glands derived from the pharyngeal walls are passed over rather lightly in Chapter IX. There is also absence of discussion of the later history of the mesenteries. Chapter X, however, is on the contrary a rather full and complete treatment of changes in the development of the kidneys and reproductive system and includes an excellent series of figures.

The circulatory system is well discussed and looks very modern with many of Heuser's and Butler's splendid figures, as well as new ones by the author, especially on the heart. The reviewer regrets the omission of the lymphatic system, since the chief stages in vessels and glands can be readily demonstrated in pig embryos and because American workers have contributed valuable papers and illustrations in this field, and important problems still lie before us here. The same might be said for the vessels of brain, face and appendages.

Chapter XII is devoted to the development of bones and of the skeleton. It is presented as a type of detailed study of one system, through histogenetic and macroscopic steps, studied by a variety of methods which give a good idea of how such work is done, as well as the results. The teeth are similarly studied in considerable detail, and many excellent new pictures are introduced in both of these chapters. Another good series is a set of pictures of the development of the face and palate in the pig.

The volume is concluded with an excellent bibliography, where the most important papers, especially modern studies, which deal with the stages considered in each chapter, are listed. References are also given to subjects slighted in the text.

Finally, the reviewer would conclude that the author of this little book has achieved a noteworthy success. It is a stimulating and exceptional text, and the publishers have certainly done their part thoroughly well. They have permitted a generous number of new illustrations, reproduced in excellent manner. These pictures not only parallel the text, but add much information. The careful artistic work of the author and his assistant is of course at the bottom of the success of the illustrations.

HENRY MCE. KNOWER

UNIVERSITY OF ALABAMA

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A RAPID METHOD FOR MECHANICAL ANALYSIS OF SOILS

As our knowledge and understanding of soils becomes greater, clearer and more comprehensive, the more we are coming to the conclusion that practically all the physical as well as the physical-chemical reactivities or relationships of soils reside almost entirely in the colloidal portion of the soil. Such properties or phenomena, for instance, as absorption of chemical elements, base exchange, retainability of plant food constituents, hygroscopic water, adsorption-absorption of water, water-holding capacity, capillary movement of water, evaporation of water, unfree water, wilting coefficient of plants, cohesive and adhesive properties of soils, shrinkage of soils, easiness of tillage operations, etc., are controlled mainly, if not entirely, by the colloidal portion contained in the soil. A study of soils, therefore, is really becoming to be a study of the colloidal portion of the soil.

This rather radically changed view of soils has been mainly brought about in the last few years by the discovery that the colloidal content of soils is infinitely greater than we used to think. The old idea, which was handed down mainly from the work of Schloessing, maintained that the amount of colloids in soils rarely exceeded 1.5 per cent. The newer methods of measuring the amount of colloids in soils, however, such as the water vapor adsorption, heat of wetting, base exchange and hydrometer method, show that the colloidal content of average soils is very high; in the sandy loams it may be as high as 20 per cent., loams 30 per cent., clay loams 50 per cent. and clay 75 per cent.

The old notion also maintained that whatever colloidal matter there was in the soils, it existed as a coating around the soil grains. It has recently been shown by the writer, however, that such is not entirely the case. The colloids exist in the soils both as a coating and as an independent component; which one of these forms predominates depends upon the amount of colloids present and upon the type of soil. In many soils, however, the largest amount of colloids exist as an independent component.

A great stride has recently been made in the study of colloids by the discovery of a method for determining the colloidal content of soils very rapidly as well as accurately. By the water-vapor adsorption, base exchange and heat of wetting methods, especially the first two, it would take more than a week to make a determination of the colloidal content of a soil. By the new method, which is the hydrometer method, it takes only about fifteen minutes to make a determination. The hydrometer method is able to accomplish this, by a rather remarkable factor or relationship that has been discovered to exist between the percentage of colloids as indicated by the heat of wetting method and the percentage of material that stays in suspension in a liter of water at the end of fifteen minutes, based upon the amount of sample taken. This relationship may appear to be empirical and incredible, but it has a fundamental relationship behind it, and the results it gives on the determination of the colloidal content of soil seem to be correct. The hydrometer method can also be used to measure the rate of settling of soil particles, from which a distribution curve could be worked out.

If it is true that the colloidal portion of the soil controls almost entirely its physical as well as its physical-chemical reactivities, as enumerated above, the question arises whether, for practical purposes at least, the determination of the colloidal content of soils would be sufficient in the mechanical analysis of soils. In other words, would merely the knowledge of the colloidal content coupled with field or sight identification be sufficient in giving us a fairly true picture of a soil, at least for practical purposes?

A comprehensive and deep consideration of the subject would seem to reveal the fact that at least in most of the phenomena or properties mentioned above a knowledge of the colloidal content of the soil is all that is necessary. For instance, if it is true that the colloidal content of soils is infinitely higher than we used to think; if it is true that all the heat of wetting and unfree water as found by the writer is controlled almost entirely by the colloids; if it is true that the water adsorption of soils is about 95 per cent. due to colloids and only about 5 per cent. due to non-colloids, as found by the U. S. Bureau of Soils; if it is true that practically all the base exchange is in the colloids as found by Parker and Pate, then certainly all that is essential to know, for these particular properties, is the colloidal content. The rest of the material acts more or less as an inactive skeleton. What is true of these properties or phenomena is undoubtedly true also of many of the others of the foregoing list, such, for instance, as the retainability of plant food, wilting coefficient of plants, shrinkage of soils, facility to water percolation, etc. There are some properties, of course, where the non-colloidal material exerts considerable influence as, for instance, in the water-holding capacity. In this case the surface and interstices of the non-colloidal material influence the total water-holding capacity. On the whole, however, there are very few if any properties of the soil which are not controlled either entirely or predominantly by the colloids.

The determination of the colloidal content does not, of course, give us the relative amounts of all the separates in the soil, but the important question to consider is, is it necessary from a practical standpoint to know the relative amounts of all the separates, since, as stated above in most cases, they merely function as inactive skeletons.

But even when we do get the relative amounts of the separates of a soil by the standard mechanical analysis, do we have the true facts? That is, do our present mechanical methods give us the true facts? If the results yielded by the methods of water-vapor adsorption, heat of wetting, base exchange and hydrometer method all show that the colloidal content of soils is infinitely greater than we used to think, then the results of the mechanical analysis method are not correct. For instance, what the mechanical analyses call clay and silt may almost all be colloids, by the new conceptions.

There seem to be three serious objections to the present methods of mechanical analyses. The first is that they are terrifically laborious and time-consuming; second, because they are so laborious and time-consuming they are employed very little to-day, and third, the results they give do not agree with our present views of soils.

In view of the above facts about the mechanical analysis of soils, in view of the fact that the colloids seem to control all the properties of soils, and in view of the fact that the amount of these colloids can now be determined in only about fifteen minutes by the hydrometer method, then it would seem that greater advance could be made by using the hydrometer method to make a mechanical analysis of soils. Because of its simplicity and rapidity everybody could use it and all the soils could be studied by it, which is impossible to do by the mechanical analysis.

By experience we know approximately when we see it that a soil is clay, loam, silt loam, sandy loam, sand, etc. If we take a sandy loam, for instance, and determine its colloidal content, and we find that it is 20 per cent., then we know that the other 80 per cent. is mostly sand, with probably some silt. The field or sight identification, together with the colloidal content, would seem to give a fairly good description of soil for all general practical and essential purposes. At any rate the colloidal content is the most important and essential single determination from the mechanical standpoint.

Like the other separates of the soil, the soil colloids are not all of the same size. While a determination of the amounts of the various sizes would be desirable, yet generally speaking it is not so important from a practical standpoint. What is probably far more important and essential is the knowledge of the activity of the colloids. Different colloids give different amounts of heat of wetting, which is partly an indication that they are in a different activated condition. The difference in activity may be partly accounted for by assuming that colloids from various soils may not all represent the same degree of decomposition or maturity, and consequently they do not all have the same state of hydration, porous, rough and felt-like surfaces, even though in size of particles they may not differ so greatly. This difference in activity makes the colloids react differently. The hydrometer method does not show this difference in activity, but the heat of wetting does. Part of this activity or condition of the colloids, however, is apparent to the eye or touch. For instance, some colloids are not so sticky or plastic as others.

GEORGE J. BOUYOUCOS

MICHIGAN STATE COLLEGE,
EAST LANSING

SPECIAL ARTICLES

OCEANOGRAPHIC RECONNAISSANCE OF THE NORTHERN SECTOR OF THE LABRADOR CURRENT

THE coastal waters off northern Labrador have long been neglected as a field for scientific study, being neither far enough away to warrant an elaborate arctic expedition nor yet near enough to be reached easily. With the modern development of dynamic oceanography it is now possible through subsurface measurements of temperature and salinity not only to secure an accurate picture of the extent of a gradient current, but also to understand how and why it flows. This gives an increased value to well-planned subsurface observation, although in most parts of the sea the stations must be many, and close together, for the best results. Along the Labrador Coast, however, the contrasts in temperature and salinity are so great that fewer stations will suffice to indicate the dominant, dynamic tendencies, so that this region offers a most promising field for a short cruise.

The existence of a powerful south-flowing arctic current, coming out of Davis Strait and following the coast line southward for 1,600 miles to the so-called "Tail" of the Grand Banks, has long been common knowledge. The fact that this arctic flow transports many bergs from Baffin Bay south to the shipping lanes aroused sufficient interest in England (1913, after the *Titanic* disaster) for the sending out of the *Scotia* expedition. Since 1914 the U. S. Coast Guard cutters on the Ice Patrol Service have spent much of their time studying the physical properties of the waters of the region, so that we now have a nearly complete picture of the circulation in the vicinity of the Grand Banks and as far north as the Strait of Belle isle. But north of this point subsurface observations off shore in the Labrador current proper, have been confined to two stations made by the *Scotia* at about lat. 54° 30′ N.

During the summer of 1926 an oceanographic reconnaissance of the current off the Labrador coast was carried out by eight Harvard students, under the leadership of C. Iselin. In a seventy-seven foot schooner, named the *Chance,* the expedition sailed as far north as Cape Chidley, the northeastern extremity of the peninsula. Forty-five stations were occupied for serial observations, at many of which plankton hauls were also made.

It is impossible here to give more than a brief survey of the more important results of the expedition, which are still being worked up at the Museum of Comparative Zoology. But two profiles of the Labrador current show the south-moving icy water considerably narrower than had previously been supposed. The current was confined to the water over the continental shelf and therefore extended off shore only eighty-five miles off Nachvak Bay (lat. 59° N.) and one hundred and twenty-five miles off Sandwich Bay (lat. 54° N.). At the outer edge of the current there was a very abrupt change from water as cold as −1.5° C. to water of 4° C. At the same time the salinity increased from less than 33.5 to about 34.5 per thousand. This region of transition was so sudden that the isotherms and isohalines are nearly vertical when plotted to the usual scale on cross-section paper. The *Chance* data, compared with the *Scotia* stations, shows that outside the edge of the continental shelf the water of this sector is remarkably homogeneous, and as far as is yet known has little dynamic cause for movement. The inshore water, though very cold, is much less saline and therefore lighter than the offshore water, a contrast great enough to cause a gradient current of about twelve miles a day to the southward along the whole length of Labrador. That this current is comparatively constant in character and volume all the way from Davis Strait to Newfoundland is proven by the available information.

Although the study of this northern sector of the Labrador current is as yet in its infancy, the following preliminary statement seems warranted. Land drainage supplies about as much fresh water to the coastal edge of the current as is lost along its outer edge through mixture with the warmer and more saline north Atlantic water. The great vertical stability of the water layers is a factor in keeping the temperature practically constant throughout the length of the current, because in summer a thin surface film of water of low salinity averaging about 3° C. in temperature prevents the penetration of solar warming by convection to the deeper water, which continues southward nearly at its winter value (−1.5° C). This same surface film is prevented from warming to any great extent during the summer, first by the field ice in the spring, and later by the melting of the bergs which it carries south. In this way a considerable volume of water with a temperature of less than 0° C. and a salinity of about 33 per thou-