two megaphyllous (wrongly termed macrophyllous). The Psilophytales are thoroughly described and to it the following 5 families are referred: Rhyniaceae, Horneaceae, Pseudosporochnaceae, Psilophytaceae and Asteroxylaceae. One might well question the propriety of making the imperfectly known Pseudosporochus the type of an independent family.

The Lycopodiales are considered to include the following 6 families: Lycopodiaceae, Selaginellaceae, Isoetaceae, Lepidodendraceae, Sigillariaceae and Bothrodendraceae, and aside from certain questions of relative values, are fairly well done.

The Articulatales stock is divided into 5 groups which I suppose have the rank of orders. These with their contained families are: Protoarticulatineae with the families Calamophytaceae and Hyeniaceae, which is considered the most primitive group, although actually based upon 3 highly interesting but imperfectly known and possibly misinterpreted species: Pseudoborniineae with the single family Pseudoborniaceae, also imperfectly known: Sphenophyllineae with the family Sphenophyllaceae: Cheirostrobineae with the family Cheirostrobaceae: and Equisetineae divided into the three families Asterocalamitaceae, Calamitaceae and Equisetaceae.

The fifth main stock, the Cladoxylales, with the single family Cladoxylaceae, seems particularly unfortunate. The group is remarkable enough in its combination of characters and is evidently an isolated one, but no one certainly knows that it is a Pteridophyte. Paul Bertrand, who knows considerably more than the present author about these forms, thinks that they were seed plants. We know something of the habit of the middle Devonian *Cladoxylon scoparium* but its foliage is less deserving of the term megaphyllous than is that of Pseudobornia or Asterocalamites and the supposed association of *Sphenopteris refracta* Goeppert with Voelkelia is by no means established.

The Filicales are treated as Eusporangiatae, Protoleptosporangiatae, Leptosporangiatae, and those of uncertain systematic position. The first includes the Coenopteridineae with six families, and is well done to the extent to which the facts are available; the Ophioglossineae and the Marattiineae. The Protoleptosporangiatae comprise the single family Osmundaceae, and the Leptosporangiatae are divided into 12 families. The volume closes with brief and unimportant chapters on the general morphology of the Filicales and the comparative morphology of the Pteridophytes.

The book is well printed and profusely illustrated, a considerable number being original. It seems to me that the discussion of impressions of Lepidodendron and Sigillaria is well done. The somewhat difficult anatomy of the Coenopteridineae is made rather clear, and there is a full discussion of the diverse forms of Psaronius. The author evidently believes that Thomas has demonstrated that Sagenopteris is the foliage of a seed plant, since it receives no mention in the present volume.

Opinions will naturally differ regarding the success with which Hirmer has performed his self-assigned task. Many omissions could be pointed out, but such are inevitably present in a work of such scope. On the whole I believe that the book will serve a very useful purpose. Its chief defect, in addition to the lack of judgment in the classification adopted which has already been alluded to, is the failure to exhibit any acquaintance with the American literature. For example I find no Mesozoic Lycopodiums recorded from North America, nor any mention of Harder's work on fossil bacteria, or of the important Lepidophyte fructification Cantheliophorus, and I might easily mention a great many other instances. However, no one but a German author seems to have the industry to produce a work of this sort, and no one but a German publisher would undertake to print such a work, so that botanist, paleobotanist and geologist should alike be thankful and give it their blessing.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A CONSTANT RATE ASPIRATOR

IN a study of the factors affecting the rate of respiration in plants,[1] it became apparent that a constant rate of aspiration was one of the most desirable features. Several well-known types of aspirators were tried but in every instance it was found that the desired constancy could not be maintained. A new type of aspirator was developed which combines simplicity, unvarying rate, a wide range of force and portability. The features of this instrument are such that we believe it will prove of value to investigators in all branches of scientific research where a constant rate of aspiration is desired.

The device consists in an arrangement employing the well-known principle of Mariotte's bottle. Two bottles, the size of which depends upon the use to which the operator puts his instrument, are arranged so that one is supported in an inverted position directly over the other as in Figure 1. The inverted bottle is fitted with an intake tube A bent upon itself in the manner illustrated with the open end at x–x′. The reason for bending this tube will be shown later.

[1] Article to appear in a forthcoming issue of *The Botanical Gazette*.

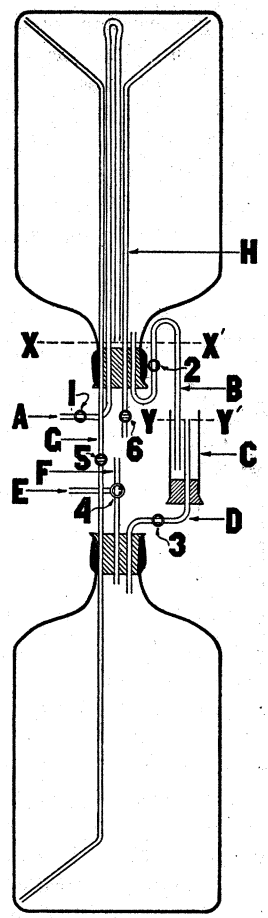

FIG. 1. A constant rate aspirator. Explanation in the text. The mechanical support for the bottles is not shown.

The outlet tube B is bent in the form of an S or a reverse curve with the intake end arranged so that it is well above the open end of A at x–x′ and with the second curve above the level of the intake end. The open end of B extends below the level of the liquid y–y′ in the automatic level device C. When the aspirator is in operation the flow of liquid from the inverted bottle through tube B, automatic level device C and discharge tube D into the lower bottle exerts a negative pressure in the inverted bottle. This negative pressure operates through intake tube A which is attached to the instrument in which a constant rate of aspiration is desired. The rate of flow of gas through intake tube A is determined by the distance between x–x′ and y–y′ minus the resistance offered in the instrument attached to A. When the latter is determined the rate of aspiration is adjusted by controlling the distance between x–x′ and y–y′.

The arrangement in Figure 1 facilitates the rapid refilling of the inverted bottle with the liquid that has been collected in the lower one while the instrument was in operation. This makes possible the reusing of the same liquid. Further, the gas collected in the inverted bottle can thus be analyzed by gasometric methods. Assuming the latter to be the case, air pressure is applied to E through three-way valve 4. Stopcocks 1, 2 and 3 in tubes A, B and D respectively, are closed. Stopcocks 5 and 6 in tubes G and H are opened. The air pressure in the lower bottle returns the liquid through tube G into the inverted bottle, the displaced gas being forced out through tube H. To this tube a gas meter and burette are attached. When all of the gas in the inverted bottle is displaced stopcocks 5 and 6 are closed and the three-way stopcock 4 is opened to F. The instrument is ready for operation when stopcocks 3, 2, and 1 are opened in the order named, tube F serving as an exhaust for the lower bottle.

When this aspirator is used for collecting the gas passing through the instrument attached to A it is essential that the construction of the former precludes the entrance of air. The greatest error from such a source is obtained when the volume of gas changes quickly in the inverted chamber with a lowering temperature. This tends to draw the liquid back through the reverse-curve tube B. To insure the sealing of this tube, constant level device C is made large enough to contain sufficient liquid to compensate volume changes due to temperature variations under the conditions of operation. The construction of the instrument also obviates the possibility of a loss of aspirated gas outward through B. This is obtained by having the level of the outlet of the tube A below the level of the intake of tube B and the second curve of B above its intake end. By this arrangement the aspiration ceases as soon as the level of the liquid in the inverted bottle reaches the intake of tube B. It is desirable not to allow the instrument to operate until the liquid reaches this level, especially if the temperature of the surrounding air is likely to increase.

If tube A is not constructed as shown it is almost impossible to keep the liquid from entering it when refilling the bottle. Should this happen the rate of aspiration is seriously affected. To prevent it, the tube is carried to the top of the bottle before being recurved.

This aspirator has been used successfully in the study of the respiration of plants both under laboratory and field conditions. It is constructed from 40 liter or 20 liter bottles when used in the laboratory and from 10 liter bottles when used in the field. Pyrex tubing with a 4 mm. inside bore is used throughout. A special liquid is employed when gasometric methods are used. It is known to absorb only slight traces of carbon dioxide and was obtained from Layng and Crum[2] of the chemistry department of the University of Illinois. It consists of a 35 per cent. aqueous solution of zinc sulphate to which 14 grams of concentrated sulphuric acid are added per liter of solution.

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A SIMPLIFIED PLANKTON BUCKET

Many users of the old fashioned naturalist's plankton net who may object to its crudeness or who have employed the commoner expedient of tying a glass bottle into a silk net, will appreciate a simple device which serves the same end much more efficiently. There are a number of elaborate plankton buckets described which serve various purposes but none of these are quite simple or inexpensive enough for the ordinary biological teacher or investigator who purposes only a qualitative collection for classroom demonstration or technical use.

The writer uses, both for class work and for his own investigations, conical fine silk nets of number twelve and twenty grade, and a plankton bucket of his own design. While not especially new in principle, the bucket is simpler and more inexpensive than any he has seen or used before. It may be constructed by almost any one. The bucket is made up of four parts: First, there is an inverted and truncated cone with a fairly long threaded tube attached to the truncated end, secondly, there is another cone exactly like the first one but without the tube, which fits closely over the other of the two cones. A threaded ring which screws on the tube of the first cone is the third part. The first cone is dropped *into* the net and its tube is arranged to project below, outside the net. The second cone is then fitted to the first from the *outside* of the net with the silk between the two. The two cones are now clamped together and held tightly by the threaded ring; they lock the device to the apex of the net. The fourth part of the apparatus is the bucket, a simple cylinder closed at one end and threaded at the other to fit the tube of the inner of the two cones. The cylinder is of uniform diameter and may or may not have a flange at its threaded end to give weight to the apparatus. The cylinder is screwed to the tube and the bucket is ready for use at once. All parts are constructed of brass.

The net arranged as above may be used exactly as other rigs, but one needs only to unscrew the cylinder to release the catch, and pour the collected plankton into a bottle for preservation or observation while alive. The writer finds the apparatus a very valuable adjunct to his laboratory classes in which a number of plant and animal plankton organisms lend much interest to the ordinary class routine. In collecting material for investigation the contents of the cylinder may be put directly into fixing reagents in the field and carried home in the best condition.

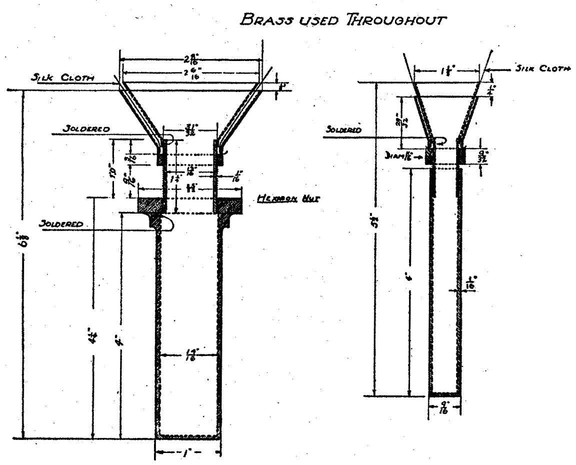

Fig. 1

The whole apparatus is heavy enough to sink easily without extra weights, but does not weigh enough to tear the wet net and it lacks the cumbersomeness of the more elaborate deep-sea apparatus. The diagrams illustrate the dimensions and form of two rigs used by the writer (Fig. 1). Others may be used of course to fit different nets and purposes.

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SPECIAL ARTICLES

OBSERVATIONS ON HEATING HAY IN THE FLOODED REGIONS OF NORTHERN VERMONT

Many interesting reports of the devastations wrought by the recent floods in Vermont and Massachusetts have been written. Little mention has been made, however, of the effect of the floods upon the tons of feeding stuffs stored on the farms for winter use. The agricultural pursuits of the farmers in the valleys of the Vermont rivers have been confined largely to dairying, most of the flat valley land being used for hay production. In New England the length and severity of the winter season make it imperative that the farmer be well supplied with hay for his stock.

[2] Layng, T. E., and S. A. Crum, "On Examination of Methods of Gas Analysis." Unpublished paper, University of Illinois.