experiments, either not perfectly exact, or not sufficiently rigorous, will serve only to interrupt its progress, instead of contributing to its advancement."

During the stormy days of the Revolution, as well as before, Lavoisier rendered frequent services to his country. In 1787 he was elected to the Provincial Assembly of Orleans. In 1790 he was a member of the commission which devised the metric system of weights and measures. In 1791 as a member of a commission he published an essay on the National Resources of France, which entitles him to high rank as a political economist. These facts show that he was a man of broad interests as well as a chemist of prœminent rank.

Some of his public acts, and especially those in connection with the collection of taxes rendered it easy to find some trivial complaint against him. And during the reign of terror, while the power of Robespierre was at its height, a trivial complaint was equivalent to condemnation. After sentence he asked for a fortnight's delay that he might complete some scientific experiments, but with the words "We have no more need of philosophers," he was hurried to execution. So died, on May 8, 1794, the greatest chemist of the eighteenth century. I had almost said of any century. For we can scarcely find in the history of thought another who has so transformed the science with which he worked. He cleared away the misconceptions and erroneous speculations of centuries and, building on a solid basis of experimental facts, he laid a sure foundation for rapid and permanent growth in chemical knowledge.

PAPERS READ.

Some Factors in the Distribution of Gleditschia Triacanthos, and Other Trees. By Ernest Walker.

The importance of winds as factors in the distribution of plants has always been recognized by all who have written on subjects connected with plant-geography. It seems, however, that their effectiveness has been appreciated only in the case of extremely fine and light seed, or those provided with appendages for suspension in air, while in the case of heavier seeds, unprovided with such appendages, they are held even by many of our most authoritative writers to be of little or no consequence. Such seeds are thought to be too heavy to be affected in the least by any wind short of a "violent storm" or real "hurricane." As these are only

occasional, and as the direction of winds is thought to be so variable, it has become customary to speak of them as among the "occasional" or "accidental" factors in plant migrations.

Darwin objected to the term "accidental," and for the best of reasons, suggesting as a substitute the word "occasional." But to the writer it seems that the second term, while not quite as unscientific as the former, is in other respects no improvement. For even if the influence of winds in seed diffusion were limited to the lighter or appendaged seeds, it would still be objectionable, as must be obvious.

By no means, however, are we justified in holding that winds affect only lighter seeds, and that moderate winds have little or no influence on heavier fruits and seeds, which any one may readily demonstrate for himself by observation. The writer shared in the prevailing opinion until observations convinced him of the contrary, and showed that ordinary winds have sufficient force to transport even the heavier fruits and seeds, when borne on parts some distance above the ground, to considerable distances. In considering the value of winds as plant diffusing agents, several incidentals occur more or less influencing their effectiveness, which it may be well to mention.

As is obvious, height of the plant is an important factor. Were a fruit as large as the cocoa-nut to be borne on a low plant close to the ground, winds could have no appreciable effect on its fall; but growing as it does, on a tall tree, the strong winds, such as are common in the regions it inhabits, may drive the fruit in falling considerably from the perpendicular before it has reached the ground. Again, tall plants are likely to travel more directly with winds in regions where these blow mainly from one direction during the fruiting season, owing to the fact that the direction of the wind is less affected by irregularities of land surface at some distance above the ground.

Rigidity of trunks and branches is an item worth considering. Flexible stems and branches will lean with the wind, and drop their fruit farther on the side from the wind than in the case of more rigid ones.

Weight, bulk and form of fruits have their values. Lighter unappendaged fruits and seeds may be carried a considerable distance by winds, even when produced upon low growing plants. Where the bulk of surrounding parts is large in proportion to the size of the seeds, it not only makes the force of wind more effective, but in some instances it is probable these bulky parts by their decay enrich the spot upon which the fruit finally rests, and thus helps in giving the young seedlings a start in life, and in traveling across infertile belts.

Peculiarities in form may enable the winds to drive some fruits before them even after the latter have fallen to the ground. The light, globular form of some pine cones when dried enable them to roll readily. In the case of other forms, the curvature of cylindrical cones or slight hooks at the tip of the scales tend to check motion due to gravity, or the influence of winds. Curvature or twisting in flat fruits is obviously an advantage in traveling before winds.

The time and duration of the fruiting season is a matter of the utmost importance; especially if what the writer shall suggest in regard to the direction of winds for certain regions and seasons shall be found to be true. Plants which fruit throughout the season would tend to spread in all directions, while those that ripen their fruit in a single crop at a stated season would be inclined to travel more in one or a few directions, and occupy particular ranges. Darlington always mentions the fruiting season; later authors but rarely, which the writer has often had occasion to regret.

Dehiscence of fruits may have an important bearing in the matter of seed dissemination. The forceful and sudden discharge of seeds in oxalis and violets makes these plants independent of outside help, and scatters the seed in all directions. In these cases the seed are discharged slightly upward as well as outward, enabling these plants to ascend, in time, even steep slopes. In violets cleistogamous flowers extend the fruiting season through even the hot months of summer. These fruits are produced for the most part under ground, and were they to remain there, would be of no value in spreading the species; but after ripe the stalk of the pod elongates and elevates the fruit during dehiscence, and the seeds are scattered as in the case of the pods of the ordinary flowers.

In *Œnothera biennis* the pods are only partially dehiscent at the top, and remain upright on the plant. The top of the plant bends with, and is shaken about by, winds. The seeds are thus scattered about during a considerable interval of time. This brings up the important point relating to the duration of the period seeds and fruits are carried or retained on the plant after their maturity. When long, it increases the chances of many of the fruits being carried to considerable distances by winds: it has relation to the direction of travel or dissemination, and may have an important bearing on the distribution or the range of some appendaged seeds which ordinarily would be thought to travel with the caprice of the lightest wind.

Liatris squarrosa affords an illustration. In this plant the heavily plumed achenes are carried on the dry receptacle till far toward January. So the distribution of the seeds of this and some other species of *Compositæ* is brought about

by the prevailing fall and winter winds. Thus it is probable that the dissemination of even light appendaged seeds is not always as hap-hazard as is sometimes supposed.

The appendages and lightness, or minuteness of many seeds, is commonly thought to have relation only to a wide distribution of the species. But the character also has relation to habitat. Some such plants, as the cat-tail flag, *Typha latifolia*, grow only in particular places. Their habitat, as it were, is divided up into small portions and scattered all over the country. Their downy seeds are necessary mainly on this account. The seeds of such plants are scattered far and wide, floating away on the lightest breeze. Only those grow that find proper homes. This is true of the appendaged seeds of some trees, which grow mainly in certain situations, as in the case of those confined chiefly to water courses. Streams are supposed to carry such seeds and be the main agents in their distribution. This is said to be the case with most of the forest trees of Indiana. The writer believes, however, that the reason so many trees are found along water courses, is not because the streams have borne the seeds along, but because the seed germinate better in the fertile and waste conditions found along their borders. Many such trees have winged or downy seeds and are carried far across extensive regions. Many, and most of the seed fall over the dry belts between streams, but not finding the suitable conditions, never germinate. Those, however, that lodge along the streams, spring up.

The importance of winds as factors in plant distribution, and the truth of some of the statements already made, will be rendered clearer, however, by an account of some observations which the writer has made in relation to the influence of winds in scattering the fruits of the *Liquidamber* and *Gleditschia triacanthos*.

It is now twelve years since first the writer noticed near New Albany, Ind., an old gum tree standing alone on a slight elevation in an old neglected field. The tree was an old one, with a trunk some 24 inches in diameter, but owing to its exposure, and the poverty of the soil, its crown had not penetrated farther heavenward than 40 feet; nor was the expanse of soil shaded by its branches above 30 feet in diameter. While making a list of the plants growing under and about the tree, it occurred to notice what became of the tree's own balls and seeds. The seeding gums springing up here and there around their parent then began to receive attention.

It was noticed that while seedlings of various ages grew in all directions around the old tree, they extended farther to the northeast than in other directions. Measurements followed. To the west and south 50 feet covered the

distance between the trunk and the farthest seedling. On the northeast, however, numbers of these reached as far as 200 feet; some 250 feet, and one 300 feet.

Three or four years ago the old tree was cut down and the field cleared of weeds, etc., and plowed up. The part of the field north-eastward from the tree was not molested, however. So the young grove of gums, which nature planted, is still growing. It is evident that the prevailing strong winds for the fall months during the years in which these young gums were planted, came principally from the southwest.

Since that time gum trees in other places around New Albany have been noticed similarily situated and in open woods. Their story has been the same. The same tendency has also been observed in seedlings of *Robinia Pseudacacia.*

Still further observations made during the past two seasons in the fruits and seedlings of the honey-locust afford additional proof of the power of ordinary strong winds to carry even heavy fruits to a considerable distance, and show that for the fall months and fruiting season of this tree the prevailing strong winds are from the southwest.

The honey-locust in question stands alone on the top of a broad, low hill, which, with the exception of the "knobs," is probably the highest point around New Albany. The soil of the hill is clothed with thin grass; is poor, being clayey on top, with fine, clayey sand beneath. The tree is a handsome one, with a trunk some twenty inches in diameter, and a broad, rounded head reaching upward forty feet, with a like spread.

In September, 1893, it was noticed that there was an enormous crop of seeds. Many of them hung on the branches until toward December. In that month the spot was visited for the purpose of making observations. The pods lay thickly on the ground; and again they were found extending principally toward the northeast. Many were under the tree extending on the south, southeast and southwest, some twenty feet beyond the branches. On the northeast, however, they reached as far as 100 feet. I looked for seedlings. There were a number of various ages. A few were found about the tree on all sides. But the great proportion were northeastward. At a distance of 112 feet there was a small thicket of seedlings two and three years old. On the north some were found at 102 feet; on the northwest 41½ feet, west 39 feet, southwest 50 feet, east 76 feet.

The past summer has been one of the dryest in many years. In September the same tree was again full of pods. At this time new young seedlings four and five inches high were found growing about the tree by the hundred, seeming to indicate that a dry season is favorable to young seedlings of this tree. On the west, south and east these seedlings were numerous within thirty feet of the trunk.

Beyond this they were few and scattering, except on the northeast, where they were found at considerable distances. Owing to the difficulty of finding the young seedlings in the grass, measurements were not undertaken.

These items are full of significance. It is a very noticeable fact, and has often been remarked, that many of the plants of the North American flora have a northeasterly range. This is true of quite a list of heavy-fruited trees which ripen their fruit in the fall. Our observations show that ordinary strong winds, such as are common at the time the fruit of such trees is ripe, are capable of carrying it to a considerable distance, and that the winds carry the fruit, for some localities, farthest in the same direction year after year. The principal range of the gum, honey-locust, common locust and a number of other trees with more or less heavy fruits, and especially those of southern affinities, is from the southwest toward the northeast. This, coupled with the writer's observations, seems to indicate that for the broad belt of country extending from Texas and Missouri northeastward to Western New York and Pennsylvania, the strong winds of the fall months blow chiefly from the southwest. If this be shown by the records of meteorology to actually be the case, the northeastward tendency so noticeable in many of our plants will have been satisfactorily explained. The investigation of this matter is not full enough yet to warrant the definite statement. An examination of the Signal Service Records for a number of successive years will be necessary to settle the point. Reports for 1882-3 giving the weather tables for 1881-2 are all that have been examined. These bear out the suggestions made concerning the direction of the stronger autumn winds for the region mentioned. They show that these winds come chiefly from the southwest, and less frequently from the south and west. They also confirm (as far as they go) the opinion which had begun to spring up concerning other regions.

It is noticed that some of these heavy fruited trees and plants, instead of extending from the southwest northeastward, seem to be of northern relationship, and extend from the northwest portion of the country, mainly eastward from Dakota, across the great Lake Region to New England and Canada; or, again, from Dakota and Minnesota southeastward to Indiana and Kentucky, then northeastward to New England. This seems to indicate stronger west or northwest winds for the late summer or fall months in the northwest. In the case of those plants which come southeastward to Indiana, the winds would be from the northwest. In Indiana they would enter the belt in which southwest winds prevail in fall and be carried northeastward.

There are other regions in which the characteristic range of certain plants is in other directions. When fully investigated, the writer is inclined to think that

it will be found that, in the majority of land-plants with heavy fruits produced at a less or greater distance above the ground, winds prevailing at the time the fruit is ripe, more than any other factor, determine the direction of their range. The slender investigation of meteorological tables so far made is in harmony with these suggestions, but the whole truth remains yet to be ascertained.

Botanists have often commented on the remarkable difference between the flora of the California coast and that of the Atlantic States; and the strange resemblances of our eastern flora to that of eastern Asia. There is a long list of trees, for instance, of similar or identical species common to east Asia and the eastern States of America, including representatives of the genera in which are found magnolias, lindens, sumacs, buckeyes, box-elder, yellow wood, honey-locust, pear, shad-bush, dog-woods, rhododendrons, holly, persimmon, catalpa, sassafras, osage-orange, planera, walnut, butternut, hazelnut, birch, alder, yellow and white pine, hemlock, arbor vitæ, bald cypress and yews.

Looking over this list, it is noticeable that most of them are trees with heavy fruits ripe in the fall; and have, for the most part, in the United States (in general) a northeasterly range. Many of them are of southern affinities, and some northern.

Now, as plants are known to be delicate indicators of climatic conditions, and as it is fair to suppose the same or identical species will always behave the same way under the same conditions, if we find them behaving in a certain manner in two different places or parts of the world, the logical inference is that the conditions of the two regions are the same, or approximately so. Again, knowing the conditions in the two places to be practically the same, and the plants common to the two regions, acting the same, we naturally conclude that the same forces are operating in the same manner in both places. Following this out, we see that the truth in regard to the influence of winds in shaping the range of some of our American trees having been ascertained, bids fair to throw some light on the similarity between our eastern flora and that of eastern Asia, and explain how similar species in the two continents came to occupy like portions of their respective homes.

Propagation and Protection of Game and Fish. By I. W. Sharp.

Anthropology: The Study of Man. By Amos W. Butler.