SPECIAL ARTICLES

A COUNTING METHOD FOR THE MECHANICAL ANALYSIS OF SOILS[1]

MANY investigators have worked on the problem of the mechanical analysis of soil, notably, Osborne,[2] Hilgard,[3] Hopkins,[4] Briggs,[5] Yoder[6] and Atterberg,[7] and the final result seems to indicate that some form based on sedimentation in water is the most serviceable for practical purposes. However, it may be of interest to soil workers to note a counting-plate method which approaches the problem from a different angle.

The counting-plate method has been used for the determination of soil particles in an attempt to save the time of centrifuging and evaporating the silt and clay suspensions. The sand is obtained by subsidence as in the regular method. The total weight of the silt and clay is determined by difference. The relative amounts are then obtained as follows:

The method is based on counting the number of silt and clay particles on a counting plate and from the relation thus established to determine the amount of clay and silt in the soil. This is an adaptation of a method employed in many different lines of work where both the number and diameter of small grains are to be obtained; as in the examination of blood, starch, etc. This method is not recommended for general use with soils, and should be used only where time is especially important or the facilities are not available for the determination of silt and clay as described above.

A definite amount of soil is weighed out, put in a sterilizer bottle with water and ammonia, and shaken in a mechanical shaker for at least seven hours. With most soils one half gram material and 120 cubic centimeters water give a good dilution for accurate counting. A compound microscope with a micrometer eyepiece and a counting plate are necessary. In the micrometer used one scale division corresponds to 0.005 millimeter, the superior limit of the clay, and ten divisions to 0.05 millimeter, the superior limit of the silt. The counting plate is marked off in squares of 0.1 millimeter a side. After removing from the mechanical shaker, the contents of the bottle are thoroughly shaken by hand and a sample for examination immediately taken from the center of the bottle. A drop is placed on the counting plate and the number of silt and clay particles in ten squares counted. The sand need not be considered. In most cases it settles quickly and escapes being taken in the subsample. If a sand particle appears in the subsample it is disregarded.

As one silt particle is much heavier than one clay particle, a factor must be used in obtaining a ratio to express the relative total weights of silt and clay in the soil. This factor was determined approximately by comparing the results obtained by counting with those obtained from analyses made in the regular way. For instance, soil No. 5,862 gives a count in ten squares of 26 silt particles and 2,020 clay particles. The regular analysis gives 23.06 per cent. silt and 45.78 per cent. clay, practically twice as much clay as silt. So first the number of silt particles (26) is multiplied by 2, giving 52. Dividing the number of clay particles (2,020) by 52 gives the factor 38 plus, or shows that 38 clay particles weigh as much as one silt particle. Therefore in this soil if we multiply the number of silt particles (obtained by counting) by 38, the result will be to the number of clay particles as the weight of the silt is to the weight of the clay. In 26 soils of widely varying texture, lately analyzed by the counting method and checked by the centrifugal analysis, an average of the factors was 35. The factors varied, however, widely enough to pre-

[1] Published by permission of the Secretary of Agriculture.

[2] Ann. Rep., Conn. Expt. Sta., 1886, p. 141; 1887, p. 144; 1888, p. 154.

[3] Ann. Rep., Cal. Expt. Sta., 1891–92, p. 243.

[4] Proc. Asso. Off. Agrl. Chem., Bull. 56, Division of Chemistry, U. S. Dept. of Agr., 1898, p. 67.

[5] U. S. Dept. of Agr., Bureau of Soils, Bull. 24.

[6] Bulletin No. 89, Utah Expt. Sta., 1904.

[7] Verhand. d. II. Inter. Agrogeol. Konf. Stockholm, 1910.

clude using this method as a regular routine analysis for all soils.

There are several reasons explaining the divergence of these factors from the average. To obtain one factor which would obtain for all soils, the silt particles (and likewise the clay) would have to be of a uniform size, shape and weight. These conditions do not exist in nature. However, if one size graded into the next, and the shape and specific gravity of the material were fairly uniform, the factors would still not be widely divergent. Another difficulty enters here; not only is this hypothesis doubtful, but it is not possible, on account of the great difference in size of the largest silt particles and the smallest clay particles, to have a counting plate and objective so calibrated that the very small clay particles could be counted and at the same time to give a field large enough to include a number of silt particles. So in order to get the silt it was necessary to use a low-power objective, and consequently many of the smaller clay particles were not counted.

The disadvantages of the method are that it is not applicable in every instance because of the small mass of clay particles in some soils; that the counts are not sufficiently uniform where great accuracy is necessary; and that in order to get the best results the operator must have a large experience in the usual methods of analysis.

C. C. Fletcher

Bureau of Soils,
Washington, D. C.

On a Posterior Communication of the Air-bladder with the Exterior in Fishes

Recently, while examining the visceral anatomy of *Ophiocephalus,* my attention was called to what appeared to be a posterior communication of the air-bladder with the exterior. My species is *Ophiocephalus maculatus,* and before its death had been an aquarium pet of a Chinese in Redwood, California. Hence from whence it came is not known, but doubtless from somewhere in China, for many of this singularly hardy fish are carried alive by the Chinese from their home country.

The abdominal cavity of *Ophiocephalus* extends for a greater distance behind the anal opening than in front of it for the accommodation of the very long air-bladder, which reaches almost to the base of the caudal fin. About midway in the length of the air-bladder a wide tube of thin membrane is attached, which opening at its lower end to the exterior through the genital pore, appears at first sight to be a duct from the air-bladder, more especially as it is of the same white, glistening membrane. It, however, ends blindly against the wall of the air-bladder where it is so firmly attached by the incasing fibers of the latter extending over and around it that considerable tearing is necessary to detach it. Both the tube and the air-bladder, where the tube joins, were opened and examined under the microscope but no opening was found in either. The end of the tube is round and blunt. Into its lower end the vas deferens opens. Just above where the vas deferens enters, or just below the middle of its length, the tube expands into a large triangular pocket with a blunt point directed forward.

Almost a century ago Weber ("De aure et audita Hominis et animalium," Leipzig, 1820, p. 73) described in *Clupea harangus* a communication from the posterior end of the air-bladder with the exterior through a duct opening with the vas deferens into the genital pore. This condition being so nearly parallel with that described above for *Ophiocephalus* leads me to question whether the tube described by Weber was not also a blind tube, and not actually opening into the air-bladder.

Having no specimens of *Clupea harangus,* and having other problems on hand, I have not attempted to go more deeply into this subject. As the supposed fact that *Clupea harangus* has a posterior opening to the air-bladder has been repeated several times since the time of Weber without any one attempting to verify his work (or at least indicating that he has verified it), it is desirable that some one do so. I pass the problem on for what it may be worth.

Edwin Chapin Starks