No.	Total distillate.	Fractionation. I. Degrees.	II. Degrees.	III. Degrees.	IV. Degrees.
7	350 Cc.	97.13	97.60	97.70	97.70
8	400 Cc.	97.20	97.75	97.83	97.80
9	450 Cc.	97.30	97.90	98.00	97.94
10	500 Cc.	97.42	98.10	98.20	98.02
11	550 Cc.	97.62	98.32	98.55	98.30
12	600 Cc.	97.90	98.85	.....	99.40
13	650 Cc.	99.00	99.00	.....	100.50
	670 Cc.	......	103.80	.....	......
14	700 Cc.	101.90	......	.....	102.90
15	720 Cc.	102.40	......	.....	......
	740 Cc.	......	......	.....	104.00

This product was not of the high degree of purity of the preceding fractionations because it was mixed with bromine substitution products which were not entirely removed by the two treatments with sodium and fractionation. The distillate had a sweet odor resembling the lower alkyl halides and entirely different from that of the heptane purified by the other methods. Those fractions within one degree were combined and this sample then reserved for photo-experiments. Further determinations of physical constants were made more for the sake of comparison than in the hope that it would have the high degree of purity of the other samples.

(*Continued in December Number.*)

*Editor's Note:—The bibliography, references to which are made in this part, will be printed at the conclusion of this contribution, December issue.

PLANT ASSOCIATIONS.*

BY HEBER W. YOUNGKEN.

Alike with humans and other animals, plants have developed, during the ages, definite habitat relations with their surroundings.

If we look about in nature we invariably find certain definite species of plants growing in the same locality, in the same kind of soil and subject to the same climatic conditions as other species with which they are associated. Thus, we are accustomed to find American hellebore growing in moist low areas of woodlands or meadows alongside of skunk cabbage; sphagnum, with drosera; the pitcher plants, cranberries and bladderworts in bogs; scrub oaks, beeches, maples, sour gums, bracken, holly, etc., in pine barrens; the splatterdocks, pondweeds, water-lilies and water-hyacinths in ponds; cacti and century plants in sandy, hot, desert regions. In each of these instances we recognize a distinct group of plants. This, then, in its entirety, occurring in a common locality, is what is recognized as a plant association.

Plant associations have been grouped in a number of ways depending either upon the relation they have assumed to various factors of environment such as light, temperature, water, other plants and animals or upon the principle of succession. There are advantages to be had in each method of grouping. In this brief exposition, however, they will be classified solely on the basis of their relation to water.

* Read before Scientific Section, A. Ph. A., City of Washington meeting, 1920.

According, therefore, to the relation plant associations have assumed in regard to water, they may be grouped as follows:

1. Hydrophytes or water plants.
2. Helophytes or marsh plants.
3. Halophytes or salt plants.
4. Xerophytes or desert plants.
5. Mesophytes or intermediate plants.
6. Tropophytes or alternate plants.

HYDROPHYTES.—The effect of aquatic environment on the structure of water plants is most striking. The root systems are reduced in size, the root hairs of those immersed in the water being absent. The supportive action of the water is such that the fibrovascular elements of the stems, which usually function both for support and conduction of crude sap, are greatly reduced in size and strength. The leaves, stems and roots possess large air spaces. The mesophyll of the leaves is spongy and the chloroplasts motile. Stomata are entirely absent from leaves that are submerged and only present on the upper surface of floating ones. Some of these plants have broad, floating leaves and dissected submerged ones, often with thread-like divisions. The submerged parts are devoid of special protective walls, *e. g.*, those containing cutin of suberin. The free-floating microscopic plants, blue-green algae, bacteria, diatoms, desmids, etc., form the plankton of our ponds, rivers and lakes. The free-swimming higher plants (the pleuston) comprise certain liverworts like riccia, water ferns, and such seed plants as water-lettuce and water-hyacinth. The aquatic plants include the algae, mosses and flowering plants, which, attached to rocks, comprise the lithophilous benthos. Another class of aquatic plants (benthos) include those with true roots, which attach the plant to the substratum, and at most possess floating leaves. This type includes the water-lilies, the water-chestnut, the splatterdocks, the floating-heart and the pondweeds.

HELOPHYTES.—To this group belong plants typical to marshes. A marsh is an area with wet soil, wholly or partially covered with water and with annual or perennial herbs (never shrubs and trees) which are adjusted structurally to a mucky soil, lacking the usual supplies of oxygen. These plants likewise show an adjustment to a partial or periodical submergence. Like hydrophytes, marsh plants are for the most part perennial. They produce adventitious roots and possess horizontal rhizomes, or runners, and frequently have air chambers in roots, stems, and leaves, so that they are adapted to meet the scarcity of air in wet soils. They also show a striking development of erect chlorophyll-bearing organs in the shape of leaves, in the flags, and stems, in the rushes. The taller seed-like plants of the marsh-land such as seed-grass (*Phragmites*), the bur-seed (*Spharganium*), the cat-tails (*Typha*), the blue flags (*Iris*), the sweet flag (*Acorus calamus*) and the papyrus (*Papyrus*) form associations known as fresh-water marshes, reed-marshes or fens. The channels or pools of water in among these amphibious plants are filled with true aquatic plants.

HALOPHYTES.—The plants of this group live in soil which is rich in soluble salt, usually common salt (NaCl), and on account of the fact that the osmotic force of the root is nearly inadequate to overcome that of the concentrated solution of the soil, the soil to such plants is physiologically dry. In fact, a halophyte is one form of xerophyte. The most striking feature among halophytes is that they are nearly all succulent plants. The leaves of such plants, for example, are thick, fleshy and more or less translucent. They are rich in concentrated cell sap by which they are able to counteract the osmotic pull of the concentrated saline solution of the soils in which they live. Anatomically they are poor in chlorophyll, the intercellular-air-spaces are small and the palisade tissue is more abundant. Coatings of wax are found and a hairy covering, although infrequent, sometimes occurs. Coriaceous and glossy leaves, especially in tropical halophytes, are noteworthy, while in many salt-loving plants the stomata are sunken. Halophytes are found in the coastal salt marshes and on saline tidal flats in temperate and tropical countries and on alkali flats of interior continents. Notable examples of these plants are the salt marsh samphire, *Salicorna ambigua*, the mangroves (*Rhizopora*) and the bald cypress (*Taxodium*).

XEROPHYTES.—The plants of this group, like the halophytes, are adjusted to live in a soil which is physiologically dry. The soil may owe this condition to its physical nature, such as porosity (sand), or to the presence of humic acids, or by chemical action, which inhibits the absorption of water. They are adapted to meet the conditions of strongest transpiration and most precarious water supply. To meet such conditions of physiological drought, the plants show various structural adaptations. In deserts, where the atmospheric precipitations are less than a certain limit, the plants acquire a xerophytic structure such as succulency, water storage tissue, associated frequently with mucilage, lignified tissue, thick cuticle of the leaves, depressed stomata (frequently in pits), reduced transpiration surfaces and thorns. Cacti and century plants (*Agave*) are types of xerophytes, while many bog plants with leathery leaves are xerophytic.

MESOPHYTES.—These are plants that grow in soil of an intermediate character which is neither specially acid, cold or saline, but is sufficiently well supplied with water and rich in the elements required for plant growth. Plants which grow under such conditions do not have structures by which transpiration is closely controlled. They have large leaves, frequently toothed and incised, with numerous stomata, usually on the lower surface and small intercellular-air-spaces. The leaves and stems are usually of a fresh green color. Typical of the mesophytes are the grasses and most of the annual and biennial herbs of the temperate regions.

TROPOPHYTES.—This term was introduced by Schimper in 1898 for land plants which have deciduous leaves and whose conditions of life are, according to the season of the year, alternately those of mesophytes and xerophytes. The mesophytic condition is found in summer, when the shrubs and perennial herbs, included in this group, are in full leafage, and when, owing to the regular supply of rain during the growing season, the soil is plentifully supplied with water to meet the demands during the period of active transpiration of these plants. During the winter they are xerophytes. The cold of the winter freezes the water in the soil so that the transpiration is reduced to a minimum, and this is associated with the fall of the leaves of the trees and shrubs and the death of the overground portion of the perennial herbs, which spring up each year from their underground parts. The vegetation of cold temperate regions is mainly tropophytic. The deciduous trees and shrubs, also known as the broad-leaved plants and summer-green plants, form the principal tropophytes. The deciduous forests, which include the oaks, the beeches, the ashes, the maples, the walnuts, the chestnuts, cover a great part of eastern and western China, central Europe (England, France, Belgium, Germany) and eastern Australia, and are coincident with countries occupied by most civilized races of man, such as the Americans, Europeans, Chinese and Japanese. The cold temperate climatic conditions which have determined the distribution of the forest trees have been influential also in the development of the energetic races of mankind.

AMERICAN STYRAX.*

BY RAY E. SPOKES.

The name styrax is applied to an exudation obtained from several species of Liquidambar, belonging to the family of Styraceae, and growing in tropical and subtropical countries. There are two commercial varieties, one known as Levant styrax, and the other known as American styrax, or sweet gum, obtained from *Liquidambar styraciflua.* Styrax is official in nearly all the pharmacopoeias, and the tests and standards refer solely to the Levant variety, or balsam of European origin.

The balsam was discovered soon after the discovery of America, and, soon after the first settlement, vast shipments were sent from Mexico to Spain and other European countries, where it was used in medicines, ointments, incense, and perfumery. Shortly before the world war, the amount of material exported to the United States was limited, and interest was aroused in the American styrax, in order to meet the demands. This had been used for years by the aborigines in the western hemisphere, even prior to the discovery of America; the early settlers appreciated its value and considered it one of the great discoveries along with tobacco, cinchona, etc. As there was thought to be some difference in composition between the Levant and the American variety the shipments fell off; there continued a local use, however, not only by people of Central America and northern parts of South America, but by people of this country.

During 1918 Levant styrax was not obtainable; in 1916–1917, styrax was quoted at $6.00 to $7.00 per pound. It is said that American styrax can be gathered and sold, at a profit, at $1.50 a pound.[1] Owing to the limited supply of the European article, even at the present time, the American species must be recognized, and for this reason has received some attention of late. It is now extensively used in perfumery, for incense, and in tobacco. Many of the analyses have been made from the exudations of South American trees; the material for this study was collected from trees growing in the vicinity of Atlanta. The South American product is semi-liquid; the product obtained from southern United States is of a firmer consistency, resembling the European styrax.

---

* The writer is indebted to Dr. Henry Kraemer, who has been deeply interested in the development of American styrax, and who assisted in obtaining the various samples.

[1] H. Kraemer, *Am. J. Pharm.*, 1918, 404.