Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.
NEW NORMAL APPLIANCES FOR USE IN PLANT PHYSIOLOGY. IV

(WITH TWO FIGURES)

In the three preceding articles I have described seven new pieces of normal apparatus devised for educational work in plant physiology; and below will be found accounts of two more, to be followed later by others. I call them normal appliances because are they designed and made expressly for their specific work, yield approximately accurate quantitative results, can be used with economy of time and effort, and are obtainable at any time from the stock of a supply company, which in the present instance is the Bausch and Lomb Optical Company of Rochester, N. Y. The development of this apparatus is part of the present movement toward the elevation of educational plant physiology to a higher plane of scientific logic, accuracy, and efficiency.

VIII. RESPIROMETER

Respiration is a universal, and the most important, process of organic nature, and hence demands effective demonstration in all biological courses. Its study is the more valuable in plant physiology because, while respiration is essentially identical in plants and animals, it can be investigated far more readily in plants. Its central and crucial fact, energy-release, cannot be directly demonstrated by any known method, but indirectly it can be proven and its amount determined through the identification and measurement of the gases absorbed and released in the process. For this purpose many arrangements have been described, of all grades from complex and precise to simple and inaccurate. The present new instrument is designed both to exhibit and to measure the gas exchanges in typical respiring material (e. g., germinating seeds), and to accomplish this with considerable accuracy and convenience of manipulation (fig. 1).

The respirometer consists of three parts. First is the stoppered oval chamber for the seeds, with a water bulb at the bottom. Second is the measuring cylinder in open communication with the chamber, graduated from 75cc to 1000cc of the combined capacity of itself and chamber, though the 75cc mark is actually placed at 77cc of the capacity. Third, and


Botanical Gazette, vol. 43}
Fig. 1.—Respirometer.
communicating with the preceding through a slender rubber tube, is the reservoir cylinder, ungraduated but with index marks 25 cm apart. Both tubes are supported vertically by any convenient laboratory clamps which permit the reservoir tube to be slipped up and down.

For demonstration purposes it is best to select seeds in which the oxygen absorbed and the carbon dioxide released are as nearly as possible equal in volume, e.g., oats. Ten of these of average size are soaked, or better, are selected from a lot which have been started in a germinator until the roots are about 5 mm long; they are then placed in the chamber, root ends down, just above the bulb, where they will stick if previously wetted. These occupy approximately 1 cc of volume; and if now 1 cc of water be placed in the bulb, there will be 2 cc of these materials and 100 cc of air, the composition of which is of course known, above the zero mark. Where greater accuracy is desired, it may be attained by first dropping the ten seeds into a proper measuring-glass, then filling this with water to the 2 cc mark, and finally placing both seeds and water in the chamber. The index liquid to be used is now poured through the reservoir tube until it stands level at the 100 cc mark of the graduated tube and at the upper index mark of the reservoir (or the lower when mercury is used). The stopper, properly lubricated, is inserted with its air opening matching that of the neck, and is then twisted, thus sealing the chamber without any compression of air. The apparatus is now shielded from light and placed under proper conditions for growth.

For the most effective educational demonstration it is desirable, though not necessary, to use two of the respirometers. In one is placed a strong solution of caustic potash, which rises steadily, as the seeds grow, to near the 21 per cent. mark and then stops. This proves that some gas has vanished from the tube, and the amount suggests oxygen. In the other mercury is used, and the constant level it maintains proves that for any gas absorbed by the plants an equal volume of some other has been released. Since however caustic postash absorbs only carbon dioxide, it is plain that the gas released must be carbon dioxide, while the gas absorbed is presumably oxygen. If it is thought this latter point still needs proof, it can be supplied by a third instrument using pyrogallate of potash. This promptly absorbs all oxygen, and the failure of the seeds to grow shows that oxygen is the gas absorbed in the other instruments. If but one instrument is available, it is best to use it with mercury, and, after the seeds have been growing for some three or four days, to make an analysis of the gas by the method earlier described for the photosynthometer. The reservoir and

rubber tubes are slipped off under water, allowing the mercury to run out, and are then used as a reagent tube, the reservoir being stoppered for the purpose.

When plant parts in which the respiratory ratio is not 0 are studied, a preliminary test is made to ascertain in which direction the ratio varies, and then the starting-level can be adjusted accordingly.

The usual corrections of course must be made. The gas pressure inside at the time of reading is equalized with the atmospheric pressure by sliding the reservoir tube up or down until the levels inside and out are equal. For very exact work it would be necessary to take account of the barometric pressures, but the slight error of this sort is negligible in demonstration. The temperature must either be made the same at the start of the experiment and the final reading; or else, as is readily possible, the change of volume due thereto must be calculated. Vapor tension should also be considered in exact work, but it is negligible in demonstration. After each use the instrument should be thoroughly washed clear of potash.

IX. NORMAL LIGHT SCREENS

In several phases of the study of photosynthesis it is necessary to apply some form of light or color screen to a leaf. To this end various arrangements are extemporized which, however inconvenient and time-consuming to prepare, are scientifically unexceptionable so long as they are physiologically accurate. But unfortunately some of these devices are logically fallacious and yield results which are only accidentally correct. This is true, for example, of that experiment common in elementary demonstration, where disks of cork, tin-foil, etc., are placed matching on opposite sides of the leaf in order to exclude light; in fact, they also exclude the equally indispensable carbon dioxide.

Screens correct in principle must allow for free access and exit of gases, but in their construction advantage may be taken of the fact that in ordinary leaves the stomata are either largely or wholly on the under surface, so that if this is left free the upper surface may be covered as closely as desired. It is upon this principle the two forms figured herewith (fig. 2) are constructed. The larger, designed to take an entire leaf of moderate size, consists of a wooden box readily adjustable for height and angle, 5 × 7 × 1 1/2 inches (internal), white without and black within, separated lengthwise into two compartments with an intermediate space for petiole and midrib. The bottoms of the compartments are largely open, but so matched by diaphragms that air can enter freely but no direct light. Movable gratings of silk threads hold the leaf firmly but elastically against the glass cover,
which may be either two separate strips covering the compartments and therefore the halves of the leaf, or a single sheet 5 × 7 inches in size. The cover may then carry tin-foil, cut with any desired pattern, gummed to its under surface; or it may carry vials of pure colors correlative to the light and dark spots of the chlorophyll spectrum (as was the case when the accompanying photograph was taken); or it may be replaced by a 5 × 7 negative for Gardiner’s striking starch-printing experiment. The arrangement does not of course permit as free access of carbon dioxide as the uncovered leaf enjoys, but this is only a matter of degree and does not affect the result when sufficient time is allowed for the experiment. In using this, as any other, light screen it is desirable to expose the plants not to direct sunlight but to strong diffused light, which is nearer the optimum and has less heating effect. The leaves of course are subsequently blanched and treated with iodin in the usual manner.

The smaller screen, of a less range of usefulness but much cheaper, is made upon the same general principle except that it is constructed to clasp a portion of a leaf. A spring clip holds a glass disk against the upper surface of a leaf, which is supported below by a grating of threads stretched across the top of a ventilated dark box. The glass is removable from the clip and may carry a tin-foil screen cut with a pattern and gummed to its under surface as in the figure; or it may be used to hold a photographic

Fig. 2.—Normal light screens.
negative (film or glass) against the leaf, in either case permitting a very striking demonstration of the need for light in photosynthesis.

Both instruments appear to be correct in principle; both are convenient and efficient in manipulation; and they yield most satisfactory results.

IS THIS BIRCH NEW?
(WITH ONE FIGURE)

The paper birch (*Betula papyrifera* Marsh.) has never been reported from Colorado. The nearest region to Colorado from which authentic specimens have been obtained is probably the Black Hills in northwestern Wyoming and adjacent South Dakota. It was therefore a great surprise when Mr. D. M. Andrews of Boulder, Colorado, reported finding a birch which in many respects resembles *B. papyrifera*. He writes of it as follows: "About three miles from Boulder on the north slope of Green Mountain, altitude 6500–7000 feet, I find one hundred trees, more or less, of the species from which I send you specimens."

An examination of the material sent, which, by the way, was secured so late in the season that the specimens are not in good condition, indicates its affinity to *B. papyrifera*. It cannot be referred to the var. *cordijolia*, and it is even less like typical *B. papyrifera*. In the material so far available, however, it is difficult to point out specific distinctions. From the latter it differs in the darker bark, which on the trunk is marked by long transverse rifts (lenticels). The current season's twigs of Andrews' specimens are light brown, the two-year-old twigs more or less grayish, and the older branches reddish brown and distinctly marked by the white oval lenticels. The bark on the main trunks is silvery gray, materially darker than in *B. papyrifera*, though it peels readily into layers as in that species. The leaves do not seem to differ essentially, being either broadly cuneate or rounded at the base. The margin is rather sharply and irregularly serrate, though the teeth are not long. The apex is somewhat abruptly short-acuminate. The bracts of the fruit are deeply 3-lobed, the central lobe being longer and narrower than the lateral. The nut is oblong-ovate, with very thin wings nearly twice as broad as the body.

Its habit is perhaps its striking character. In *B. papyrifera* there is usually a single trunk, which branches above in true tree fashion. Andrews writes of his birch as follows: "You will notice the uniform tendency to form clumps or stools, which is true of quite young specimens. The