unique means of adhesion and locomotion and the surprising metamorphosis from extraordinary larval forms are all alike ignored. Another striking case is that of the cephalopods, whose unusual modes of locomotion, remarkable means of concealment when in retreat, and highly developed eyes, surely demand at least a reference. On page 298, the statement occurs: "The most complicated eye in the Mollusca is found in the scallop"—one wonders just what is meant by "complicated" and why the cephalopod eye is overlooked. Omission of many other extraordinary structures, functions and activities among invertebrates might be cited but lack of space forbids. Among the vertebrates we find no reference to the shell and skeleton of turtles, only a trivial allusion to the locomotion of snakes, no reference to the nest-building and egg-laying of birds, and no reference to animal voices, not even the singing of birds. It would of course, be foolish, and unfair to Professor Dakin, to extend indefinitely this list of omissions, but the point the reviewer wishes to emphasize is that too much is overlooked or ignored to justify calling this book "The Elements of General Zoology."

That there is much of value in the volume is beyond question. The text is clear, the illustrations and diagrams good and the marginal subtitles are helpful. There is a brief introduction of 8 pages, followed by Section I "An Introduction to the Protozoa." The 25 pages thus used form one of the most satisfactory chapters in the book. Just enough of classification is introduced to hold together the facts and the student who really masters this account will have a coherent idea of the Protozoa. Section II, "The Study of the Biology of the Multicellular Animals" occupies over 400 pages and suffers from the attempt to omit everything in the nature of a classification. It is not necessary to enumerate here all the chapters or to discuss their contents. The general arrangement is that of the usual text-book on physiology—nutrition, respiration, blood and its circulation, locomotion, nervous system and sense organs, excretion and reproduction. A chapter on the animal skeleton precedes that on locomotion, while another on the cell is intercalated between locomotion and the nervous system—just why at this point it is hard to see. Chapters on life histories, on the fresh-water pond as an animal community, on symbiosis, parasites, disease and bacteria and on the animal as a whole, make up the remainder of this section. A dozen of the chapters end in suggestions for "Practical Work," experimental studies and observations by the students themselves. The discussion of the animal as a whole leads to a brief account of some of the aspects of heredity and evolution, and the relation of biology as a study, to human life. The book ends with 35 pages of general instructions for laboratory work, a brief appendix, and a not very satisfactory index of four pages. The student who really masters the contents of Section II will have an admirable idea of animal physiology, but his ideas of structure will undoubtedly be more or less confused and he will know almost nothing of the animal kingdom.

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## SCIENTIFIC APPARATUS AND LABORATORY METHODS

### A CONVENIENT DEVICE FOR PLANT SOLUTION-CULTURE WORK

THE paraffin-impregnated corks commonly used as supports for the seedlings in plant solution-culture investigation present certain disadvantages which I have attempted to eliminate by substituting perforated paraffin discs supported on glass rods of appropriate design.

Two hundred cc. of hot water are measured into a 250 cc. Pyrex beaker which is placed on a hot-plate. To this is added ten grams of paraffin m.p. 52–56° C. When the latter is melted the beaker is removed from the hot-plate. When the paraffin disc has solidified by cooling, it is loosened with a thin-bladed knife and removed from the beaker. The diameter is lessened by paring off a millimeter or two from the circumference so that the disc fits loosely within the beaker in which the cultures are to be made.

The glass supports are made from 4 mm. rod. This is cut into 15 cm. lengths and marked off accurately at 2.5, 5.0, 10.0, and 12.5 cm. with a blue pencil. Right-angle bends are carefully made at these points using an iron block 2.5 cm. high as mold, and the small but hot flame of the micro-burner for heating. The complete support has this shape.

Four notches are cut in the paraffin disc so that it rests easily on the two supports hanging from the

edge within the beaker. When the discs and supports are properly made the former present a plane surface parallel with the surface of the culture solution which can be of any desired distance from the disc. Then the convenient number of holes is made in the paraffin disc through which the roots come in contact with the culture solution. These holes are made of any desired diameter by means of appropriately selected cork-borers. In order to prevent cracking of the disc it is necessary that the cork-borer be hot. I have found that immersion of the instrument in hot water does this best. So heated, a little well-like curbing is formed around the hole which serves nicely to keep the seedling raised from the flat upper surface of the disc.

It will be at once evident that this device is capable of any modification necessary to suit the individual need. It also allows of easy adjustment of depth of culture solution and degree to which the roots are immersed therein. Its convenience will be apparent to those who have wrestled as I have with the unplastic cork.

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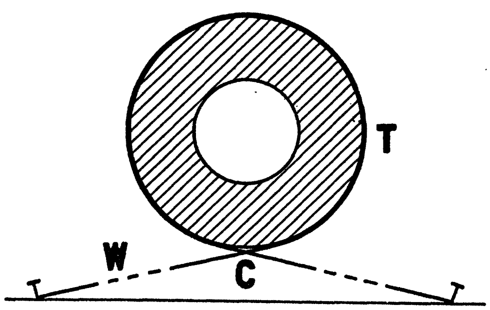
## A METHOD FOR CUTTING GLASS TUBING

THE accompanying figure illustrates a method which has been found to be successful for cutting heavy glass tubing. A piece of bare, soft-drawn copper wire "W" is wrapped once around the tube "T" and fastened to the work bench. A mixture of carborundum powder and glycerine makes a convenient grinding compound. A to and fro motion of the glass in a direction parallel to the plane of the figure produces relative motion between the wire and glass and the carborundum is thus carried around. The glass should occasionally be turned so as to make a cut of uniform depth. In case it is




necessary to locate the cut exactly some kind of clamp or guide should be used until a groove is started. If a deep cut is made the point "C" where the wire crosses causes binding. When this stage is reached it is well to mount the tube in a lathe and hold the wire in the groove using only one half of a turn. (Be sure to protect the lathe from the compound.) New wire should replace the old frequently to avoid binding when the new is used.

The author's first use of the method was in cutting a Pyrex tube having an outside diameter of 4.4 centimeters and 1.2 centimeter walls. Number 80 carborundum powder was used, first with Number 18 wire and then with Number 20. The cutting time was about three hours. Finer wire and powder would be better for smaller or more delicate pieces.

The method has the advantages of simplicity, small breakage risk and freedom from strains introduced by methods using heat. It is particularly useful in cutting short lengths of tubing.

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# SPECIAL ARTICLES

## REFLECTION OF LIGHT FROM THE SURFACES OF LEAVES

THE classical studies of Brown and Escombe[1] on the interchange of energy between the leaf and its environment form our only important sources of information as to the quantitative income and outgo of energy during the processes of photosynthesis, transpiration and thermal emissivity. They measured the solar radiation with much care, determined the coefficient of absorption of energy by the leaf, measured the amount of energy expended in the various forms of internal work, and the gain and loss of energy during positive or negative thermal emissivity at the leaf surface. From these various determinations they attempted to construct a balance sheet of the energy income and outgo of the leaf.

Careful consideration of their work makes it obvious that their figures, which account for 100 per cent. of the energy inflow in terms of work and transmission, can not be as accurate as they appear to be at first glance. The most patent error is one to which they referred, but neglected because they thought it was a small error. This is the reflection of light from the leaf surface, which, they say, with perpendicular incidence "must be very small in amount." The reflected light was allowed to enter, as an error, into the calculation of the coefficient of absorption, which is therefore too large.

During the last two years many measurements of the reflection of light from leaf surfaces have been made by means of the Keuffel and Esser direct reading spectrophotometer. This instrument is designed to measure the percentage of reflection at an angle of 90° to the surface of the leaf when the incident light falls upon the leaf from almost every possible angle. By means of a wheel, carrying a wave-length

[1] Brown, Horace T., and Escombe, F. "Researches on some of the Physiological Processes of Green Leaves with Special Reference to the Interchange of Energy between the Leaf and its Surroundings." *Proc. Royal Soc.* London B. 76: 29–111. 1905.