point with the drum can be very delicately adjusted. The matter of obtaining a uniform pressure over a large range of movement of the pointer is a difficult one on account of air eddies, but a very satisfactory air stream for recording small changes of pressure can be obtained by blowing air through an ordinary fish tail burner tip, commonly used on Bunsen burners, as illustrated in the figure.

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# SPECIAL ARTICLES

## PRE-CARBONIFEROUS FORAMINIFERA

THE foraminifera, representatives of the most primitive invertebrate phylum, are, paradoxically enough, essentially missing from the roster of the geologically older faunas. The various reasons for their apparent absence can not be discussed here; but because our paleontologic knowledge of the group prior to the mid-Mississippian (when at least one species, *Endothyra baileyi,* definitely became abundant), is so scanty, even the vaguest pre-Carboniferous foraminiferal record is eagerly sought for by paleontologists.

The specimens recorded from the pre-Cambrian of Brittany by Cayeux, however, are regarded by many as unauthentic. Those described by G. F. Mathew from the Cambrian of New Brunswick, according to Howell,[1] turn out to be phosphatic concretions; and a large percentage of the few Cambro-Ordovician and Silurian species of Europe, described by Chapman, Ehrenberg, Brady, Terquem and Keeping, has been looked upon with considerable skepticism by some paleontologists. In 1930, however, Moreman[2] described a rich faunule of arenaceous foraminifera from the Silurian Chimney Hill formation of Oklahoma, and a few species from the Arbuckle and Viola formations. This was the first *bona fide* North American occurrence of pre-Carboniferous age to be reported. But since the appearance of Moreman's paper, Whitcomb[3] has reported (but not described) Ordovician foraminifera from Pennsylvania, and Thomas[4] has described posthumously a single Devonian species from Iowa. To these three American records it is now possible to add a number of others.

For several years a group of graduate students, under the direction of the senior author, has been carrying on detailed micropaleontologic examinations of the older Paleozoic sediments of Ste. Genevieve County, Missouri. As some of these investigations have resulted in the discovery of arenaceous foraminifera in considerable abundance, it is thought advisable to make announcement of this important fact prior to the publishing of the detailed descriptions of the faunas.

Late in 1930 Mr. Dunn found a number of arenaceous foraminifera in siliceous residues of the Bainbridge limestone (Niagaran of southeastern Missouri). Accordingly, on our return to the University of Chicago's Missouri Field camp in June, 1931, we were equipped to carry on microscopical studies of the sediments essentially at their outcrops. In this way it was found that almost all samples of the Bainbridge, regardless of lithologic appearance and stratigraphic or geographic position, contain foraminiferal remains. The Brassfield (Alexandrian) strata of southeastern Missouri also were found to carry an abundant fauna; and later it was discovered that a suit of Brassfield samples, collected by Professor D. J. Fisher near Joliet, Illinois, was likewise replete with the same general types of foraminifera. Furthermore, although the suspected remains thus far found are decidedly fragmental, we have a strong suspicion that the Niagaran beds of the Chicago area and the Waldron strata of Indiana also contain similar forms, though in considerably diminished numbers. So far as the Waldron is concerned we understand that this suspicion is shared by Professor Willard Berry, of Ohio State University. Mr. Dunn will soon have the results of the research on these Silurian sediments ready for publication. In the meantime, however, it may be pointed out that forms similar to if not identical with the following typical Chimney Hill species are common in the Bainbridge fauna:

*Ammodiscus excertus,* Cushman.
*Ammodiscus incertus* (d'Orbigny).
*Bathysiphon curvus,* Moreman.
*Colonammina conea,* Moreman.
*Lagenammina stilla,* Moreman.
*Lituotuba exserta,* Moreman.
*Psammosphaera cava,* Moreman.
*Sorosphaera tricella,* Moreman.
*Thurammina triangularis,* Moreman.

The similarity of these unusual faunas suggests the possibility of accurate correlation of a number of mid-Paleozoic formations on the basis of arenaceous foraminifera. The writers are fully aware of the fact that this is in part a presumption. The effectiveness

1 B. F. Howell, Appendix E, Rept. Nat. Research Council Sub-committee on Micropaleontology, April, 1931.
2 W. L. Moreman, *Jour. Paleont.,* iv, 1, 1930.
3 L. Whitcomb, Appendix E, Exhibit A, Rept. Nat. Research Council Sub-committee on Micropaleontology, April, 1931.
4 A. O. Thomas, *Jour. Paleont.,* v, 1, 1931.

of such a correlation scheme depends not alone upon the extent to which the foraminifera can be found in beds wherein their presence previously has not even been suspected, but also upon whether such primitive types change sufficiently during a relatively short elapse of geologic time to be really diagnostic. The tremendous geologic range of such species as the modern *Ammodiscus incertus* (d'Orbigny) might seem to indicate that they do not, but on the other hand there is no difficulty in separating Alexandrian Brassfield samples from the Niagaran Bainbridge sediments solely on the basis of differences in their foraminiferal remains. That a number of other mid-Paleozoic formations may yield foraminifera when the unsoluble residues are studied is suggested by the fact that we have also found the Helderbergian Bailey formation of southeastern Missouri to contain their abundant remains, though the assemblage has not yet proven to be particularly diversified. This new fauna is being described by Mr. Hunter.

In addition to the very definite discoveries mentioned above, it may be well to list the less positive and the entirely negative results of our studies. The Oriskanian Little Saline limestone pretty certainly contains these microscopic organisms, although our specimens are thus far both rare and discouragingly fragmentary. The mid-Devonian Grand Tower, Beauvais and St. Laurent formations have been carefully examined, thus far with only negative results. The Ordovician Joachim formation apparently does not contain foraminifera, but there is evidence, still far from certain, that the Plattin, Kimmswick and Fernvale may yet yield unquestionable specimens. A number of older formations of the Ozarks, such as the Gasconade, Jefferson City, Cotter and Powell, also have been studied, but without positive results. As H. S. McQueen, of the Missouri Bureau of Geology and Mines, however, has run literally thousands of careful mineralogical studies on the insoluble residues of these sediments without noticing foraminifera, we may at least assume that very few of the organisms were preserved in these strata.

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## TREATMENT OF COTTON ROOT-ROT WITH AMMONIA

A TOXIC effect of ammonia on the root-rot fungus, *Phymatotrichum omnivorum* (Shear) Duggar, has been determined as a result of a series of experiments in growing the fungus in different media, during the season of 1931. When ammonium salts were used as the source of nitrogen in Duggar's solution, the growth of the fungus was notably restricted, and this indication was confirmed by subsequent tests. It was found that both the mycelial and sclerotial stages of the fungus were killed by short exposure to the gas, and where dilute concentrations of the hydroxide were applied under field conditions, the fungus was killed in the tissues of cotton roots.

In the cultural experiments with ammonium nitrate and ammonium sulfate, when used at a concentration to yield approximately 12.4 grams of nitrogen per liter, very little growth of mycelium appeared after intervals of 11, 18 and 31 days, whereas the other sources of nitrogen, *viz.*, calcium nitrate, potassium nitrate and sodium nitrate, produced an abundant growth.

After pH readings had revealed that the suppression of growth with the ammonium salts was not attributable to an acid reaction of the media, the apparent toxic effect was studied. The procedure was as follows: fresh cultures were prepared in 125 cc Erlenmeyer flasks containing 50 cc of neutral carrot agar, and after growth was well established over the media, the mycelium in each of four flasks was exposed for 20 minutes to dilute ammonium hydroxide (.1, .5 and one per cent. by volume, prepared from 28 per cent. ammonia water). Four untreated flask cultures were reserved as checks. After the above exposures, transfers were made immediately from the treated and check flasks to neutral carrot-agar slants in test-tubes. In every case, the inoculum from the cultures treated with ammonium hydroxide failed to grow, but growth occurred in all cases from the check inoculum.

Other flask cultures were subjected to ammonia treatment for 30 seconds by generating the gas from 500 cc of 28 per cent. ammonia water and allowing this to enter the culture flask by means of glass tubing. The gas treatment also completely inhibited growth of the fungus when transfers were made. Further tests were made with root-rot sclerotia by exposing them to ammonia, chlorine and formaldehyde gas for short intervals (10, 15 and 20 seconds) with the ammonia treatments showing complete mortality.

Roots obtained from freshly wilted cotton plants were exposed to the same gases for intervals of 30 seconds and of 1 and 2 minutes and later tested for viability of the fungus in moist chambers. The ammonia treatments prevented growth, while the formaldehyde and chlorine were only partially effective. Good growth occurred in all of the checks.

Field tests have also been conducted at various times during the season to compare the effectiveness of 6 per cent. solutions of ammonium hydroxide, formalin and sodium hypochlorite when applied in the soil to the roots of infected cotton plants. In