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MILTON WHITNEY, Chief.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., March 26, 1912.

SIR: I have the honor to transmit herewith the manuscript of an article on Sponge Spicules in Swamp Soils, by R. O. E. Davis, Scientist in Physical Laboratory Investigations, Bureau of Soils, and to request that this be published as Circular No. 67, of this bureau.

Very respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

SPONGE SPICULES IN SWAMP SOILS.

By R. O. E. DAVIS, *Scientist in Physical Laboratory Investigations.*

Recently a number of inquiries have been received by this department concerning the cause of itching sensations produced in men and work animals employed upon certain soils, especially in Georgia and Florida. The trouble is experienced in working the soils of certain areas, which happen in each case to be land that has been drained. During dry weather the workmen suffer from a terrible itching of the feet, and the feet of mules used in plowing become sore and inflamed. The trouble is not so bad if the soil is worked in a fairly moist condition.

One of the places in Georgia from which a sample of soil was obtained is described as an old cypress pond of 8 to 10 acres, which has been drained for about 30 years. The soil is fertile and from 1 to 8 feet in depth. The same trouble is met on a farm in Lee County, Ga., and in submitting a sample of the soil one of the field workers of the Office of Experiment Stations writes:

> The soil can be cultivated only when wet, as the mules and men can not stay on the land when it is dry. Shoes are ruined in one day and mules' feet are made raw in the same length of time. Most of the drained land in the neighborhood is affected with the same trouble and this fact deters people from undertaking work in drainage.

Various suggestions have been made as to the cause of this peculiar action of the soil, such as the presence of the hook-worm, pollen, alkali, and sulphuric acid formed from the oxidation of sulphides in

the soil. A thorough examination of the soil, however, made it appear improbable that any of these was the true explanation. A physical action suggested as causing the burning sensation was that the dry, powdered soil, consisting of a mixture of organic matter and the finest of mineral clay particles, produced a drying effect on the skin. The moisture was absorbed so rapidly that an apparent burning resulted. This explanation, however, was not entirely satisfactory, and a careful microscopic examination of the soil was made.

The microscopic examination [1] revealed in the soil the presence of immense numbers of sharply pointed crescent-shaped bodies of siliceous material. These have been identified [2] as siliceous residues (spicules) of certain species of sponge. They are somewhat crescent shaped, about 0.2 mm. long and 0.02 mm. in width and are readily

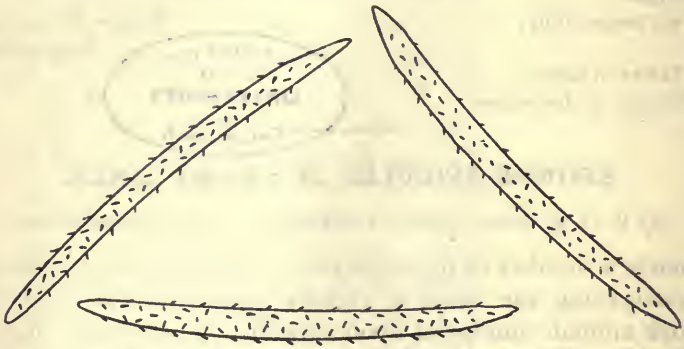

FIG. 1.—Sponge spicules magnified about 200 times.

distinguished from the siliceous remains of certain elongated diatoms by the lack of the elaborate sculpturing generally present in the latter. These are the remains of fresh-water sponges and may vary in size and shape. The most common in the Georgia soil is the *Mayenia millsii*, which is crescent shaped, with tiny spines projecting from the body of the spicules. The presence of these spicules in large quantities in the soil causes the irritation described. The character of the spicules is shown in figure 1.

Mayenia millsii is described by Edward Potts [3] as follows:

> Skeleton spicules nearly straight, cylindrical, slender, rather abruptly pointed, entirely microspined. Spines few, low, conical. Measurement of skeleton spicules 0.0107 by 0.0005 inch. Collected from Sherwood Lake, near De Land, Fla.

All the forms of fresh-water sponges as yet discovered are siliceous. The skeleton or framework (corresponding to the elastic fiber of which commercial sponges are composed), upon which slimelike sponge flesh, known as "sarcode," is supported, and

[1] Mr. W. J. McCaughy made the microscopic examination which located the trouble.

[2] The identification was made by Dr. Albert Mann, Bureau of Plant Industry, who was also kind enough to make examinations of several samples of soil.

[3] Synopsis of forms of fresh-water sponges, Philadelphia Acad. of Nat. Sci., 39, 225 (1887).

through whose interstices the currents meander, is composed of siliceous spicules, slightly bound together by an almost invisible quantity of firm sarcode, or, perhaps, of colloidal silica. In the different species these skeleton spicules vary in size, in the shape of their terminations, and in their more or less spinous character.

The soils of the region investigated carried as high as 25 per cent of these spicules. Of course, their presence in such quantities is unusual and presents a problem to the soil technologist. Importance attaches to its solution, because any land that has remained as a swamp for a long time may be infested with these spicules. Their presence has been frequently noted in regular mineralogical examinations of soils and evidently they are quite widely distributed.

Examinations were made of nearly 200 samples of soil from different parts of the United States taken from beds of lakes and from swamps. Spicules were found in nearly all, but generally in very small quantities. Those in soils from other localities than Georgia varied somewhat in character. They were crescent shaped but did not have the small spines on their surfaces. The quantity in the soils of the Klamath project of Oregon was large. Diatoms were also present. The muck soil of Florida showed the spicules in the greatest abundance, with the exception of the Georgia soils already mentioned, but the spines were missing from them also. In none of 40 soils collected from the cypress swamps and bayous of Louisiana and other Gulf States were the spicules found in any quantity.

It was desired to know whether these sponge spicules were present in the lower layers of soil and, if so, in what amounts. Prof. W. A. Worsham, of the University of Georgia, secured samples from the spot near Montezuma, Ga., showing 25 per cent of spicules. These samples were carefully taken at different depths and sent to this bureau. Dr. Mann made an examination of these samples to determine the relative number of spicules at the different depths. This was done by preparing representative samples on slides and making counts of the number of spicules in each sample. The result follows:

Quantity of sponge spicules in the soil at different depths.

Sample No.	Depth.	No. of spicules on slide.	Approximate percentage of spicules in soil.
1	Surface	58	25
2	Surface, cultivated	63	25
3	6 inches	58	25
4	10 inches (side of ditch)	Negligible.	
5	12 inches	14.5	6
6	2 feet (side of ditch)	None.	
7	2 feet	Negligible.	
8	3 feet (side of ditch)	None.	
9	3 feet	Negligible.	
10	5 feet (bottom of ditch)	None.	

From these results it would seem that the spicules are practically confined to the first 6 inches of surface soil. A few appear at 12 inches, although they are absent from the 10-inch sample, but this irregularity may be due to some disturbance of the soil strata or to the fact that the 10-inch sample was taken from a ditch.

The treatment of soil in which the spicules are present in quantity must be regarded as a physical problem, as the spicules are siliceous in character and there is no practical method for their removal by chemical means. The presence of the spicules in the soil up to 4 or 5 per cent does not seem to have any bad effect, but with larger quantities the disagreeable results ensue. The microscopic spicules are like finely divided glass and cut into the flesh of man or beast, and upon the quantity of the material depends the severity of the result.

It has been observed that in parts of the affected district where sand has been washed over the land the unpleasant results are not observed, and it appears that the best way to solve the problem is to mix some other soil with the infested soil. The most convenient and practical way to do this is by mixing some of the subsoil with the surface soil, and since in the worst infested areas the presence of the spicules is confined to the first 6 inches, this can be done with comparative ease by deep plowing.

It is very likely that no bodies of fresh water exist for a very long period without a growth of fresh-water sponge and the consequent deposition of the sponge spicules. Their presence in unusual quantities presents a subject of practical interest. It is suggested, then, that in areas where drainage is contemplated the soil from the lake bed or swamp be examined microscopically for these remains. If present in considerable quantities the depth of the deposit and the possibility of admixing extraneous material to ameliorate the condition should be determined.

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