result from partial isolation due to distance alone. A remote portion of a population does not in practice, even if in theory, have access to the entire

[2] Recent investigations are summarized by Klages (1942).

stock of genes of the species as a whole. When a species is divided into geographic subspecies and ecotypes, these conditions probably apply to them also, but less obviously. No species is completely panmictic.

On a basis of the Law of Tolerance (Good, 1931), it is concluded that each individual organism can live only within the inherent limits of its tolerances for the environment, and the tolerances of a species is the sum of the tolerances of the component individuals of the species population. Now it seems to me that this summation of Good's can have no real meaning for an individual. No individual can contain (inherit) all the genic variability of the population, although in a panmictic population any individual might theoretically contain any possible pair of allelomorphic genes. In many cases it is an observed fact that morphological polymorphism decreases away from the center of area of a species or subspecies. Although it is more difficult to demonstrate, it is reasonable to assume that individual members of a species differ as much physiologically as they do morphologically. In fact, it seems entirely likely that adaptation and ecological amplitude reside more in unseen features than in the characters of the type usually employed in systematic studies. Both, of course, ultimately result from the genic constitution of the individuals, and may be linked. In this connection Hiesey, Clausen and Keck (1942) say, "Within populations, hereditary variants occur, some of which may possess physiological qualities that give them the potential capacity to survive in different kinds of places. Other variations seem to have no significance for survival, representing random differences that are not incompatible with the main requirements of existence in their population." Just as individuals vary within a population, so may populations show a statistical difference, which may or may not be adaptive and favor survival. It would seem to follow, then, that when polymorphism is greater near the center of area than at its periphery, it is entirely likely that there will be less dependence upon a restricted habitat at the center of area. This should not lead to the assumption that any one individual has a wider tolerance and a lesser dependence upon a restricted habitat because it happens to live near the center of area.

If primitive members of a group have a wider tolerance than more advanced ones, and if primitive members are more likely to be found near the center of origin, there should be a lesser dependence upon a restricted habitat at the center. The wide ecological tolerance that primitive species are supposed to have is sometimes based on the paleontological evidence of large areas which species of modern genera are known to have had in Cretaceous or Tertiary times. This is frequently a spurious argument because many of these species are known not to have had these wide areas synchronously, and furthermore, little is known of ecological subdivisions of the species. Finally, there are no physiological studies, so far as I know, which indicate that primitive species have unusually broad tolerances. Circumstantial evidence, on the contrary, indicates that old relic species are frequently markedly restricted in area and habitat type.

This problem has received at least one excellent consideration in paleobotanical literature. Ater pointing out that certain fossil floras of later Tertiary age contain mixtures of plants from widely different habitats, Axelrod (1941) suggests that the explanation may not be due only to overlap of floras (in ecotonal regions, or from migratory mingling), or to the fact that Miocene and Pliocene vegetation was "generalized" and modern forests derived by "climatic segregation only in the late Cenozoic," but to the ancient existence of ecospecies. For example, *Sequoia Langsdorfii* (close to *S. sempervirens*) was variously associated with species of boreal, warm-temperate, and temperate type. Other modern endemics, now of restricted type, but of once wider association, include *Lyonothamnus, Ginkgo, Glytostrobus pensilis, Picea Breweriana,* and *Quercus tomentosa,* according to Axelrod. He says, "it seems highly probable that many Miocene and Pliocene species related to living endemics may represent extinct ecotypes of more widely distributed Tertiary ecospecies." Probable as this concept is, it still does not show that primitive species are of wide ecological tolerance and recent ones of narrow amplitude. The late Cenozoic was a time of climatic breakup and, for many species, biotype depauperization with only "senile," relic endemics remaining; but, as Axelrod supposes, the wide area and diversified conditions under which certain Tertiary species lived were due to the biotype (ecotype) richness of the species as a whole. That richness represents the mature condition of a species history. As with previous criteria, we find ourselves confronted by many "ifs." The above arguments concerning the region of least dependence upon a restricted habitat are applicable in the determination of center of origin only when the center of origin is also the center of variability, and when the center of origin has not been disturbed and reduced in biotype richness.

The idea that a species is usually ubiquitous in the center of its range, occurring in all kinds of places, and restricted to only the most favorable sites at its areal limits, according to Griggs (1914), is probably attributable to Blytt, and has been favored by Cowles. This idea includes the assumption that the favorable climate in the central portion of the species range somehow overcomes diverse edaphic factors, whereas at the margin of range edaphic factors permit a spotty extension of area. I remember Cowles, when lecturing on the dunes of Lake Michigan's shores, saying of the cactus, "It sits on the southern and western slopes, looking toward its home." There is, of course, a large element of truth in this generalization, as is shown by the usual disposition of preclimax and post-climax communities in any region.

Let us turn again to the often cited polyploids. Anderson (1937) says, "The diploid species are of limited distribution and even in those areas where they do occur are usually restricted to one particular habitat. By contrast, the tetraploid species and races have wide distributions and most of them have the ability to flourish under a variety of situations." Allopolyploids, especially, may combine the tolerances of their diploid progenitors.

In amplifying his discussion of this criterion, Adams (1909) selects what seems to me to be a particularly vulnerable example. He says, "Outlying colonies tend to have a limited or restricted range. At the same time such colonies are peculiarly liable to become extinct, as they are usually near the limit of favorable conditions . . . this is true of the 'boreal islands' in swamps within the glaciated portion of the continent. For example, members of the tamarack bog association, toward their southern limit, have very restricted or local range; but to the north, *the bog forest conditions, as it were, spread from the bogs proper and become of extensive geographic range,* as the water beetles invade the damp mosses . . . These restricted, attenuated, or isolated colonies, dependent upon special conditions, are clearly indicative that they are pioneers or relics, which point toward the region where the range is spread out and becomes of geographic extent." I have italicized a portion of the above quotation to emphasize the fact that the areal pattern is apparently wholly dependent upon the pattern of occurrence of suitable conditions. This is an ecological matter that of itself denotes nothing concerning origin. Adams goes on to say that the isolated colonies are *either* pioneer or relic, destroying his own thesis, it seems to me.

Criterion 8. Continuity and Directness of Individual Variations or Modifications Radiating from the Center of Origin along Highways of Dispersal

This criterion, related to number six, frequently is a reliable one. With respect to changes in character frequency (as shown by the mass-collection techniques: Fassett, 1941) we can only conclude that there can be a gene flow in any direction through a population. Any attenuation of the frequency of a certain gene is presumably direct evidence of the center of origin of that gene in the region of highest frequency. One of the most interesting cases of this sort concerns the distribution of the recessive melanistic mutation in *Cricetus cricetus,* the hamster. Timofeeff-Ressovsky (1940) says, "In the course of the last 150 years this mutation has spread from its original center of high concentration along the northern border of the species-area . . . populations with rather high concentration of this gene are spread westward as far as the river Dnieper." Apparently the melanistic form is adaptive in the wood-steppe ecotone along the northern portion of the species area, and this is one of the few cases in which it is definitely shown that mutations participate in the origination of geographical races.

When introgressive hybridization (Anderson and Hubricht, 1938) is demonstrable and when a series of chromosome changes, such as a polyploid series, can be shown along highways radiating from a center, it would seem that the indication of center of origin is incontrovertible. When several characters show a parallel and direct continuity of gradation of frequency or of modification, it is likely that there has been active migration of the population from a center. This is sometimes recognizable by chains of subspecies, pairs of species, etc. Payson's (1922) work on *Lesquerella* provides a good example based on comparative morphology. He says, "In a graphic representation of the subsectional groups they may be shown by lines radiating from a common center. Such a diagram could be superimposed upon a map and in nearly every case the species at the base of each line of development would be nearer the Texas region (center of origin) than species derived from it."

Once again it can be said that this criterion alone is of no significance. A geographic series of size expressions may be due to environmental conditions reflected in growth responses (phenotypic changes in a genotype) or it may be due to selection operating through a region of gradually changing environment. When morphological, phylogenetic, and geographical data are used to support one another, the validity of the conclusions regarding direction of migration depends upon the validity of the morphological criteria employed.

Criterion 9. Direction Indicated by Geographical Affinities

This criterion is frequently valid for organisms located at stations removed from the major area they occupy. As mentioned earlier, in any region there are usually numerous extraneous species representing two or more different floristic elements, and recording as many different migrations in the vegetational history of the region. In this connection Grinnell and Swarth (1913) say, "We cannot expect to derive universal laws for the behavior of species, to be applicable uniformly in any region . . . where two faunas meet . . . Upon reflection it is difficult to conceive of precisely the same set of delimiting factors operating upon any two species alike." For extraneous species, it is frequently a fairly safe assumption that they were derived from the areas where they have their principal distribution. If a genus or family is largely characteristic of a single formation or climatic type, and has one or a few species of different type, it is likely that the latter migrated and evolved from the generic center. Bromeliads have migrated away from the humid tropics and entered the deserts of southern Mexico, and, conversely, cacti have migrated out of the desert region and established themselves as epiphytes in the tropical forest, according to Gleason (1923). No one suspects certain rather large tropical groups as having a temperate origin because of a few temperate representatives, as in *Diospyros, Tripsacum,* and *Phoradendron,* but quite the contrary. The point is well illustrated by a quotation of Merrill (1936). "When a genus is described from material collected in a certain place and is known only from that region for many years, we more or less automatically accept it as a group characteristic of that region. If a representative of it is later found in another area, we are apt to consider it as an extraneous entity there."

Returning to our own region we can cite an example. Typical Atlantic and Gulf coastal plain species have long been known from the Appalachian and Cumberland uplands (Gattinger, 1901; Kearney, 1900). Sometimes these inland plants are rare, and stations are of small area and widely disjunct from the coastal plain where the species are now common. Fernald (1931) has correctly hypothesized the origin of some of these species on the old lands that are now part of the Cumberland plateau, and Braun (1937a, 1937b) has found them most abundantly in the undissected portions of the now elevated peneplain. Fernald says, "With the Tertiary uplift of the Appalachian region and its final conversion into a vast well-drained mesophytic area . . . the Cretaceous xerophytes and hydrophytes which had previously occupied the ground gradually moved out to the newly available and for them more congenial Coastal Plain and similar habitats to the west and northwest." In such a case as this, the principal area is a derived one and is no indication of the center of origin. It really is not a question of coastal plain plants in the Appalachian and Cumberland uplands, but of upland plants in the coastal plain, if we view the relationship historically. Not all coastal plain species in the interior have had this history. In his monographic study of the Scrophulariaceae, Pennell (1935) has detected some forms that have migrated from the coastal plain into the Piedmont and the Blue Ridge provinces.

The direction of dispersal and the center of origin are many times indicated by geographical affinities, but the criterion can not be used alone, and the principal area and biographic type may be derived and the minor area relic.

Criterion 10. Direction Indicated by the Annual Migration Routes, in Birds

Applied to plants, this criterion would be restricted to species whose diaspores are bird disseminated, either epizooically or endozooically. If the migration takes place both northward and southward over the same route, as for some species employing the Mississippi valley and others using the Appalachian uplands, direction of plant movement is not necessarily indicated. In cases where the northward and southward migration paths are not coincident, the direction of movement is indicated.

Criterion 11. Direction Indicated by Seasonal Appearance

Although Adams was aware of this criterion at the time of publication of his first list (1902a), he did not include it until later (1909). In the northern hemisphere, vernal activity suggests boreal origin. He also thought that there is an altitudinal as well as latitudinal relationship, i.e., that mountain forms spreading downward should belong to the vernal aspect, and lowland forms spreading upward should belong to the aestival aspect.

It is undoubtedly true that such relationships between origin and aspect occur. It does not seem to me, however, that this criterion expresses any inherent indication of origin. The described relationship could exist, for example, for a form or series of forms occupying montane, subalpine, and alpine belts (or the corresponding latitudinal zones) with the center of origin in either terminal belt or the middle. The limitations to the spread of a form are found in the action of the whole environment upon the physiology of the form, with such factors as temperature, light intensity, and photoperiod operating. Therefore, it would seem as easy and sound to conceive of a vernal form of the south spreading northward with a change to aestival aspect, as the reverse. This fact seems to me to illustrate perfectly the pitfialls of deductive reasoning and generalization.

Criterion 12. There is an Increase of the Number of Dominant Genes towards the Centers of Origin

This criterion could only have been proposed after the development of genetics and is appended to the older ones of Adams because of its apparent validity. It can, I think, be attributed solely to Vavilov (1927), who said, "The direct study of the centres of the origin of cultivated plants . . . has revealed not only a great diversity of forms but also a prevailing accumulation of dominant forms characterized by dominant genes in the centres. A considerable number of plants investigated show this regularity . . . The secondary centres of the origin of forms are, on the contrary, characterized by a diversity of chiefly recessive characters."

Several cases are discussed by Vavilov, but only one will be mentioned here by way of illustration. The center of origin of cultivated rye and the genus *Secale* to which it belongs is in Eastern Asia Minor and Transcaucasia. Here are all the species of rye and the whole diversity of characters of the varieties; but also here are concentrated the dominant characters of red-eared, brown-eared, black-eared, and marked pubescence of flowering glumes. In the secondary centers are such recessive characters as liguleless leaves, yellow-ears, and glabrous glumes. Cultivated plant types in their progress from their principal genetical centers seem to exhibit a "falling out" of the dominant genes and "proportionally to the spread of isolation, proceeds the accumulation of recessive forms."

Criterion 13. Center Indicated by the Concentricity of Progressive Equiformal Areas

This criterion, developed by Hultén (1937), primarily concerns centers of dispersal for arctic and boreal biota from refugia; but it also concerns centers of origin when evolution as well as migration has occurred. Hultén's thesis is as follows: from a refugium, each species tends to spread in all available directions, but because of different tolerances and capacities for dissemination it could not be expected that all plants would spread to the same extent or with the same rapidity. The result is a tendency toward the development of approximately circular areas of different size around the center; but in nature the theoretically circular form of areas is seldom attained because of various barriers. There still remains, however, the chief feature of areas: those plants that radiate from the same center have progressive equiformal areas of different size. This criterion is obviously related to number six stated by Adams. As developed by Hultén, however, there is a clean-cut scientific basis with the conclusion reached through strictly inductive reasoning.

Conclusion

There seems to be only one conclusion possible, and it carries implications far beyond the scope of the present discussion of criteria of center of origin. The sciences of geobotany (plant geography, plant ecology, plant sociology) and geozoology carry a heavy burden of hypothesis and assumption which has resulted from an over-employment of deductive reasoning. What is most needed in these fields is a complete return to inductive reasoning (Raup, 1942) with assumptions reduced to a minimum and hypotheses based upon demonstrable facts and proposed only when necessary (Hultén, 1937). In many instances the assumptions arising from deductive reasoning have so thoroughly permeated the science of geography and have so long been a part of its warp and woof that students of the field can only with difficulty distinguish fact from fiction.

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Literature Cited

Adams, C. C. 1902a. Southeastern United States as a center of geographical distribution of flora and fauna. Biol. Bul. **3**: 115-131.

———. 1902b. Postglacial origin and migrations of the life of the northeastern United States: Jour. Geogr. **1**: 303-310; 325-357.

———. 1905. The postglacial dispersal of the North American biota. Biol. Bul. **9**: 53-71.

———. 1909. The Coleoptera of Isle Royale, Lake Superior, and their relation to the North American centers of dispersal. Ecol. Surv. Isle Royale. Mich. Geol. Rept. **1908**: 157-215.

———. 1915. The variations and ecological distribution of the snails of the genus *Io*. Mem. Nat. Acad. Sci. **12** (2) : 1-86.

Allen, J. A. 1892. Variations in vertebrated animals. Amer. Nat. **26**: 87-89.

———. 1905. The evolution of species through climatic conditions. Sci. **22**: 661-668.

Anderson, E. 1937. Cytology in its relation to taxonomy. Bot. Rev. **3**: 335-350.

——— and K. Sax. 1936. A cytological monograph of the American species of *Tradescantia*. Bot. Gaz. **97**: 433-476.

——— and L. Hubricht. 1938. Hybridization in *Tradescantia*. III. The evidence for introgressive hybridization. Amer. Jour. Bot. **25**: 396-402.

——— and R. E. Woodson. 1935. The species of *Tradescantia* indigenous to the United States. Arnold Arboretum Contrib. **9**: 1-132.

Axelrod, D. I. 1941. The concept of ecospecies in Tertiary paleobotany. Proc. Nat. Acad. Sci. **27**: 545-551.

Babcock, E. B. and D. R. Cameron. 1934. Chromosomes and phylogeny in *Crepis*. II. Univ. Calif. Pub., Agr. Sci. **6**: 287-324.

——— and G. L. Stebbins, Jr. 1937. The genus *Youngia*. Carnegie Inst. Wash. Publ. 484: 1-106.

——— and ———. 1938. The American species of *Crepis*, their interrelationships and distributed as affected by polyploidy and apomixis. Carnegie Inst. Wash. Publ. **504**: 1-199.

Baldwin, J. T., Jr. 1941. *Galax:* The genus and its chromosomes. Jour. Hered. **32**: 249-254.

Benson, L. 1941. The mesquites and screw-beans of the United States. Amer. Jour. Bot. **28**: 748-754.

Braun, E. L. 1937a. Some relationships of the flora of the Cumberland Plateau and the Cumberland Mountains in Kentucky. Rhodora **39**: 193-208.

———. 1937b. A remarkable colony of coastal plain plants on the Cumberland Plateau in Laurel County, Kentucky. Amer. Midl. Nat. **18**: 363-366.

Camp, W. H. 1941. Studies in the Ericales: A review of the North American *Gaylussacieae;* with remarks on the origin and migration of the group. Bull. Torrey Club **68**: 531-551.

———. 1942. On the structure of populations in the genus *Vaccinium*. Brittonia **4**: 189-204.

Cockerell, T. D. A. 1906. The evolution of species through climatic conditions. Sci. **23**: 145-146.

Du Rietz, G. E. 1930. The fundamental units of biological taxonomy. Svensk Bot. Tidskr. **24**: 333-428.

Fassett, N. C. 1941. Mass collections: *Rubus odoratus* and *R. parviflorus*. Ann. Mo. Bot. Garden **38**: 299-367.

Fernald, M. L. 1926. The antiquity and dispersal of vascular plants. Quart. Rev. Biol. **1**: 212-245.

———. 1931. Specific segregations and identities in some floras of eastern North America and the Old World. Rhodora **33**: 25-63.

Gattinger, A. 1901. The Flora of Tennessee. Nashville.

Gleason, H. A. 1923. The vegetational history of the Middle West. Ann. Assoc. Amer. Geogr. **12**: 39-85.

———. 1925. Species and area. Ecology **16**: 66-74.

Good, R. D'O. 1931. A theory of plant geography. New Phytol. **30**: 149-171.

GOODSPEED, T. H., AND M. V. BRADLEY. 1942. Amphidiploidy. Bot. Rev. **8**: 271-316.

GREENMAN, J. M. 1925. The age-and-area hypothesis with special reference to the flora of Tropical America. Amer. Jour. Bot. **12**: 189-193.

GRIGGS, R. F. 1914. Observations on the behavior of some species on the edges of their ranges. Bull. Torrey Club **41**: 25-49.

GRINNELL, J., AND H. S. SWARTH. 1913. An account of the birds and mammals of the San Jacinto area of Southern California. Univ. Calif. Publ., Zool. **10**: 197-406.

HIESEY, W. M., J. CLAUSEN, AND D. D. KECK. 1942. Relations between climate and intraspecific variation in plants. Am. Nat. **76**: 5-22.

HULTÉN, E. 1937. Outline of the history of arctic and boreal biota during the Quartenary Period. Stockholm.

HUXLEY, J. 1940. The New Systematics. Oxford.

HYDE, J. 1898. Variations in the rate of agricultural production and one of its causes. Sci. **8**: 575-576.

KEARNEY, T. H. 1900. The Lower Austral element in the flora of the Southern Appalachian region. Sci. **12**: 830-842.

KINSEY, A. C. 1936. The origin of higher categories in *Cynips*. Ind. Univ. Publ., Sci. Ser. **4**: 1-334.

KLAGES, K. H. W. 1942. Ecological Crop Geography. pp. 1-615. Macmillan. N. Y.

KOSTOFF, D. 1938. Cytogenetic behavior of the allopolyploid hybrids *Nicotiana glauca* Grah. × *Nicotiana Langsdorffi* Weinm. and their evolutionary significance. Jour. Genet. **37**: 129-209.

MASON, H. L. 1942. Distributional history and fossil record of *Ceanothus*. pp. 281-303 in "Ceanothus" by Van Rensselaer and McMinn. Santa Barbara.

MATTHEW, W. D. 1939. Climate and Evolution. Special Publ., N. Y. Acad. Sci. **1**: 1-223.

MERRILL, E. D. 1936. Malaysian phytogeography in relation to the Polynesian flora. Essays in Geobotany, pp. 247-261. Berkeley.

PAYSON, E. B. 1922. A monograph of the genus *Lesquerella*. Ann. Mo. Bot. Gard. **8**: 103-236.

PENNELL, F. W. 1935. The Scrophulariaceae of eastern temperate North America. Acad. Nat. Sci., Phila., Monogr. **1**: 1-650.

RAUP, H. M. 1942. Trends in the development of geographic botany. Ann. Assoc. Amer. Geogr. **32**: 319-354.

SCHONLAND, S. 1924. On the theory of "age and area." Ann. Bot. **38**: 453-472.

SCHUCHERT, C. 1935. Historical Geology of the Antillean-Caribbean region. N. Y.

SHREVE, F. 1934. Vegetation of the northwestern coast of Mexico. Bull. Torrey Club. **61**: 373-380.

———. 1936. The plant life of the Sonoran desert. Sci. Mo. **42**: 195-213.

———. 1937. Lowland vegetation of Sinaloa. Bull. Torrey Club **64**: 605-613.

SIRJAEV, G. 1934. *Ononis* L. Die Pflanzenareale. **4**: Reihe, Heft. 2.

STEBBINS, G. L., JR. 1940. The significance of polyploidy in plant evolution. Amer. Nat. **74**: 54-66.

VAN STENNIS, C. G. G. J. 1934-1936. On the origin of the Malaysian mountain flora. Buitenzorg Jard. Bot. Bull., Ser. 3. **13**: 135-262; 289-417. **14**: 56-72.

SZYMKIEWICZ, D. 1937. Contributions a la geographie des plantes. IV. Une nouvelle methode pour la recherche des centres de distribution geographique des generes. Kosmos **62**: 1-15.

TAYLOR, W. P. 1934. Significance of extreme or intermittent conditions in distribution of species and management of natural resources, with a statement of Liebig's law of minimum. Ecol. **15**: 374-379.

Timofeeff-Ressovsky, N. W. 1940. Mutations and geographical variation. pp. 73-136 in The New Systematics by Huxley.

Turesson, G. 1925. The plant species in relation to habitat and climate. Hereditas **6**: 147-236.

———. 1932. Die Genezentrumtheorie und das Entwicklungszentrum der Pflanzenart. Kungl. Fysiogr. Sällsk. i Lund Fördhl. **2**: (6).

Vavilov, N. I. 1927. Geographical regularities in the distribution of the genes of cultivated plants. Bull. Applied Bot. **17** (3) : 420-428. [Russian with English summary.]

———. 1928. Geographische Genzentren unserer Kulturpflanzen. Verhandl. V. Intern. Kongr. Vererbungswissenschaft. Berlin.

———. 1940. The new systematics of cultivated plants. pp. 549-566 in The New Systematics by Huxley.

Willis, J. C. 1922. Age and Area. Cambridge.

———. 1940. The Course of Evolution. Cambridge.

Phytopathology—1867-1942*

George M. Reed

The three decades 1850-1880 are noted for fundamental discoveries in the field of biology. In 1859 Charles Darwin published "The Origin of Species," a work which changed completely the viewpoint in biology. In 1865 Gregor Mendel published the results of his experiments on inheritance in peas, an account which made no impression upon his own generation, but proved to be the keystone of genetic investigation in the early twentieth century. Louis Pasteur, in 1855-1859, carried out his researches on fermentation, maintaining that the changes which occurred in various organic substances were the result of the activity of micro-organisms, instead of purely chemical processes in which the observed rods were supposed to originate as by-products. In 1860-1864 he was engaged in experiments on the problem of spontaneous generation. It was almost universally believed that the micro-organisms originated from the decomposition of higher plants and animals. The fungi associated with plant diseases were thought to arise from changes in the higher plants of unknown causal origin. In 1865-1870 he carried out his classic studies on the silkworm disease, demonstrating the microbic origin, not of one disease only, but of two. Robert Koch, in 1876, supplied decisive evidence that anthrax of cattle was due to a microscopic rod-shaped organism which had been associated with this malady by Devaine and Rayer in 1850. Koch's results were confirmed by Pasteur in 1881, who carried out his experiments on the prevention of anthrax of sheep by vaccination.

L. R. and C. Tulasne, in 1861, published the first volume of their standard work on the fungi, describing in great detail the life history and structure of the powdery mildews. In 1863 Anton de Bary worked out the life history of a powdery mildew, *Sphaerotheca castagnei,* on dandelion, describing the appearance of the sex organs. De Bary's most important work, however, was published in 1865, when he recorded heteroecism in *Puccinia graminis.* Previous to the work of Tulasne, de Bary, and others, the nature of the lower fungi was quite misunderstood and the idea that they were the cause of various diseases was not accepted. The demonstration of the polymorphism of the rusts, involving four or five spore stages, was a great advance in our knowledge. It was, of course, difficult for that generation to accept the view that a rust was not only parasitic, but required at least two different hosts in order to complete its life cycle of four or five types of spores.

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The idea that a plant disease might be due to the growth of one organism in another, resulting in the observed changes, was slow in developing. The more common view was that the growths observed followed rather than preceded the disease, which was assumed to be due to environal conditions—the weather, changes in temperature, moisture, and illumination, and other factors such as the time of planting the crop, the nature of the soil, and the application of fertilizers.

Perhaps the first disease of higher plants to be definitely connected with the growth of a fungous parasite was bunt of wheat. Tillet (1755) provided part of the evidence by showing that the "dust" from the bunted grains, when applied to the seed, in some way resulted in infected wheat heads. Prévost (1807) made a further advance by observing that the "dust" from the smut balls resembled fungous spores and germinated in a characteristic fashion. Kühn (1858) also studied the germination of the smut spores and observed the penetration of the germ tubes into the living wheat seedling. De Bary (1863), in his early experiments on the rusts, showed by inoculation of different spore forms that the disease followed in its characteristic symptoms. At the time of the outbreak of the potato blight in England and Ireland beginning in 1845, Berkeley was quite insistent that the fungus observed, now known as *Phytophthora infestans,* was actually the cause, although most of those with anything to do with the disease believed that environal conditions, particularly wet weather, were the primary factors.

Since 1867 there has been remarkable progress in working out the relation of fungi to diseases of plants. Further, other causes of disease have been demonstrated, since the bacteria are now known to produce many different types. We also have a whole group of diseases which are caused by a virus. So-called "physiologic" diseases, in no way associated with a living pathogen as a causal agent, are recognized. Many of these are due to the lack of some essential element such as boron, manganese, or some other.

It is interesting to note the parallel development in our knowledge of human and animal diseases along with the discoveries in the plant kingdom. Koch (1876) demonstrated that anthrax of cattle was due to a microscopic spore-producing organism and by 1881 Pasteur had developed his vaccines for the control of the disease. Klebs (1883) had observed the organism which causes diphtheria, Loeffler (1884) studied the organism and obtained pure cultures, Roux and Yersin (1888) discovered the toxin, and Behring and Kitasato (1890) isolated the antitoxin.

The organism causing bubonic plague or "Black Death" was seen independently by Yersin and Kitasato in 1894, and the accidental proof of its association with the disease came in 1898. About the same time, rats and fleas were found to be the carriers. The organism which causes tetanus was observed by

Nicolaier (1884), Kitasato (1889) giving the proof of its causal connection. One of the most striking developments was in connection with malaria, known in various forms since ancient times. Laveran (1880) had come to the conclusion that its spread was associated in some manner with mosquitoes and Ross (1898) demonstrated conclusively that a species of *Anopheles* was the carrier and, further, that the causal organism underwent cyclic changes in both mosquitoes and man. Soon after, the method of distribution of yellow fever was discovered. Finlay (1881) believed that mosquitoes might be the carrier and Reed and his associates (1900) demonstrated that the mosquito *Aedes calopus* was the responsible agent. The application of these discoveries led to the elimination of yellow fever as a serious disease in most parts of the world.

The story of plant pathology contains many chapters which are concerned with disastrous diseases of economic plants. Frequently the outbreaks are due to the introduction of susceptible hosts to new regions where an indigenous parasite attacks them. In some cases a pathogen is carried to other parts of the world, where it finds susceptible hosts.

The potato blight, which appeared in England and Ireland in 1845, focused attention on this particular disease and led to great advances in plant pathology, although the immediate results were disastrous for the people who depended on potatoes for their food. Frequently since then potato blight has occurred in destructive forms, and continues to be under constant investigation for methods of control. The coffee disease, caused by *Hemileia vastatrix,* appeared in Ceylon about 1869 and during the following years proved to be very destructive. The final result was that the growing of coffee was given up in Ceylon, being replaced by tea plantations, and coffee culture developed in Brazil.

The American chestnut blight was first observed in Greater New York in 1904 and the evidence is that the causal organism, *Endothia parasitica,* came from the Orient on nursery stock. Since the first appearance of the disease our native chestnut tree has been practically wiped out. The white pine blister rust caused by *Cronartium ribicola* was first noted in America in 1906 on three year old white pine seedlings imported from Germany. Previous to that, the disease had spread widely through Europe on the American white pine, which had been introduced. Shortly after the pathogen appeared in America it spread far and wide on the five-needle pines and necessitated radical methods of control, which involved the attempted eradication of wild and cultivated species of *Ribes* adjacent to the white pine forests.

The rust of wheat caused by *Puccinia graminis* doubtless accompanied the introduction of wheat into new regions and, wherever wheat is grown, damage has been done. In the United States, 1904, 1916 and 1935 are especially noted for the destructive outbreaks.

Since 1867 progress in plant pathology has proceeded along several lines.

1. Life history and classification of the fungous pathogens. Following the demonstration of heteroecism in the stem rust of wheat by de Bary (1865), the life histories of many rusts were determined. De Bary (1866) demonstrated heteroecism in the crown rust of oats caused by *Puccinia coronata,* the aecial stage occurring on species of *Rhamnus.* Oersted (1865) established the hereroecism of *Gymnosporangium sabinae.* Almost every year one or more connections were established, largely by workers in Europe. Halsted (1886) and Thaxter (1887) showed that the life cycle of *Gymnosporangium juniperi-virginianae* required the red cedar and the apple for its completion. Klebahn (1888) demonstrated the connection between the white pine and species of *Ribes* in the blister rust, *Cronartium ribicola,* and for a period of years he devoted himself to a study of heteroecious types, by 1904 listing 178 species belonging to 11 rust genera. Dietel (1918) listed a total of 264 heteroecious rusts. Arthur (1900-1921) was an active worker in growing cultures of various rusts on different hosts in order to determine their life history, and demonstrated that approximately 50 different North American rusts were heteroecious, in 1934 listing 153 species belonging to 14 genera in his Manual of the Rust Flora of the United States and Canada.

Along other lines, great advances in our knowledge of the rusts have been made. Eriksson (1894) discovered racial specialization. Blackman (1904) and Christman (1905) described what they interpreted as a method of sexual reproduction at the base of the young aecial cups. It remained for Craigie (1927-1933), in a series of papers, to demonstrate the relation of the pycnia and the young aecia in the life cycle, thus completing the main outlines of the life history of this pathogen. There was an immediate application of these studies in connection with the possible origination of new races of rusts.

The main facts in the life history of the bunt of wheat were established by Tillet (1755), Prévost (1807) and Kühn (1858). A further point in the method of distribution was brought out by Woolman and Humphrey (1924) in which they showed that soil contamination was an important factor in our Northwestern States.

The life history of the other smuts of cereals has also been worked out. L. R. and C. Tulasne (1847) differentiated some of the main types. Jensen (1888) devised the hot water treatment for the oat and barley smuts and distinguished two species on the latter host and Kellerman and Swingle (1890) separated the covered smut of oats from the loose smut. Brefeld (1870-1912) published 15 volumes recording the results of his labors on the smuts and other fungi. Of special significance was the demonstration of the flower infection method in the loose smut of barley and wheat by Brefeld and Falck (1905). Zade (1924) added to our knowledge of the method of distribution of the loose smut of oats, suggesting that to a large extent the wind-blown spores germinated in the flowers, finally forming a resting stage, so-called "gemmae," beneath the glumes, which later produced the infection in the young seedling.

Leveille (1851) brought out his standard work on the powdery mildews, describing the genera which, for the most part, are accepted today. De Bary (1863) worked out the main points in the life history, describing the sexual organs and Harper (1895, 1896, 1905) investigated the cytology of sexual reproduction and ascospore formation. From the taxonomic standpoint, Salmon's monograph, published as a Memoir of the Torrey Botanical Club in 1900, was a landmark in our knowledge of the powdery mildews.

Among the downy mildews, potato blight has been the subject of intensive investigation wherever potatoes are grown. Studies have been concerned not only with the pathology and the control of the organism, but also with its life history. Berkeley, in the late 1840's, made the first detailed studies. It remained for Clinton (1911) to discover the oospores, Jones, Giddings, and Lutman (1912), and Pethybridge and Murphy (1913) adding further data on the conditions necessary for sexual reproduction. Gaümann (1923) brought together the results of his detailed studies on the genus *Peronospora.*

Great strides have been made in the large group of the Ascomycetes and the connection between the conidial and ascospore stages of many have been established. L. R. and C. Tulasne (1853) described in detail the life history of *Claviceps purpurea,* which causes the ergot of rye. Aderhold (1894) and Clinton (1901) established the connection between the common apple scab organism and the ascocarp known as *Venturia inaequalis.* Norton (1902) discovered the apothecia of the brown rot of stone fruits, although Schroeter (1893) concluded that the species of fungi causing brown rot belonged in the genus *Sclerotinia* and Woronin (1898) showed that there were two distinct species of this genus, *S. fructigena* and *S. cinerea.*

2. Physiologic specialization. Proper identification of hosts is basic to an advance in the knowledge of pathogens which cause disease. Taxonomists have been concerned largely with genera and species, while the agronomists and horticulturists have been interested in the cultivated varieties. Students of the parasitic fungi must necessarily be familiar with the host plants upon which they grow since, in works dealing with their classification, the keys are largely based upon the proper host identification, and Arthur's recent Manual of Rusts (1934) is a fine illustration.

One of the great advances in pathology since 1867 is the demonstration of physiologic specialization. Schroeter (1879) called attention to this phenomenon in connection with certain rusts on *Carex.* The first important work, however, was that of Eriksson (1894) who made an intensive study of *Puccinia graminis* from the cultural standpoint. On the basis of his experiments, he recognized 6 *formae speciales—Avenae, Secalis, Tritici, Airae, Agrostidis,* and

Poae. Another step was taken in 1917, when Stakman and Piemeisel found that *P. graminis tritici* consisted of at least more than one specialized race or physiologic form. By 1922, 37 specialized races of this pathogen were known and by 1934 not less than 127 had been isolated, and now the number is about 160. Similar specialization has been found in other groups of grass rusts. In crown rust of oats Murphy (1933) listed 33 races and Johnston et al (1942) brought together the data for *Puccinia rubigo-vera tritici,* recording 129 races known in various parts of the world. Most rusts which occur on several species of grasses, particularly if they belong to different genera, show the phenomenon of specialization. It is interesting, however, that *Puccinia subnitens* does not, the spores from the uredial and telial host being able to infect aecial hosts belonging to 15 genera, distributed among 6 different families.

Specialized races of the powdery mildews were first recorded by Marchal (1902) when seven were differentiated on the basis of cultural experiments—*Avenae, Agropyrae, Bromi, Hordei, Poae, Secalis,* and *Tritici,* all being limited to one or more species of a single genus. Salmon (1903) and Reed (1906-1916) extended the evidence for specialization within this mildew. A further step was taken by Mains and Dietz (1930) when they showed that *Erysiphe graminis hordei* consisted of at least 5 distinct races, and Mains (1933) found 2 races of *E. graminis tritici.*

The first evidence of specialization in the smuts was recorded by Zillig (1921) in *Ustilago violacea.* Faris (1924) demonstrated the occurrence of 5 physiologic races in the covered smut of barley, *U. hordei,* and Reed (1924) demonstrated races in both loose and covered smuts of oats. At the present time 30 specialized races of loose smut and 14 of covered smut are known. Faris (1924) demonstrated specialization in the bunt of wheat, his data being extended by Reed (1927, 1928) when 5 races of *Tilletia levis* and 6 of T. *tritici* were differentiated. Rodenhiser and Holton (1937) listed 8 physiologic races of *T. levis* and 11 of *T. tritici.* Such specialization has also been found in *Sphacelotheca sorghi, Sorosporium reilianum, Ustilago tritici,* and *U. zeae.*

Physiologic specialization is an essentially universal phenomenon among the pathogenic fungi. In any case where a morphological species of a fungus occurs on several hosts, it is almost certain that strains or races exist which are limited in their capacity for producing infection.

Ward (1903), in his study of the brome rust, *Puccinia dispersa,* raised the question whether "bridging hosts" existed, publishing data which he regarded as evidence that a particular race of brome rust might be grown on a specific host and then be capable of infecting other brome grasses which originally it was not able to do. Salmon (1904) published similar data for the powdery mildew on the brome grasses. For many years no clear-cut confirmation of these conclusions was available. The general idea, however, was held in connection with the rusts that the aecial host might be a meeting place for different races, resulting in a changed capacity for infection in the uredial stage. It is now known that on the aecial host hybridization of the races of the pathogen may take place, and thus new races arising might differ greatly in their capacity for infection.

Reddick and Mills (1938), in connection with the potato blight organism, have suggested that when it is grown on partially resistant hosts, it may acquire an ability to infect a wider range of varieties, thus bringing to the fore again the question of bridging hosts.

3. Environal factors. Before 1867 the view was that environal factors were the principal cause of plant diseases and, as a corollary of this, the fruiting bodies of the fungi which appeared upon the plant followed the disease. Epiphytotics, such as the potato blight in the 1840's were largely attributed to the weather.

We now recognize the very great importance of environal factors as predisposing the appearance of a diseased condition; in fact, three different things are necessary: (1) a susceptible host, (2) a causal agent such as a fungus, bacterium, or virus, and (3) environal factors that are favorable for the establishment of the relation between the two. We must emphasize the interrelations of environal factors, including soil temperature, moisture, and reaction, since it is impossible to find a fixed optimum for any one, regardless of the possible associated variables.

While we know that the real cause of many diseases is due to specific organisms, we also know that particularly disastrous epiphytotics occur only under peculiar environal relations. Jones, Giddings, and Lutman (1912) worked out the relation of weather conditions to the development of potato blight. The prevalence of wheat bunt depends upon low soil temperature at the time of seeding. Oat smuts are not as destructive, ordinarily, in the Eastern United States as in the Western.

Intensive studies on the relation of environal factors to plant diseases have been made. The relation of temperature and moisture to the infection of wheat by the two species of *Tilletia* was made by Hecke (1909), Heuser (1922), Munerati (1922), Hungerford (1922), and Faris (1924). Faris (1924) studied the temperature and moisture relations for infection of barley by the covered smut, Bartholomew and Seymour (1923) for the loose smut of oats, and Reed and Faris (1924) for the covered smut of oats and the loose and covered smuts of sorghum.

On the establishment of the Department of Plant Pathology at the University of Wisconsin, Professor L. R. Jones and his students conducted extensive studies over a period of years, with elaborate equipment, on the influence of environal factors on the development of many plant diseases. While emphasis was laid on temperature, other factors such as moisture and soil conditions were determined in the case of cabbage yellows, flax wilt, tomato wilt, tobacco root rot, stem canker of potato, and other diseases. An interesting result was observed in seedling blight of cereals caused by *Giberella saubinetii*, an organism causing the disease in both corn and wheat. In corn, severe infection occurs at 16° C. and only slight infection at 24°, while in wheat the temperature relations are reversed. Jones, Johnson, and Dickson (1926) have summarized the investigations.

Seasonal development influences the reaction of many plants to a particular disease. Waterhouse (1929) found that barley hybrids gave different results in winter and summer months, when inoculated with *Puccinia anomala*. Some families in winter gave a normal ratio of 3 resistant to 1 susceptible, while in summer the progenies failed to show the expected segregation. Harrington (1931) found that a series of progenies of a cross of Marquillo × Marquis showed susceptibility as dominant with a race of *P. graminis tritici* at a high temperature, while at a low temperature resistance was dominant. Mains (1934) found that hybrids between Michigan Amber and Chinese wheat were difficult to classify in their reaction to a race of *Erysiphe graminis tritici* when grown in the spring, while it was easy to group the hybrid lines when grown in the winter. One parent, Michigan Amber, was resistant in the winter and more or less susceptible in the spring. Gordon (1930, 1933) found that some oat varieties showed no significant differences in their reaction to certain physiologic races of *Puccinia graminis avenae* when grown at four different temperatures from 57.4° to 75.4° F. The Joanette variety, however, was very resistant to some other races at low temperatures and susceptible at high. Peturson (1930) found that Red Rustproof oats was resistant to a race of *P. coronata avenae* at 57° and susceptible at 70 and 77°. Four other varieties were fully susceptible at all three temperatures, while a fifth variety was resistant. Another aspect of the problem was brought out by the work of Goulden, Newton and Brown (1930). Some wheat varieties showed no essential differences in reaction to particular physiologic races of *P. graminis tritici* in the seedling and in the mature plant stage. Other varieties, however, differed markedly in resistance in the two stages of plant growth. These results have been confirmed by other investigators.

4. Diseases caused by bacteria and other organisms. In addition to the diseases of plants caused by fungi, it is now known that many important diseases of plants are caused by bacteria and other organisms.

Let us recall the fact that Koch (1876) demonstrated conclusively that anthrax of cattle was caused by bacteria. In the period 1878-1883 Burrill carried out his studies which showed the relation of fire blight of pears to particular bacteria. Then followed in rapid succession other demonstrations of the relation of bacteria to plant diseases—Wakker (1883-1889), yellow disease of hyacinths; Smith (1897) and Russell and Harding (1898) black rot of cabbage; Stewart (1897) bacterial wilt of sweet corn; Smith and Townsend (1907) and later publications by Smith and others on crown gall. These, and such other diseases as blight of beans, citrus canker, soft rot, cucurbit wilt, black leg or black rot of potato, red-stripe disease of sugar cane, and wildfire of tobacco, have all been associated with bacteria. Smith (1905, 1911, 1914) published three large volumes dealing extensively with the bacterial diseases and in 1920 published his summary. Elliott (1930) listed 177 species of bacterial plant pathogens—13 caused by *Aplanobacter,* 53 by *Bacillus,* and 111 by *Bacterium.*

It is also interesting to recall the controversy between Dr. Alfred Fischer and Dr. Erwin F. Smith in 1899. The former maintained that bacteria did not cause disease in plants, while Smith affirmed their causal connection.

Other organisms have also been associated with plant disease. Club root of cabbage, caused by *Plasmodiophora brassicae,* has been studied by Woronin (1878), Lutman (1913), Kunkel (1918), and others. Root knot or root gall, caused by nematodes, was first observed by Berkeley (1855). Greef (1872) described the nematodes, Frank (1885) and Atkinson (1889) gave further details on the disease and the causal organism. The nematode disease of wheat was found by Johnson (1909) in California and by Fromme (1917) in Virginia. Byers (1918-1920) has made detailed studies.

5. Virus diseases. A separate chapter in plant pathology deals with the virus diseases of plants. The first scientific studies were concerned with the tobacco mosaic, which has continued to be a favorable subject of many investigators. Mayer (1886) discovered the infectious nature of the juice of mosaic tobacco plants, Ivanowski (1892) discovered that the infectious principle could pass through a Chamberland filter, which held back bacteria, and Beiyerinck (1898) extended the work, introducing the term "contagium vivum fluidum." Many plant diseases are caused by a filterable virus, among them aster yellows, curly top of beet, sugar cane Fiji disease, peach yellows, stunt disease of rice, mosaics of sugar cane, cucumber, hop, lily, and potato. We may note in passing that Loeffler and Frosch (1898) established the first causal connection of a virus to a disease of animals, the foot and mouth disease of cattle.

Studies have been made on the methods of transmission of the filterable viruses, being distributed by grafting, budding, and on the seed, as in the case of the legume mosaic. A most interesting development is the discovery of insect vectors. Takami (1901) found that the stunt disease of rice which was often destructive in Japan, sometimes resulting in crop failures involving famines, was caused by the feeding of the leaf hopper, although the actual virus was not discovered until 1908-1909. Aphids and leaf hoppers are very common vectors. Usually, there is a high degree of specialization in the carrier, a specific insect being responsible for a particular disease. Remarkable progress has been made in the study of the nature of the viruses. Duggar, Kunkel, Smith, Stanley, and many others have made important contributions.

6. Disease resistance. From the earliest times it was observed that species and varieties varied in their susceptibility to disease, and the resistant ones were selected in order to minimize loss. In recent years great progress in the selection of these has been made and programs have been developed in the field of plant breeding for combining the resistant quality with other desirable characters. Success is dependent upon the close cooperation of the plant breeder and the pathologist.

Orton (1899 and later) stressed the value of types of watermelons resistant to the wilt disease and by 1913 had developed commercial varieties. Norton (1910) obtained varieties of asparagus resistant to the rust. Jones and Gilman (1915) began their work on cabbage resistant to yellows. Edgerton (1918) and Pritchard (1922) have developed wilt-resistant tomatoes. Jagger and Scott (1937) obtained cantaloupe varieties resistant to the powdery mildew.

Finding resistant stock is the first step in any breeding work. The species or varieties may be brought in from other countries and used in the program. Wild potatoes have been sought in Mexico and Peru, and melons from India have proved useful. Graves is finding chestnuts from the Orient useful in developing hybrids of our native chestnut which are resistant to blight. Barley, oat, and wheat varieties have been carried from one part of the world to another and serve as basic stock in breeding programs.

In most groups of economic plants, studies on varietal resistance have been made, for example: Reed, Griffiths and Briggs (1925) on the resistance of oat varieties to both loose and covered smuts, Reed and Melchers (1925) on the resistance of sorghum varieties to the covered smut, and Tisdale et al. (1923) on the resistance of varieties of wheat to the flag smut, and (in 1925) to bunt. At the Institut für Pflanzenbau und Pflanzenzüchtung, Halle-Saale, students of Director Th. Roemer have made similar studies of several of the cereal smuts.

Rieman (1939) stated that about 80 resistant varieties of vegetable crops had been developed and at least 20 of these were recognized by the trade, including asparagus resistant to rust, snap beans to mosaic, cabbage to yellows, corn to Stewart's bacterial disease, lettuce to brown blight and powdery mildew, peas and tomatoes to fusarium wilt. Coons (1937) estimated that about one-quarter of the acreage devoted to 17 important crops in the United States was planted to disease-resistant varieties.

Breeding for disease resistance is a difficult and time-consuming procedure and there are many hazards by the way. Frequently new physiologic races of the pathogen appear. This is well illustrated in potato breeding for blight resistance. The first attempts to obtain resistant varieties were made in the late

1840's and ever since efforts have been continued to secure resistant varieties. In a few cases promising results were secured, especially when a new breeding stock was obtained from Mexico or Peru. Since 1918, Reddick in the United States, Salaman in England, Müller and Schick in Germany, and workers in Russia, have developed blight-resistant potato breeding programs. However, the discovery of specialized races of the pathogen in 1933 by Müller and by Miss O'Conner and Peterson (1933) have made the program more difficult. Another example of the difficulties in the successful development of resistant varieties is found in breeding oats for smut resistance. The variety Victoria was imported from Uruguay by the United States Department of Agriculture in 1927. After its introduction it proved to be resistant to all races of loose and covered smut known at that time. It was crossed with other varieties and by 1940 many valuable selections had been obtained which combined smut resistance with other desirable qualities. The discovery of a new race of smut in 1941, which attacks Victoria and most of the selections derived from its crosses, necessitates a new breeding program.

The genetics of disease resistance has been investigated by many workers. Biffen (1904) early published data on the yellow rust of wheat, *Puccinia glumarum,* which indicated that the inheritance of resistance followed the Mendelian laws. The rusts have been suitable for such studies, since the results from an experiment may be secured in seven to ten days. However, environal factors must be carefully considered. Many hybrids have been studied by Hayes et al. (1920), Harrington and Aamodt (1923), Clark and Ausemus (1928), Goulden et al. (1928), McFadden (1930), as well as other investigators. Sometimes the results have indicated a simple relation, while in others the genetic situation is quite complex.

The smuts of cereals have been favorable subjects for the study of the inheritance of disease resistance. One of the difficulties, however, is the long period of time required for securing the data, and another is the great importance of the control of environal factors at the time of infection. Gaines (1923) obtained a complicated situation in his studies of the genetics of bunt resistance. Briggs (1926 and after) secured quite clear-cut results which usually indicated monohybrid ratios. He reported, however, the occurence of several factors for resistance found in different varieties. Crosses between resistant and susceptible varieties of oats have been studied with reference to their resistance to loose and covered smuts, beginning with Wakabayashi (1921), Gaines (1925), and Reed (1925). Many different hybrids have been studied by workers, and the results sometimes indicate clearly a single factor difference, while in other crosses two, three, or even more factors are required to explain the data. Mains (1934) studied the resistance to powdery mildew of wheat hybrids and Briggs (1935 and later) carried out a series of experiments with different hybrids of barley, sometimes obtaining simple relations, but identifying several distinct factors for resistance to a specific race of the powdery mildew.

7. Disease control. Viewed by the practical man, the control of disease is the primary consideration, and the emphasis is placed on securing adequate methods for avoiding the losses due to the destructive diseases. The selection of resistant varieties is one method of procedure, but many others have been employed. The prevention of disease, rather than an attempted cure of infected plants, is recognized as of first importance. Ward (1882), in connection with the coffee disease, clearly emphasized the idea of preventive treatment. It is essential that the toxic material be applied so that it is on the leaves when the spores of the pathogen are germinating. Whatever material is used, it must be applied at the right time.

In a few cases curative measures are successful. In loose smut of wheat and barley, the invasion of the parasite occurs just after the period of pollinization and as the grain ripens the fungus passes into a dormant condition, and may be killed by the hot water treatment. There are a few other illustrations, particularly in the case of virus diseases, as discovered by Kunkel.

Previous to 1867 there were two diseases of plants which were more or less effectively controlled by chemical substances. One was the powdery mildew of the grape by the use of sulphur, discovered by Tucker (1847), and the other the bunt of wheat by a method of seed treatment with salts of copper, as worked out by Prevost, Kühn, and others. Since 1867 great strides have been made in the control of diseases by chemical means. Many sprays and dusts have been utilized, one of the most important being Bordeaux mixture, discovered by Millardet in 1882, which was effective against the downy mildew of the grape. This spray, with modifications, is still one of the standard materials in the control of many diseases. Lime-sulphur was accidentally discovered in 1885 as an effective control of the peach leaf curl, Pierce (1900) giving the history of its use. Scott (1908) reported experiments on the value of self-boiled lime-sulphur, which was effective in the control of peach scab and brown rot, and was successfully used to control apple scab in 1910. Great emphasis has been placed upon the use of dusts instead of sprays in the control of fruit diseases. Whetzel and his associates have been active in the development of suitable dusts.

Copper, mercury, and sulphur remain, at the present time, the principal materials for the chemical control of disease. However, great advances have been made in the use of these elements in new types of compounds and in the physical make-up of the dust or the spray. Investigations have been carried out on the proper methods of applying the material, the discovery of suitable spreaders and stickers, and methods of control involving the combination of insecticides and fungicides. Important changes have occurred in developing suitable spraying and dusting machinery, and elaborate schedules for applications for the control of various diseases and insect pests have been worked out.

Great advance has been made along the line of seed treatments. Formaldehyde was first successfully used by Bolley (1897) for the control of oat smut, and Haskell (1917) devised the spray method, thus solving the problem of the wet grain. Copper carbonate dust was introduced for the control of bunt of wheat by Darnell and Smith (1915) in Australia and Mackie and Briggs used this material successfully in the United States in 1920. Riehm (1913) discovered the value of organic mercury compounds, as chlorphenol mercury, in the control of smut diseases. Important advances in the use of the organic mercurials have been made, utilizing such substances as uspulun, germisan, chlorophal, and semesan.

The application of heat has proved successful in the case of some diseases. Jensen (1882) partially controlled the potato blight by heating the tubers. In 1888 he applied the hot water method to the seed of oats and barley for the prevention of smut. The hot water method was improved by Appel and Riehm (1911) and by the pathologists in the United States Department of Agriculture since 1920. Kunkel (1936) found that heat treatment is effective in the control of peach yellows, diseased plants recovering after being held for some time at 35° C. The yellows of periwinkle disappeared if infected plants were held 38°-42° C. for two weeks (1941).

8. Research and teaching. With rare exceptions, previous to 1867 botany was not recognized as an important subject for research or instruction in colleges and universities. Little attention was paid to pathology, most of the work being done in Europe. Since 1867, however, research and teaching have greatly expanded, not only in Europe but also in the United States. Thomas Taylor was appointed microscopist in 1871 in the Department of Agriculture and in his first report published an illustrated article on the diseases of grape, pear, and peach trees and lilacs. In 1886 a Section of Vegetable Pathology with Frank Lamson-Scribner as Chief was organized in the Division of Botany, and the first bulletin was on the fungous diseases of the grape vine. E. F. Smith, an assistant in the Division, started his investigations on peach yellows, the first bulletin on this disease appearing in 1891. Farlow (1874) began his investigations and teachings along pathological lines. Burrill (1878) began his studies on pear blight.

In 1888 B. T. Galloway was appointed Chief of the Division of Vegetable Physiology and Pathology, heading the Bureau of Plant Industry when it was established in 1901. Further reorganization of the botanical and pathological work of the Department has taken place, but diseases of plants continue to occupy the time of many investigators. The importance of pathology is emphasized by the organization of the Division of Cereal Crops and Diseases, Division of Fruit and Vegetable Crops and Diseases, and the other Divisions of the Bureau of Plant Industry.

The Rockefeller Institute for Medical Research in 1932 established at Princeton, New Jersey, a laboratory for research in plant pathology, an institution largely devoting its attention to the virus diseases of plants.

In the State Universities, Agricultural Colleges, and Experiment Stations, the study of plant diseases has been given increased attention. Before 1900, the botanists of the institutions may have carried on investigations on some diseases of plants. Later, men were appointed to devote their entire time to pathology. No State, however, had a pathologist until after 1900, although fine pathological work was done by Burrill, Arthur, Jones, and others. The first separate Department of Pathology was organized at Cornell in 1907 under Professor H. H. Whetzel. In 1909 Professor L. R. Jones headed the Department of Plant Pathology at the University of Wisconsin. In California Dr. R. E. Smith in 1903 was appointed Assistant Professor of Plant Pathology in the Department of Botany, and in 1907 Dr. E. M. Freeman received the title of Assistant Professor of Botany and Pathology at the University of Minnesota. Pathology, in most institutions, is a part of the Department of Botany, although in a few it is separated.

There has been a great increase in the facilities for the encouragement and publication of research. The American Phytopathological Society was founded in 1908 with about 200 charter members, the enrollment in 1941 consisting of 1120 members.

Most botanical journals publish papers on plant pathology. A few, however, are devoted largely to this phase of botany: Zeitschrift für Pflanzenkrankheiten (1891) edited by Dr. Paul Sorauer; Phytopathology (1911) first edited by L. R. Jones; Société de Pathologie Végétale de France (1914); Review of Applied Mycology (1922) edited by E. J. Butler; Phytopathologische Zeitschrift (1929) edited by E. Schäffnit.

The Bureau of Plant Industry, United States Department of Agriculture, from 1901-1913 published 285 Bulletins, as well as Circulars, many of which were devoted to pathological subjects. The Journal of Agricultural Research succeeded the Bulletins in 1913, and has published many papers along pathological lines. In addition, the Department still continues to issue Technical Bulletins in pathology, as well as in related botanical and agricultural fields. The Agricultural Colleges and Experiment Stations have issued many Circulars, Bulletins, and Memoirs, on plant diseases.

Previous to 1867 there were very few textbooks dealing with pathology. Among the earlier were those of Unger (1833); Weigmann (1839); Meyen (1841); Berkeley (1854-1857); and Kühn (1858). Sorauer published the first edition of his Handbuch der Pflanzenkrankheiten in 1874, consisting of a single volume. In 1933 the first volume of the sixth edition of the greatly expanded work appeared. Hartig (1882) published his text on tree diseases. Kirchner (1890), von Tubeuf (1895), and Frank (1896) wrote general texts. Since 1900 many texts have been published, among the first being Duggar's Fungous Diseases of Plants (1909). Some of the texts cover the general field, while others are limited, dealing either with diseases of fruit trees, vegetables, cereals, ornamental plants, or trees.

One of the most important developments in the advancement of plant pathology and the control of plant diseases was the passage of legislation. Great Britain (1877) passed its Destructive Insects and Pests Act against the Colorado potato beetle and, in 1907, against all insect pests, the first ruling being applied against American gooseberry mildew and the wart disease of potato. The United States Department of Agriculture (1912) established a Federal Horticultural Board and issued the Quarantine Act. The first orders were against white pine blister rust and the wart disease of potato.

Brooklyn Botanic Garden
Brooklyn, New York

At the meeting at the Brooklyn Botanic Garden on Thursday, June 25, a fourth paper was presented by Dr. A. F. Blakeslee on "Technical Applications of Genetics in Plant Breeding in 75 Years." Unfortunately this paper is not available for publication.

The Field Trip to the New Jersey Coast and Pine Barrens Friday and Saturday, June 26-27, 1942

E. J. Alexander and H. K. Svenson

As in the case with most field trips the participants came from many directions by train and automobile, to join at Point Pleasant. The early departure from New York had left most of the group without breakfast so that an hour or so was squandered in the various cafés of the village, but Doctor Chrysler finally rounded up a party and we proceeded along the railroad track and road to the south of Point Pleasant. We had gone perhaps a quarter of a mile, noticing the large trees of *Quercus phellos* on the roadside, when we were pulled up into a meadow on the east side of the track. This meadow had a good many of the interesting plants to be found along the seacoast above tide-level, such as the two milkweeds, *Asclepias rubra* and *A. lanceolata*, the latter species apparently reaching its northern limit at this point. There was much interest in the yellow flowers of *Oenothera* (Kneiffia), but all the variations seemed to resolve themselves into one species, *O. longipedicellata*. The meadow also had a good deal of *Aletris farinosa*, the white spikes being especially conspicuous at this time of year, and some scattered plants of *Polygala lutea*, a species which is more at home in the pine barrens. A large colony of *Viola Brittoniana* was found here, the plants in full seed. This is an attractive cut-leaved inhabitant of acid coastal soils, rather rare and localized in its occurrence, so that a future trip was planned for the following spring to see the colony in flower.

Making a short turn toward the ocean we came to one of the lagoon-like ponds bordered by a wealth of interesting aquatics. Creeping along the shore were *Myriophyllum tenellum* in great abundance and also the more common *M. humile;* along with a carpet of the small yellow *Utricularia gibba, Gratiola aurea, Eriocaulon septangulare, Hydrocotyle umbellata,* and *Elatine americana.* At the margin of the pond were several specimens of *Ranunculus sceleratus,* an interesting species with exceedingly acrid juice and rare in the New York region. Farther out in the water, to be reached only by deep wading, was a growth of *Potamogeton pectinatus,* a species generally of limestone regions but scattered in semi-brackish ponds along the coast. An hour or two was spent along the borders of this pond which ended up not far from the coastal dunes, where several members of the party had their first glimpse of dune plants such as the ever-present *Euphorbia polygonifolia,* sea-rocket (*Cakile*), seaside goldenrod, (*Solidago sempervirens*), *Artemisia caudata,* and the silvery-leaved *A. Stelleriana,* which is commonly known as Dusty Miller.

Our transportation had been very carefully arranged by Dr. Small, and we caught here the bus going southward to Seaside Park where we were to stop for the night. After lunch, again through the careful planning of Dr. Small, we went by automobile southward to Island Beach, one of the wildest places on the New Jersey coast. This area forming the northern barrier-beach of Barnegat Bay is many miles in length, and since it has been kept under private ownership it is still relatively undisturbed. The dunes on the oceanside were especially colorful with carpets of *Hudsonia tomentosa,* the yellow flowers projecting only an inch or so above the shifting sand. Here the prize find was *Carex macrocephala,* now to be called *Carex Kobomugi.* The staminate and pistillate plants are separate in the species, which forms deep-rooted mats in the shifting dunes. Except for a station at Cape Henry, Virginia, it is not otherwise known on the Atlantic coast; its presence is undoubtedly due to marine shipping. Crossing to the bayward side all of our party were greatly pleased with the large trees of various sorts which had been dwarfed and cut into fantastic shapes by the wind. Here were junipers, hollies with trunks a foot or so in diameter, splendid examples of the southern red oak (*Quercus falcata*) which reaches its northern limit at about this area, and large patches of our native cactus (*Opuntia compressa*).

Some of us were even more interested in the vast and variable numbers of blueberries which filled the bushes in the damp hollows. Some of these hollows had sphagnum with the pink orchid (*Pogonia ophioglossoides*) and in one of the little depressions were plants of the smallest of the bladderworts, *Utricularia cleistogama.* In all these hollows there were also plenty of mosquitoes. This long tongue of land is only a few hundred yards in width and the sheltered bayside was soon reached. Here just above the high-water mark were vast rows of the so-called ditch grass (*Ruppia maritima*), cast up by the tide, and just one fragment of the related *Zannichellia* was found. Along these beaches were numerous plants of the sow thistle (*Sonchus arvensis*) with attractive large yellow flowers, a species not common in our region. The salt marsh just to the southward was investigated by some of the members, in spite of the mosquitoes, and here were found numerous clumps of *Kosteletzkya virginica,* a mallow characteristic of salt marshes and reaching its northern limits on Long Island and the Hackensack Meadows. By this time some of the members of the group had become isolated in various blueberry thickets and others were already beginning the homeward journey of three or four miles to Seaside Park. Among the interesting plants along the road were several clumps of roses of which the identity has not yet been established. In one of the roadside ditches were found two clumps of purple loosestrife, *Lythrum Salicaria,* hitherto unreported from this region.

We spent the evening and night at Seaside Park (this closely built-up town is on the seashore but none of us was able to find any trace of a "park"). The town is connected with the mainland by a railroad which runs over a trestle across Barnegat Bay. It was originally planned to reach Toms River by this railroad, but our director of transportation, Dr. Small, had found that a motorboat could be obtained for a little more than the train fare.

At an early hour on Saturday morning, under a threatening sky, we were embarked for Barnegat Landing, some four or five miles across the bay to the westward, with a walk of five miles ahead for Toms River. Shortly after leaving the boat it began to rain in earnest, but this rain proved to be only a shower and the weather soon partially cleared. After we had disembarked, our road led through salt marshes and finally to the sandy pine woods characteristic of the pine barrens. Nothing striking was seen in these salt marshes; but at the upper margin was a good stand of *Rynchospora Torreyana,* a species which is not too abundant, and well-marked clumps of *Eleocharis ambigens,* the representative of *Eleocharis palustris* along the southern coastal plain. As we left the salt marsh area the rain had stopped and we visited bogs with cotton grass (*Eriophorum*), pitcher plants, and *Calopogon* on the way. Some of the party stopped to browse over a burned area which was studded with *Arenaria caroliniana* and *Lobelia Canbyi, Liatris graminifolia* not yet in flower, and the five coastal Eupatoriums, *E. album, E. hyssopifolium, E. leucolepis, E. verbenaefolium* and *E. rotundifolium,* and a long discussion was held over the differentiation of these species. The oaks, especially possible hybrids, were the subject of a good deal of argument, as was also the question of whether *Pinus rigida* could always be determined from *P. echinata* by the character of the bark. Both species of pine were here in approximately equal numbers. Probably the most interesting discovery of the whole trip was that of *Oenothera rhombipetala* in a vacant lot at River Bank; this species is reported in Gray's Manual as being known from Indiana to Minnesota, Nebraska, and Texas. Our five mile walk having been completed without much rain, we landed in the village of Beachwood in time for lunch and a heavy downpour. Since our party now numbered about twenty-six we pretty nearly cleaned out the eating facilities of the village. A few who had important business in New York left the group at this point, but the rest of us proceeded in a bus southward to the botanical stamping ground of Forked River, and especially to the middle branch where there is a bus-stop bearing the name of Ostrom. From here it was only a short walk down to the river. Our principal plant of interest was the curly grass (*Schizaea pusilla*), a small fern which has always been the most interesting single attraction of the barrens. Although one may know the exact location of the plant from past experience, it is not always easy to find. This was true in the present case, but the tiny plants were finally located in little hollows among the *Dendrium* bushes, associated with *Lycopodium* and the orange milkwort (*Polygala lutea*). In another location to the south the plants grew adjacent to *Pyxidanthera* and *Drosera filiformis* in an open pathway where there was a slight accumulation of sphagnum moss. The flora along the margin of the river was as brilliant as any of us had ever seen in the pine barrens, and the slightly cloudy weather tended to enhance the golden flowers of *Lophiola* and *Narthecium americanum,* both now in full bloom. In shallow water there was an expanse of yellow bladderwort (*Utricularia cornuta*), with little islands formed entirely of red-leaved sundew (*Drosera intermedia*). Floating in the deeper water were many colonies of *Utricularia fibrosa* and *U. macrorrhiza.* Here the pitcher plant (*Sarracenia*) filled up shallow coves in unbelievable abundance, but flowering time had long passed. It was with regret that we plodded back a mile or so to the bus-station, since we all felt that the region could have stood â couple of days' exploration at the least; but our walk was somewhat enlivened by the large number of stray species, such as *Polygonum cuspidatum,* which are now appearing on the roadside rubbish-piles, characteristic of so many of our highways.

While the bus and train took us toward New York, our party became smaller as the members took their various ways home. Headlines in the newspapers of fellow passengers reminded us of the sterner events in the world at large, and made us appreciate all the more the respite we had enjoyed of a few days in which to dwell upon the botanical achievements of the last seventy-five years, and the opportunity to visit again some of the favorite collecting grounds in the range of the Torrey Club. Thus, drew to its close, the Seventy-fifth Anniversary Celebration of the Torrey Botanical Club.

ACTIVITIES OF THE CLUB

May to November 1943

May 19. Meeting in Schermerhorn Extension, Columbia University.

The meeting was called to order by the first Vice-President, Dr. Seaver, at 3:30 p.m. Attendance: 24. The minutes of the preceding meeting were approved. The scientific program was presented by Mr. Louis P. Flory of the Boyce Thompson Institute, who spoke on "Color Photography," discussing the problems of equipment, exposure, and lighting in color photography. He illustrated his talk with sample slides. The meeting adjourned at 4:45 p.m.

Honor M. Hollinghurst,
Recording Secretary.

June 5. Field Trip to the Brooklyn Botanic Garden for a study of exotic trees and a tour of the herb garden. Leader: Miss G. Elizabeth Ashwell. Attendance: 2.

June 6. Field Trip along Appalachian Trail near Southfields, N. Y. The "finds" were *Betula papyrifera* and *Orobanche uniflora*. Leader: Mr. G. G. Nearing. Attendance: 2.

June 12. Field Trip to Egbertville, Staten Island. Leader: Mr. Charles Ericson. Attendance: 3.

June 20. Field trip to Montclair Heights, N. J. Joint outing with the Newark Museum Nature Club. Leader: Prof. Oliver P. Medsger. Attendance: 39.

June 26. Field Trip to the New York Botanical Garden to see the laboratory and field work of the leader, Dr. A. B. Stout, Director of Laboratories. Attendance: 3.

July 4. Field Trip to Arden, N. Y. for fungi. Most prized catch was *Hygrophorus psittacinus*, one of the few fungi with a green color. Leader: Mr. F. R. Lewis. Attendance 7.

July 11. Field Trip along Stony Brook Trail, Sloatsburg, N. Y. for lichens and fungi, both of which were fairly abundant. Leader: Mr. G. G. Nearing. Attendance: 10.

July 17. Field Trip to the home of Mr. W. H. Dole, our leader, to see many species of native and introduced ferns as garden plants. Attendance: 33.

July 25. Field Trip along the Kakiat Trail at Tuxedo, N. Y., for lichens, fungi, and general botany. Leader: Mr. G. G. Nearing. Attendance: 18.

August 1. Field Trip to Sloatsburg, N. Y. A successful search for Boleti. Leader: Mr. F. R. Lewis. Attendance: 9.

August 8. Field Trip to climb Schunemunk Mt., Washingtonville, N. Y. Leader: Dr. Alexander V. Tolstoouhov. Attendance: 5.

August 14. Field Trip to the vicinity of Midvale, N. J., for fungi. Leader: Mr. F. R. Lewis. Attendance: 2.

August 15. Field Trip to Glen Cove, L. I., for fossils and general botany. Leader: Mr. James Murphy. Attendance: 9.

August 22. Field Trip to Mt. Vernon and the Bronx, for general flora, asters and goldenrods in particular. Due to confusion about the assembly point, two trips were held. Mrs. Mary Holtzoff, the scheduled leader, had 6 present, and Mr. Joseph Monachino led a group of 11. Each group reported a satisfactory outing.

August 29. Field Trip to Harmon, N. Y., for fungi. The dry season reduced the number found materially. Leaders: Mr. F. R. Lewis and Mr. A. D. Mebane. Attendance: 3.

September 11. Field Trip to Butler, N. J., for fungi, but the weather had continued dry and fungi were less than scarce. However, *Russula elegans* was found. Leader: Mr. F. R. Lewis. Attendance: 3.

SEPTEMBER 12. FIELD TRIP to Preakness Hills, N. J., for lichens, fungi, and general botany. *Stereocaulon pileatum* was found. This is believed to be the first record for New Jersey of this species which is usually collected in the Adirondack or White Mountains. Leader: Mr. G. G. Nearing. Attendance: 17.

SEPTEMBER 18. FIELD TRIP to Richmond Valley, Staten Island, N. Y. Several hybrid oaks were seen and the general botany observed. Leader: Mr. W. T. Davis. Attendance: 25.

SEPTEMBER 25. FIELD TRIP to the Boyce Thompson Arboretum led by Mr. J. H. Beale, Superintendent. Attendance: 10.

SEPTEMBER 26. FIELD TRIP to Mineola, L. I., N. Y., for Myxomycetes. Still too dry. Leader: Mr. Robert Hagelstein, Honorary Curator of Myxomycetes at The New York Botanical Garden. Attendance: 6.

SEPTEMBER 26. FIELD TRIP to Van Cortlandt Park, Bronx, N. Y. *Fraxinus nigra* and *F. pennsylvanica* were found. They are not often seen in this vicinity. Leader: Dr. A. H. Graves of Brooklyn Botanic Garden. Attendance: 18.

OCTOBER 2. FIELD TRIP to Grassy Sprain region, Yonkers, N. Y., for fungi. The leader, Dr. M. Levine, reported a "perfect trip." Attendance: 3.

OCTOBER 3. FIELD TRIP to Point Pleasant vicinity, N. J. Species attracting most attention were *Gentiana saponaria, Polygala Nuttallii* and *P. cruciata, Jasione montana, Bartonia virginica*, and a species of *Sabatia*. Leader: Mr. V. L. Frazee. Attendance: 3.

OCTOBER 5. MEETING AT THE BROOKLYN BOTANIC GARDEN.

The meeting was called to order by the President, Dr. Robbins, at 8:15 p.m. Attendance: 34. The minutes of the meeting of May 19th were approved. Twenty-two persons were elected to annual membership and seven to associate membership. It was voted to invest another $10,000 of the capital of the Club in war bonds. The collecting experiences of the Club members provided the scientific program of the evening. These experiences ranged from collecting on field trips or by proxy to working in victory gardens; from identifying an uncommon plant to research in the field of rubber. By the conclusion, a picture of the varied fields of interest of the Torrey Club members had been presented. The meeting adjourned at 9:40 p.m. and refreshments were served by members of the Garden staff.

HONOR M. HOLLINGHURST,
RECORDING SECRETARY.

OCTOBER 10. FIELD TRIP to Richmond, S. I., N. Y., for general flora of brookside, old fields, and salt marsh. Leader: Miss Hester M. Rusk of the Brooklyn Botanic Garden. Attendance: 15.

OCTOBER 17. FIELD TRIP to the Brooklyn Botanic Garden for the study of coniferous plants. Leaders: Drs. A. H. Graves and Alfred Gundersen of the Garden staff. Attendance: 11.

OCTOBER 20, 1943. MEETING AT THE NEW YORK BOTANICAL GARDEN.

The meeting was called to order by the President, Dr. Robbins, at 3:30 p.m. Attendance: 37. The minutes of the preceding meeting were approved. A Memorial Tribute to the late Dr. C. Stuart Gager was read by Dr. Dodge, chairman of the Memorial Committee:

October 20, 1943.

It is with profound sorrow and a realization of a great loss to our organization that the Torrey Botanical Club records here the death of Doctor Charles Stuart Gager, who died August 9, 1943.

Doctor Gager was elected to membership in the Club October 25, 1905. He had served the Club with high honor and distinction, not only on committees which had to do with formulating plans and policies, but also as Recording Secretary for three years and delegate of the Club for several years on the Council of the New York Academy of Sciences and to the Council of the American Association for the Advancement of Science. He was Vice-President for fourteen years, from 1917 to 1941, and served the Club well as its President during the year just previous to his death.

In recent years it had been the custom of the Club to hold its first fall meeting at the Brooklyn Botanic Garden, at which time members were given an opportunity to report on their work during the summer period. Those who attended these meetings will long remember the cordiality and sincerity of his greeting which always left one with the impression that in him one had a very warm personal friend.

As a token of appreciation of the importance of his contributions to our knowledge of plants and recognition of his administrative abilities, and also for his example of right living, it is directed that this memorial be published with the minutes of this meeting and a copy sent to members of the bereaved family.

(Signed) Sam F. Trelease
P. W. Zimmerman
Arthur H. Graves
B. O. Dodge, *Chairman.*

After Dr. Dodge so moved, the Memorial was accepted by a rising vote of the Club members.

The scientific program was presented by Dr. Michael Levine, who spoke on "The combined effects of colchicine and x-rays on onion root tips."

Fifteen series of experiments were made in which six to forty onions (*Allium cepa* var. *Yellow Globe* or var. *Brigham Yellow Globe*) were used in each. The bulbs were selected for their uniformity of weight, size and freedom from fungus diseases. The bulbs were placed in water for periods of three to twelve days to insure an adequate number of roots. The bulbs were then placed in a 0.01 per cent aqueous solution of colchicine and after 6,18,24,36,48,72,96,125, or 140 hours of exposure were removed and washed in running water. After each given exposure, beginning with the 18 hour treatment the bulbs were divided into two groups of equal number. The first group was returned to fresh water, the second group was exposed to x-rays. A third group, not treated with colchicine, was irradiated simultaneously with the second group; both groups were then returned to water. A fourth group of bulbs was kept in water. The x-ray treatment consisted of a single exposure for 11 to 30 minutes during which time 900, 1500 or 3000 roentgen units (r) were delivered.

The roots of the four groups of bulbs were examined daily and photographed at frequent intervals. Selected root-tips from all the bulbs were prepared for microscopical examination. Root-tips exposed to colchicine for 72,96,125, or 140 hours and irradiated with 900 r when returned to water failed to grow. Root-tips exposed to colchicine for 24 to 48 hours and irradiated with 900 r showed temporary growth inhibition and resumed growth as indicated by the prolongation of the tips below the swellings induced by the colchicine. With larger doses of x-rays, 1500 r and 3000 r, roots colchicinized for 36 to 48 hours failed to resume growth for 14 to 21 days after their return to water.

The microscopical examination of these arrested tissues showed progressive coagulation and destruction of the nuclear materials of the cells in the root-tips. The root-tips colchicinized only were studied concurrently but showed complete recovery when returned to water. The roots irradiated, only showed temporary arrests of growth. With the higher doses of x-rays some injury was noted but growth was halted temporarily.

Acenaphthene used in lieu of colchicine had no effect on the activity of the x-rays. Roots so treated behaved like those non-chemically treated.

The combined effect of colchicine and x-rays was also studied on the growth of leaves of the onion of the *Brigham Yellow Globe* variety. The leaves of the colchicinized bulbs showed little growth after irradiation with 3000 or 1500 r. While the plants x-rayed only showed some leaf growth but less than that which occurred in normal or colchicinized bulbs. The latter two groups showed little difference between them.

These observations led to the conclusion that colchicine sensitizes the formative embryonic tissue of the root to x-rays. The influence was not determined solely by the division phase of the nucleus. The resting nuclei as well as the dividing ones seemed to be affected. The effect of the colchicine and x-rays on the dividing nuclei was more obvious for the chromosomes in metaphase stage were clumped or coagulated while no visible change appeared in those of the resting phase.

It appears that colchicine combined with x-rays has a definite role in cancer therapy. Some tumors of known cytogenetic homogeneity should be the basis for further study.

The meeting adjourned at 5:00 p.m. Tea was then served by members at the Garden.

HONOR M. HOLLINGHURST,
RECORDING SECRETARY.

OCTOBER 24. FIELD TRIP to Alpine and the Palisades, N. J. General leader: Mr. G. G. Nearing. Assistants: for fungi, Mr. F. R. Lewis; for lichens, Mr. W. L. Dix; for bryophytes, Dr. Holberg; for higher plants, Mr. L. E. Hand. Attendance: 20.

OCTOBER 31. Members were invited to participate in the annual pilgrimage of many New York hiking clubs to Long Mountain in Palisades Interstate Park, in memory of the late Mr. Raymond H. Torrey, who was President of the Torrey Botanical Club when he died in 1938.

Dr. Small, the chairman of the Field Committee, reports that during 1943 a total of 43 field trips were arranged. This is about one-half of the number of trips offered in recent years. The total attendance was 485, or about one-third of that of recent years.

NOVEMBER 17. MEETING AT THE NEW YORK BOTANICAL GARDEN.

The meeting was called to order at 3:30 p.m. by the President, Dr. Robbins. Attendance: 36. The minutes of the preceding meeting were approved. It was voted that the Club act as host to any sectional meeting of the Botanical Society of America which might be held in the New York area.

Dr. Matzke read the following letter from Mrs. C. Stuart Gager:

29 Linden Boulevard
Brooklyn.

DR. EDWIN B. MATZKE
Corresponding Secretary
Torrey Botanical Club

My dear Dr. Matzke,

I am deeply grateful to the Torrey Botanical Club for the high tribute paid to my beloved husband in the Memorial recorded in the Minutes of the meeting of the Club on October 20.

This expression of their esteem and sense of loss in his passing is most sincerely appreciated.

Faithfully yours,

(Signed) BERTHA B. GAGER

NOVEMBER 14.

The first part of the scientific program was presented by Dr. Bassett Maguire, and entitled a "Report on the 1943 Field Summer in the Great Basin."

A general and brief description of the physiographic and vegetative characteristics of the Intermountain Region was given. In somewhat more detail the structural and floral characters of the Deep Creek and Raft River Ranges, Utah, and the Ruby, North Humboldt, and Santa Rosa Ranges, Nevada, were discussed. The net results of the summer's activities were listed as approximately 1000 numbers and 6000 sheets collected.

Mr. Robert Hulbary, the second speaker, discussed "Three Dimensional Cell Shapes in the Differentiating Cortex of Elodea Stems."

There were three purposes for making this study; one to determine the three dimensional shapes of the mature cortical cells in the presence of large air spaces, another to investigate the shapes of the cells in the apical meristem, and a third to study changes in shape as the cortical cells differentiate.

In the cortex of Elodea (*Anacharis densa* Victorin) the three-dimensional shapes of the cells in the stem cortex are influenced by the presence of large internodal lacunae. The cortical cells are elongated parallel to the long axis of the stem, and they contain chloroplasts and starch grains. One hundred cells from each of 27 consecutive internodes were studied to determine the number of faces per cell. Then 600 additional cells—100 from each fifth internode—were studied more intensively for number and kinds of faces and the combinations of faces. The average number of faces per cell for the 3300 cells was 8.79. More than one third of all the cells (1443) were 8-hedra. Quadrilateral faces occurred more frequently than all of the other kinds added together. In 600 cells studied more intensively only 31 different combinations of faces were encountered. This apparent uniformity in cell shape in Elodea stem cortex is further attested to by the fact that three of these 31 patterns were outstandingly characteristic for the issue.

Using the method of Duchartre, the average number of faces per cell in the apical meristem was found to be 13.88.

The large internodal air canals originate schizogenously, and they are completely delimited at the base of the apical meristematic region. The reduction in number of faces per cell from the apical meristem to the mature cortex and the other differentiations in cell shape concomitant with the development of the internodal lacunae are due to the cell enlargement and to cell divisions which are limited to two distinct planes.

Following discussion of the two talks, the meeting was adjourned at 4:55 p.m. Tea and refreshments were then served by friends at the Garden.

Honor M. Hollinghurst,
Recording Secretary.

Additions to the List of Botanists in the Frontispiece

No. 24. For C. F. Mook read P. V. Mook
No. 47. Mrs. George S. Powell
No. 48. George S. Powell
No. 49. Mrs. Robert Hagelstein

Dates of Publication of Torreya, Volume 43

Number 1.	July	August 27, 1943
Number 2.	December	February 10, 1944

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THE TORREY BOTANICAL CLUB

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Fred J. Seaver
Lela V. Barton

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Honor M. Hollinghurst
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Michael Levine
John A. Small
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1941-1943

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Helen M. Trelease
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1942-1944

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W. J. Bonisteel
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1943-1945

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Cryptogams

Ferns and Fern Allies: R. C. Benedict, W. Herbert Dole, N. E. Pfeiffer
Mosses: E. B. Bartram
Liverworts: A. W. Evans, E. B. Matzke
Freshwater Algae: H. C. Bold
Marine Algae: J. J. Copeland
Fungi: A. H. Graves, J. S. Karling
Lichens: J. W. Thomson, Jr.
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OTHER PUBLICATIONS

OF THE

TORREY BOTANICAL CLUB

(1) BULLETIN

A journal devoted to general botany, established in 1870 and published bi-monthly at present. Vol. 69, published in 1942, contained 711 pages of text and 44 full page plates. Price $6.00 per annum. For Europe, $6.25.

In addition to papers giving the results of research, each issue contains the INDEX TO AMERICAN BOTANICAL LITERATURE—a very comprehensive bibliography of current publications in American botany. Many workers find this an extremely valuable feature of the BULLETIN.

Of former volumes, 24-69 can be supplied separately at $6.00 each; certain numbers of other volumes are available, but the entire stock of some numbers has been reserved for the completion of sets. Single copies (75 cents) will be furnished only when not breaking complete volumes.

(2) MEMOIRS

The MEMOIRS, established 1889, are published at irregular intervals. Volumes 1-18 are now completed. Volume 17, containing Proceedings of the Semi-Centennial Anniversary of the Club, 490 pages, was issued in 1918, price $5.00.

Volume 18, no. 1, 108 pages, 1931, price $2.00. Volume 18, no. 2, 220 pages, 1932, price $4.00. Volume 18 complete, price $5.00.

Volume 19, no. 1, 92 pages, 1937, price $1.50. Volume 19, no. 2, 178 pages, 1938, price $2.00.

(3) INDEX TO AMERICAN BOTANICAL LITERATURE

Reprinted monthly on cards, and furnished to subscribers at three cents a card.

Correspondence relating to the above publications should be addressed to

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