

## THE DEVELOPMENT OF SOIL SURVEY.

T. M. BUSHNELL, Purdue University.

The ancients believed in the elemental nature of earth, air, fire and water. This simple concept has been replaced by complex, modern science, yet to the average person, soil is simply "dirt". Simple, contrasting adjectives such as "good or bad, wet or dry, hard or soft, sand or clay, and black, white, red or yellow" are commonly used and seem sufficient. Men may agree that soil is a simple subject until they have some examples before them and find they can not agree as to what is "black" or "clay" or even say what the soil is.

Before attempting any sort of definition of the soil, mention will be made of the beginnings and growth of the Soil Survey idea. Students of ancient history find references to soil studies which might be considered the germs of the idea. However, when the modern period of the study of nature arrived, soil science, as such, seems to have been neglected. Apparently no great scientist worked in this field so intensively as in other branches of study, and much soil knowledge came as by-products of botany, zoölogy, physics, chemistry, geology, etc. Perhaps this neglect resulted because the agriculture on soils of the civilized world was the outgrowth of centuries of use, and this use had greatly modified the natural soils. Many soil studies have been designed to learn how to increase crop yields, rather than to learn to know the soil itself. Numerous physical and chemical studies have been made—not of the soil—but of soil materials, disturbed and mixed, often without knowing what soil or what portion of a soil was being investigated. The results were little more informing about the actual soils than the analyses of odd bits of animals would be. The need of knowing the "kinds of soils", and of having a strictly scientific taxonomy of soils was gradually recognized. One of the earliest forms of classification was based on the natural vegetation of the land and gave rise to such terms as "prairie", "walnut", or "piny woods" lands.

Probably the most extensive and best system of soil classification until recent years, was an outgrowth of geology, and took into consideration physiography, drainage, lithological nature of the soil-forming materials, and some of the processes by which they were accumulated. Thus we use such expressions as "upland or bottom", "limestone or sandstone", and "glacial or residual" soils. While these factors are all of importance, especially in connection with the geographical distribution of soils, this mode of attack failed to get at the fundamental relationships of soils.

Dr. C. F. Marbut, of the U. S. Bureau of Soils, stated in 1921 that there was "a complete lack throughout the world, until less than 40 years ago, of a knowledge of the real characteristics of soils, and the lack of this knowledge in this country until less than 20 years ago". European scientists, especially those in Russia, are credited with the first understanding of soils. A soil map of European Russia, published in 1901, embodied some of the earliest soil survey work of the

world. About the same time an independent start was being made in this country where the recognized pioneer is Prof. Milton Whitney, Chief of the U. S. Bureau of Soils.

Russian soil survey progressed until interrupted by the war and has since been resumed. In the United States it has grown continuously, largely through work of the U. S. Bureau of Soils, with or without the co-operation of various state agencies. Some states have carried on independent work, and naturally there has been great divergence in the methods and products of the various surveys, but all have classified lands upon some basis and have shown the location of the classes on a map. That is the essence of soil survey. It is primarily field work designed to identify, describe, classify, correlate and map soils. In recent years the tendency is to enlist the aid of all branches of science which have any contact with the soil and to consider correlative laboratory work, experiments and extension as integral parts of a complete survey.

What, then is the true soil? Marbut defines it as the weathered surface horizon of the earth's crust, which forms a natural body, developed by natural forces acting through natural processes upon natural materials. The soil embraces that layer of the earth's surface having the most abundant and complex flora and fauna. It is the meeting ground of the organic and inorganic materials. Soil is dynamic and everchanging. It passes through youth, maturity, old age, rejuvenation and transmigration. The one-sided observation of soils, chiefly from the top, contributed to general ignorance of their nature. Cultivation mutilated the true soil. Soil survey workers went a little deeper with soil augers and learned something from the mixed and displaced material they brought up, but made the mistake of limiting the study to three feet or some other arbitrary depth. Even today this idea persists in the form of analyses of the surface three feet divided into arbitrary layers. Yet who would attempt to study corn by cutting three feet off of the tassel end of stalks standing from two to ten feet high, then subdividing these lengths into segments for analysis?

A scientific classification of soils must be on the basis of features of the soils themselves, rather than on the growth they support or the way the materials accumulated. The characteristic features by which a soil type or species is recognized and identified and classified are embodied in the natural soil section extending from the surface to the unweathered parent materials, whether it be one or twenty feet below. This soil section is made up of natural horizontal layers which are different from each other but relatively uniform within each, as to color, texture, structure, thickness and chemical composition. Each soil type has a definite number of layers in the same relative arrangement, and is derived from geologic parent materials of a certain character.

A soil series or genus includes soil types which are practically alike save in the texture of the upper layers. Formerly, soil series were grouped into provinces which corresponded to certain geological features of the country, but a more scientific classification results from grouping the series into families according to features of the soil sec-

tions which are the mature expression of various sets of climatic conditions. Mature soils develop where topography favors drainage and aeration and the accumulation of weathered products. On rolling or eroded lands the soil section may be immature, and on flat lands it may have passed through maturity to old age, marked by strongly leached surface and so-called "hardpan" layers. In associated lands with a high water table there is preservation, rather than weathering, of the parent materials, and accumulation of organic remains. Weathering of alternately wet and dry lands proceeds in a complex manner.

The chief factors of climate affecting soils are conditions of heat and moisture. In this country east of the Rocky Mountains there are two or three temperature zones and three or four zones according to rainfall and humidity, and as the resultant of prevailing climate Marbut has described ten distinct soil families. These families may be grouped into two soil orders—the arid and the humid. The soils of the arid order are marked by a zone of carbonate accumulation in the soil section, while those of the humid order lack this zone, but are leached and often acid.

At present a soil survey embraces several phases. First is the strictly research work designed to collect enough data to serve as a basis of a natural and sound classification, and provide adequate nomenclature so that all soil science may be related to soil types. A part of the records of soil survey is in the form of maps, and this map making is one of the chief functions of the field workers. A soil survey includes some physical and chemical tests in both field and laboratory. Since the work is supported chiefly by agricultural appropriations it is expected to justify its existence by ultimate benefits to the farming interests. Efforts to be of more immediate benefit take the form of aiding the interpretation of results on experimental fields and of showing where these results apply, or of furnishing data to extension workers. However, most soil survey workers feel that an attempt to occupy middle ground between the "practical and scientific" promises little progress in either direction, and believe that sound soil science is a prerequisite to sound advice on practical soil problems. It is hoped to collect and organize soil facts into a science comparable with other branches of knowledge. Just as we receive aid from geologists, botanists, bacteriologists, etc., they should be benefited by a fund of exact knowledge whenever the soil is involved in their problems.

In Indiana the soil survey has passed through several stages. The U. S. Bureau of Soils mapped ten counties between 1901 and 1908. Beginning about 1907 the State Geological Department carried on work under the name of "Soil Survey" which eventually covered most of southern Indiana. In this the classifications were based more on geological formations than on soil, and the mapping was very general. In 1912 the Bureau of Soils resumed work in the state, now in co-operation with the State Geologist. Under this arrangement sixteen counties were mapped in the central and northern part of the state. It includes some very good work needing little revision to bring it up to date. Nothing was done in 1918.

In 1919 the U. S. Bureau of Soils began co-operation with the Soils and Crops Department of the Purdue University Agricultural

Experiment Station, which also carries on the experimental and extension work linking the soil survey with the agriculturist, who is the one most interested in the soil. Under this arrangement six counties have been worked, though but one is published. Such rapid development of new ideas concerning the nature and classification of soils has been made in the last few years that delays in publication permit the reports to be put in the most up to date form. We are now emerging from the transitional period and hope to proceed on a more logical and permanent basis with the work of knowing and mapping the soils of Indiana.