One pipe would be sufficient for a small table, so that one might thus utilize a small corner of a room. Pipes driven into the ground are, of course, practicable only when the laboratory is on the ground floor and does not require too great an extent of the pipe above the ground.

The special features of these shelves are their cheapness, the carrying of a number of shelves on the same pair of pipes, and the ease with which they can be fixed up, so that one might readily set up shelves for different pieces of apparatus.

I use the shelves for work where a plant is on a lower level than the apparatus used with it. This result is gotten by boring a hole through the shelf and fastening the rod of a ring-stand in the hole with a nut. The ring can then be adjusted to any height on the rod.

Figure 1. Respiration Apparatus.

New Apparatus for Vegetable Physiology.[1]

By J. C. Arthur.

[Abstract.]

The following apparatus was described: (1) A respiration apparatus to determine the amount of carbon dioxide exhaled by breathing plants within a certain time at a fixed temperature, the baryta method being used; (2) a centrifugal apparatus for revolving growing plantlets at a high speed, to replace gravity with a similar force, that may be varied at pleasure, in order to determine its effect in giving direction to the forming organs of plants; (3) a gas chamber to supply different gases to living tissues under the microscope; (4) a slide with binding posts to convey a current of electricity through living tissues under the microscope; and (5) a hygrometer to exhibit the comparative rate of evaporation of water from the two sides of a leaf. An instrument of each kind was exhibited, except the first one mentioned, which was illustrated with a drawing.

1. The Respiration Apparatus consists of a small glass chamber in which the seeds or other growing parts are placed. This is suspended by means of a brass cover, in an outer jar containing water of suitable temperature. The respiration chamber is connected through potash bulbs and a wash bottle with an aspirator, so that to begin with, all carbon dioxide may

be removed from the chamber and afterwards a current of air free from carbon dioxide be forced slowly through the chamber. As the air leaves the chamber it passes through a long Pettenkofer baryta tube, containing a solution of barium hydrate, and then through a similar but smaller tube, also containing barium hydrate. Only one long and one short tube are used at a time. When the first period is ended the current of air is diverted to the other pair of tubes by the turn of a stopcock, and in the meantime the first pair of tubes is emptied, refilled with fresh solution and placed in readiness to be used when the second period is ended, and so on. The solution from the tubes is titrated, and by a simple calculation the amount of carbon dioxide exhaled by the plantlets ascertained for each period.

The apparatus is a modification of the one used by Prof. Pfeffer (Unters. Bot. Inst. zu Tübingen, I, 637), which in turn was an adaptation of Prof. Pettenkofer's apparatus for studying the respiration of animals.

2. The Centrifugal Apparatus is to illustrate Knight's famous experiment in geotropism. The essential part of the apparatus consists of a closed chamber kept moist by dripping water, in which a cork disk is made to revolve. On this disk are pinned germination seeds. This disk is revolved rapidly (from one hundred to five hundred revolutions a minute) for some time, and the position assumed by the growing roots and the stems observed. The moist chamber and revolving disk may be set horizontally, vertically or at any intermediate angle. The speed is found by moving a paper over a pencil point at the lower end of the spindle for a definite time. It may be run by any convenient power, as a small water motor, or an electric motor. The apparatus is an invention of the writer.

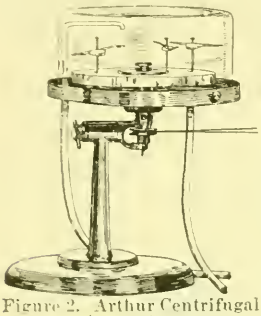

Figure 2. Arthur Centrifugal Apparatus.

3. The Gas Chamber, for use on the stage of the microscope, consists of a shallow brass chamber, three inches long by one and three-fourths broad, with projecting metal tubes at either end. One side of the chamber is provided with a glass window, and the opposite side has a circular opening, which is to be closed when in use with the cover glass bearing the object for the experiment. The object to be examined is placed in a drop of water upon the center of the cover glass. The glass is then inverted over the opening of the gas stage, the margin having first been smeared with vaseline in order to

Figure 3.

make the glass fit air tight to the metal. The gas is now passed into the chamber from a generator or reservoir through one tube, escaping through the other. The apparatus has been in use some time in European laboratories.

4. The Glass Slide with Binding Posts, to be used when it is desired to pass an electric current through a microscopic object, consists of the usual form of microscopic slide, with a small brass binding post at either end, connected with a pair of clips. To put into use, two small wedge-shaped pieces of tin foil are placed under the clips, so that the points nearly touch. The object is then mounted between them and covered with a cover glass in the usual manner.

Figure 4.

5. The Awn Hygrometer is used to indicate the loss of moisture from a leaf surface. It consists of a thin glass chamber, across the month of which extends an adjustable metal rod. An awn of stipa is supported from the middle of the rod by a set screw, and from the other end of the awn an index projects at right angles. As the air of the chamber becomes moister the awn untwists, and the index is carried around. The most satisfactory way of using this instrument is to fasten a pair of hygrometers of equal sensitiveness to a leaf, one on either side, by means of a mixture of wax and oil. The leaf is either left attached to the plant or dipped into water to prevent wilting, as shown in figure 5a. The comparative rate of transpiration from the upper and lower surfaces of a leaf is thus obtained.

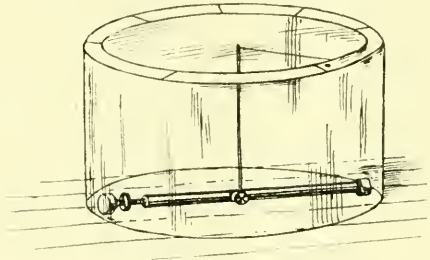

Figure 5. Darwin Awn Hygrometer.

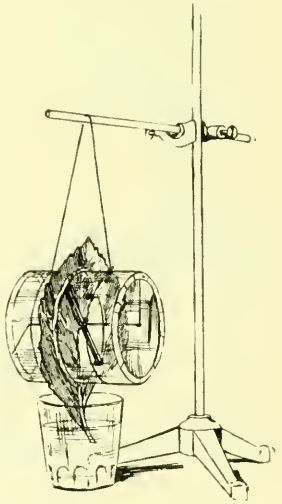

Figure 5a. Hygrometer in Use.

This instrument in the crude form was seen by the writer when visiting the laboratory of Mr. Francis Darwin at Cambridge in 1888, and has been in use in the physiological laboratory of Purdue University since that time. The present form is the result of this experience.