Since there was some shrinkage during the curing process, a small amount of refitting was necessary. This was accomplished by inserting the free end of the shaft in the chuck of a heavy-duty stirring motor and holding a strip of sandpaper against the tip of the rapidly turning pestle. Slight touches of sandpaper against the other high points on the pestle soon resulted in a good fit, preferably somewhat tighter at the shoulders than at the tip. The final fitting was accomplished by pouring a suspension of carborundum powder in water into the tube, inserting the pestle, and rotating the pestle at medium speed in this mixture. The carborundum served two purposes. It completes the fitting and removes the glaze from the mortar wall. This latter step strikingly increases the efficiency of the homogenizer.

If desired, a spiral groove may be cut into the pestle from the shoulder to the tip in such a direction that the rotation of the pestle tends to carry the homogenate to the bottom of the mortar. The complete homogenizer is shown in Fig. 1.

This motor-driven homogenizer works best if sample sizes are kept to 500 mg or less. A 300-mg sample of leaf disks from the interveinal area of tobacco leaves can be completely macerated in about 30 sec. This homogenizer has been found to be very durable, and a large number of samples may be homogenized with a minimum of refitting. It is assumed that it would be equally effective for macerating animal tissues.

References and Notes

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New Techniques for the Study of Restoration of Compacted Soil

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About 5 years ago we (*1*) visited an airport where investigations were being made on methods of maintaining soil in a compacted condition for a firm landing strip. It appeared then that even firmly compacted soil eventually becomes restored to its normal structure. Compaction of soil that is caused by farm animals and machinery may persist for years, but it also is known to disappear in time. The effects of physical factors—wetting and drying and freezing and thawing—and the effects of bacterial and fungal growth on the soil structure have been subjected to some investigation. In contrast, the specific effects of animals in the restoration of deteriorated soil have had less attention.

These facts suggested a study of the relationships among the various physical and biological factors in the restoration and maintenance of soil structure. First

Fig. 1. Core with alfalfa meal additive, exhumed after 4 mo. Most of the original core had been removed by earthworms. Light-colored material from the core had been deposited as casts throughout the adjacent region.

we sought to devise satisfactory methods for destroying the structure of soils. In an exploratory series of experiments, surface soils from a fertile garden and from an old compost heap were mixed with water into thin mud and molded into cores in 1-pt paper cartons. These cores were removed from the cartons, air dried, and buried just below the surface near the places from which the soil was dug. In the course of a winter the cores literally disappeared as compacted objects. Wetting and drying, freezing and thawing, and extensive tunneling by earthworms and other animals all seemed to be factors in the structural restoration.

In a second series of experiments, soil of lower organic content from the B horizon of Miami silt loam of a badly eroded garden, was mixed with water and molded into cylindrical cores of about 3.5 in. by 3.5 in. in diameter and in height. These core dimensions have become standard for all our experiments. The cores were buried to a depth of 3 in. in three separate sites: (i) a dense woodland, (ii) the garden from which the soil was taken, and (iii) an old field that had not been cultivated for 10 yr. After 2 yr the cores in the woodland were little changed. There was little penetration by roots and almost no evidence of shrinkage cracks or tunneling by animals. The forest appeared to have insulated the cores from the severe effects of moisture and temperature changes. In contrast, the cores buried in the two open areas showed, after 1 yr, many horizontal shrinkage cracks and some vertical ones. The cores in the old field, after 1 yr, had been pierced by the roots of grasses and weeds. There was some tunneling by wireworms. Platy structures had developed, with fungi growing on the surfaces of the plates. Nematodes, mites, and collembolans were active in the cracks in the cores. In a few instances, ants had penetrated the larger cracks and had enlarged the spaces by nibbling at the fungi on the soil faces. The cores in the eroded garden were less affected by roots, fungi, and small animals than the cores in the old field.

As a result of these observations, a third series of cores was prepared from soil of even lower organic content, from the B_2 horizon of Crosby silt loam. One set of control cores was made by adding only water to the soil; to a second set, inorganic fertilizer and sufficient lime to bring the *p*H to neutrality were also added; to a third set, alfalfa meal was added; and to a fourth set, the insecticide, chlordane, was added. These cores were buried in late May and early June in two sites, a woodland and an open field, both of Crosby silt loam. All were buried at 1-ft intervals 5 in. beneath the surface, the types being distributed by a standard randomized formula. Half of the cores in the field were given clean surface cultivation, and the remainder were sodded over by grass that was clipped regularly.

The most rapid transformations occurred in the alfalfa-meal cores (Fig. 1) that were buried in the open field. Molds and bacteria grew quickly throughout the mass of the cores. In a few weeks the initial aggregate stability (as determined by the S.C.S. modification of the Yoder wet-sieving technique) had increased from about 20 to nearly 100 percent. There was little change in volume from wetting and drying. Earthworms ingested the material of the cores from all sides, so that within 3 mo some of them had the appearance of almost-eaten apples. Worm casts from the cores were recognizable for several inches in all directions. The nature and extent of the worm tunnels was recorded by making latex casts of the voids by a process developed earlier (*2*). Ants and microarthropods were active on the eroded surfaces of the cores.

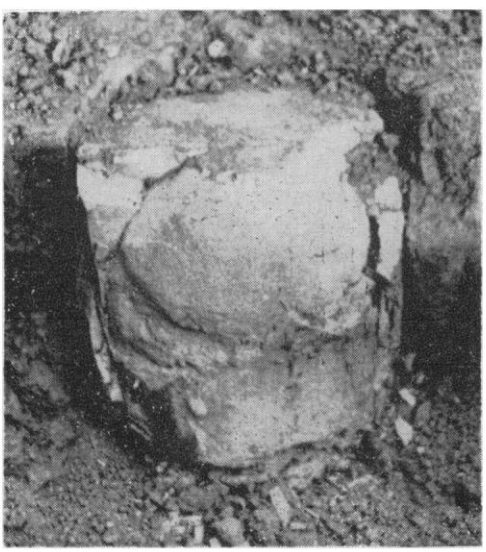

Fig. 2. Core with no additive, exhumed after 4 mo. The shrinkage cracks and exfoliated structure are the results of alternate wetting and drying.

At the end of the first summer the remaining three types of cores in the open field showed relatively little change except for the development of horizontal shrinkage cracks with platy structure (Fig. 2). Their aggregate stability continued to be very low. Fungi developed to some extent on crack faces. Some nematodes, mites, and collembolans were found.

The cores of the various types buried in the forest soil underwent less transformation than their replicates buried in the open fields. We were surprised by the low level of faunal activity. The full implication of this phenomenon requires further study.

These experiments indicate that the restoration of compacted soil occurs in orderly processes that vary widely according to location and organic content. Cores rich in organic matter and buried in open areas develop a mass stability that retards the formation of shrinkage cracks. However, earthworms ingest large quantities of the soil and fungi, thus mixing the material of these cores with the surrounding soil. Cores low in organic matter lack this stability and develop extensive cracks into which roots may penetrate. Fungi developing on the interfaces may be eaten by microarthropods, with possible subsequent enlargement of the spaces.

Recognition of further details of the restorative process may be expected as the experiment continues. We believe that the techniques of preparing and burying standardized cores of soil, compacted by puddling and variously treated to attract or repel organisms, offer a means of studying the processes of change in soil structure through the interaction of physical and biological factors that will be useful in many aspects of soil research.

References and Notes

1. An interdepartmental team at Earlham College is carrying on a project in soil research under a grant from Charles F. Kettering and the Kettering Foundation.
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New Design of Ultrafiltration Apparatus

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Ultrafiltration is superior to other methods for the concentration of colloidal solutions in that it (i) avoids the denaturing action of precipitating agents or heat, (ii) provides for removal of salts as well as solvent, (iii) assures essentially quantitative recoveries of the colloids, and (iv) requires little attention from the operator. A new apparatus for this purpose, similar to a filter press in design, is described in this paper. This apparatus is versatile with respect to capacity and does not require disassembly for collecting the concentrates. With its aid we have readily succeeded in obtaining up to 94-fold concentration of large vol-