The study of soils began not as an independent branch of science, but as an adjunct to some established scientific discipline, such as geography, geology, mineralogy, chemistry, or a combination of some of these. The scientific study of soils began in the laboratory, not in the field. As a result, soil morphology made no progress until extensive studies in the field forced the workers to describe the soil, give its morphological characters, such as color, structure, constitution, consistency, and texture. But in the early period of field study, it was not morphology of soils, but of soil material. Not until the soil was recognized as an independent natural body did scientific soil morphology find its place in the scheme of soil studies and became the valuable aid in unravelling the problems connected with soils.

**HISTORICAL**

**Soil science as an independent science**

Because of its geographic position Russia presented an ideal geographic unit for the systematic study of soils. The vast stretches of the plain in European Russia with its fairly homogeneous character of topography at its gradual change of climatic conditions, expressed by the temperature and moisture relationships, as one moves from north to south made it imperative for the man in the field to study the soil in all its aspects. The consequence of this favorable physico-geographical position was that the Russian soil workers were the first to recognize the soil as a distinct and independent discipline of natural science. One may find hints to that effect in the work of other students of soils long before the savant and founder of the Russian soil science, Dokuchaev, announced his conclusions on the genesis of the Russian chernozem (black earth), which served as the basis for ushering in the new concept of soils as a historical, independent, natural body.

The natural scientists and early students of soils did not look upon soils as a distinct branch of natural science. Soils were appreciated simply as an object of agricultural activities for the human. The famous chemist, Berzelius,
calls the soil “the chemical laboratory of nature in whose bosom various chemical decompositions and syntheses take place in large quantities in a hidden manner.” [Quoted from Yarilov (77).] Sprengel (62) designates the soil as a changed mass of material derived from minerals containing the decomposition products of plants and animals.

Thaer (66) looked upon soils from a utilitarian standpoint. He divided soils into six species, each one being subdivided into several classes primarily on the basis of their utility. The species are: (a) Clay soils, (b) loam soils, (c) sandy loam and loamy sand, (d) sandy soils, (e) humus soils, and (f) limestone soils. This is a purely physical concept. Thaer calls the soil “a raw material from which the agriculturist obtains various organic products without which he could not persist.”

The geologic point of view was developed by Berendt (5). He states: “Petrography and pedography, the study of native rocks, and soil science are branches of the same science—geognosy.” He distinguishes between “Boden” and “Grund.” The latter according to Berendt is “the native rock which appears to us in undisturbed solid form.” The former is considered as “the part of native rock which comes out to the surface and which is mellowed mechanically because of its contact with the air, which changes it chemically.”

The famous German soils man, Wahnschafte (71), does not agree with Berendt’s definition of soils, which would exclude the marsh and peat soils. He therefore gives his own definition. “Soil is not a geognostic conception, but a cultural-technical, primarily an agricultural. . . . As soils I understand the upper mellow and earthy layer of the earth’s mantle even though it may support but the poorest vegetation.”

Fallou (16) occupies a unique place in the history of soil science. His work has not been appreciated and has been forgotten, although historically he may be looked upon as the founder of pedology. Fallou showed how the utility standpoint of the students of soils, up to his time, prevented the crystallization of a scientific appreciation of the nature of soils as such. He criticized severely the chemical theory of soils. He wrote: “Recently the millenium for agriculture was looked for from the chemist; it was thought that a chemical analysis of the soil would give a complete idea about the soil. . . . Soil science was recognized not as a science by itself, but as a branch of agricultural chemistry. . . . Soil science is an empirical science. Nature itself is its source. Observations on soils in their geognostic relations, or in their relation to the strata formation and to the underlying rock are of special importance.” We may readily see that Fallou was a proponent of the purely geognostic or geologic point of view. He realized, however, that the science of geology does not exclude soil science as a distinct discipline. “Just as petrification is looked upon independently of the native rock which accompanies it and we have paleontology as a distinct science, in the same way, soils may be separated from the native rocks and investigated as a separate independent scientific discipline.” The definition given by Fallou for soils is: “Soil is
decomposed, more or less disintegrated native rock distinct and separate from
the compact, undisturbed native rock, with an admixture of organic materials;
the rock has changed and metamorphosed in its form and infrequently also
in its makeup. Soil as such does not therefore belong any more to the rock
formation, but is a formation by itself.”

Contemporaneously with Fallou, Dokuchaev began to develop his views on
soils as a result of his extensive studies of the great belt of black earth found
in Russia, known as chernozem.

Fallou, as has been pointed out, had recognized the soil as a distinct natural
body, but he presented no evidence to that effect and for this reason his
presentation of the soil classification did not stand the test and found no sup­
port in later years.

Richthofen (51), who followed in the footsteps of Fallou, did not differentiate
sharply between soils and powdered and crushed rock materials obtained
mechanically. Instead of connecting the regional distribution of soils with
the physico-geographical conditions responsible for the dynamic processes,
he fell back on the geological periods. And Glinka (19) justly states: “When
one speaks of geographical position he understands the existence of a natural
relation between the present distribution of climatic elements and the present
geography of the soil cover. The regionality as described by Richthofen has
at times no connection with the present climatic conditions. Thus the regions
of glacial denudation, accumulation, river denudation, abrasions, and of vol­
canic transport exist on the surface of the earth entirely independently of the
present climatic conditions.” Richthofen, as well as Walther (72) who con­
tinued to develop the ideas of the former (51) considered the distribution of
soils not from the standpoint of their origin but from their position. For this
reason the “soil as natural historical body” was interchangeable in their
scheme with geological material of soils, which eventually would be converted
into soil as a natural body. It is this point which distinguishes Dokuchaev’s
views as a unique contribution which was later developed by other Russian
soil scientists.

Dokuchaev as a trained geologist started out with the geologic point of view
on soils current in those days. As soon as he came in contact with the vast
stretches of Russian chernozem his keen eye immediately noted the homo­
geneous character and features (morphology) of the soils in a definite geo­
graphic region. In 1877 (10) he stated: “Whether we admit that the south­
western portion of Russia was submerged under the sea in the beginning of
the post-tertiary period, as some geologists think, or it was covered by glaciers,
as other geologists think, or it was dry land, as still another group of geologists
think, matters little. For us it is important that after this or the other of
the given phenomena the upper layers of the soils were apparently subject to
various processes due to weathering and to processes due to vegetation; both
of these were instrumental in changing the upper horizon of the parent material
to a greater or lesser depth. These parent materials which have undergone
changes by the mutual activities of air, water, and plants, I call soil.” In 1879 (11, 12) Dokuchaev formulated his ideas on soils in general: “Soils are the superficial mineral and organic constituents, always more or less colored by the humus, which constantly manifest themselves as a result of the combined activity of the following agencies: living and dead organisms (plants and animals), parent material, climate, and relief.”

The original views of Dokuchaev differ little from those of the Western European students of soils and of Hilgard in the United states, who appreciated the genetic relationships in soil formation. The genetic principle as the foundation of soil classification was known and used by other workers besides Dokuchaev. Thus Hilgard (21, 22) in his extensive studies of the soils of the United States could not help but notice the regularity of the distribution of soils under the various physico-geographical conditions of the country. Hilgard had therefore, the genetic approach, noting the relations of the various soils with the different natural conditions and factors of soil formation. He failed, however, to see soils in their morphologic constitution as a result of the soil forming processes. He appreciated the factors of soil formation, but failed to correlate them and build a system of soil classification based on the correlated factors. Of the factors of soil formation Hilgard emphasized the moisture factor.

In discussing the relations of soils to climate Hilgard (21) said: “Since soils are the residual product of the action of meteorological agencies upon rocks, it is obvious that there must exist a more or less intimate relation between the soils of a region and the climatic conditions that prevail, or have prevailed therein.”

“Since water is the prominent agent in soil formation, it follows that the variations in its supply—in other words, the greater or less amount of rainfall—must affect materially that process.” The logical consequence of such a viewpoint was Hilgard's broad division of soils into two large groups: arid and humid.

Fundamentally the parent rock was the starting point of Hilgard’s elucidation on soil characters and features, and in this respect he may be considered as an adherent of the geologic school of soil science.

The geologic point of view predominated in the work of the other early American students of soils. Thus Shaler (54) in his splendid monograph treats the subject of soils from the geologic point of view. To him soil is “a mixture of decayed rock and organic matter.” Johnson (25) simply states that “soils are broken and decomposed rock.” King (26), one of the keenest of American soil students, also had the geologic point of view.

There is a lot of material on the history of the subject in the reports of the geological surveys of the states and in the reports of the different agricultural societies in the United States. A partial list of references may be found in No. 13 Bibliographical contributions, U. S. Department, Agriculture Library, published in 1927.
SOIL AS AN INDEPENDENT NATURAL BODY

The far reaching effects of Dokuchaev's later views (13, 14) consisted "in excluding soils from the system of surface cover formations and placing them into a distinct independent system of natural science." [Quoted from Afanasiev (2).] For Dokuchaev soil science is just as distinct a science as botany, zoology, or any other of the natural sciences. This view was an outgrowth of his original thesis that "soil is an independent, natural, historical body." The factors of soil formation determine the type of soil in its genetic construction as manifested in the profile. "If we know the factors of soil formation we are able to state in advance what the soil must be like." This was one of the theses in the summary of Dokuchaev's doctor's dissertation.

One of Dokuchaev's collaborators, disciples, and followers was Sibirtzev. Indeed, some Russian soil investigators designate the Russian school of soil science as that of Dokichaev and Sibirtzev. These two are considered as the founders and creators of the new school.

According to Sibirtzev (57, 59): "Under the term 'soil' we agreed to include what is known as the surface horizons of the parent material, in which the general dynamic processes are related to the biological processes. The variation in soils is determined: (a) by the parent material, i.e., its physico-chemical properties and position in space; (b) by the organisms, i.e., their kind, number, activity, and chemical transformations, resulting from it; and (c) by the physico-geographical conditions prevailing in the region during the process of soil formation and in their present final state." Sibirtzev considered moisture as the primary climatic factor in soil formation. In this his views coincide with those of Hilgard. He states [I am quoting from Glinka (19)]: "More important than the temperature is the humidity of the climate. Elsewhere enough was said about the primary and manifold influence of moisture on mechanical as well as chemical weathering. It is quite clear that in any isothermic belt the weathering of rocks varies (qualitatively and quantitatively) with the moisture conditions." In speaking of the climatic conditions in North America he stated: "The humidity conditions of the American climate change in an entirely different direction from those of European Russia: the loss in moisture does not follow the northwest-southeast direction, as in the southern half of European Russia, but the east and west. The eastern states are humid; the precipitation is twice as high as in our southern provinces. The western states, on the other hand, are very dry and are known among the Americans by the very inappropriate name 'arid region.' Correspondingly goes the distribution of soils."

It will be of interest to quote at this point the views of Sibirtzev (58) as to why the new concept of soils did not develop in the west [I am quoting from Afanasiev (2)]: "The causes which impeded the independent scientific study of soils in the west, and prevented the establishment of a genuine genetic classification of natural soils, were local, more or less accidental, due to external conditions, and were by no means of an essential nature.

"West-European scientists were less fortunate in this, for in most cases
they had to deal either with feebly developed soils, mixed with various geological deposits of inconsiderable thickness, or with eroded soils; and besides the soils have appreciably changed through cultivation.

"The methods of intensive and deep cultivation of the soils in the west, leaving out of consideration the introduction of various fertilizers, make them an artificially loosened mixture of natural soil material and of the underlying parent rock. The characteristic morphological horizons of the natural soil are either no longer or hardly distinguishable. The color and structure of the soil are altered and its composition tends to approach the composition of the parent material. Hence—the wide distribution of the geologico-petrographical and physico-chemical ideas on soil classification among the European scientists."

One of the prominent pupils of Dokuchaev was the late Dr. Glinka, whose volume on the distribution of soils—after having been translated into German—had a profound influence on the penetration of Dokuchaev's views into Germany and the United States.²

Glinka (19, 20), more than any of his predecessors, stressed the climate as a factor in the process of soil formation. He recognized, however, that in a number of cases the climatic factor may not be the predominating one and hence his divisions of endodynamomorphic soils, in which "the influence of the internal factors of soil formation (the properties of the parent material) definitely appears" and ectodynamomorphic in which climate as a factor in the process of soil formation is predominating.

We shall go no further in the historical development of Dokuchaev's ideas. Very new ideas developed on the concept of soil. The investigations of his followers deal to a great extent with soils as a natural body from the standpoint of soil classification. In this respect there is a wealth of material in the work of Nabokikh (42, 43), Visotzkii (70), Tumin (67), Kossovich (27, 28), Sabanin (53), Neustruev (44), Dimo (9), Vilenski (69), Kostichev (29), Gedroiz (18), and a great number of others. In this paper we are not directly interested in this phase of the work and leave it for an opportune moment. A summary of the classification schemes as an outgrowth of Dokuchaev's views may be found in the paper of Afanasiev (2) and in the volume of Glinka (19).

The review of the development of the concept "soil" in historical perspective would be incomplete without the mention of some of the other German satellites, like Liebig and Ramann. Liebig (31, 32), whose influence for a while overshadowed all other currents in soil science, fundamentally paid but little attention to soils as such. For him the soil was the test tube in which one may introduce the chemical ingredients necessary for plant growth. The chemical composition of the plant was the criterion by which he judged soils. In his famous Letters (32, p. 122) Liebig quotes the definition of soils given by

² Dr. Marbut, Bureau of Soils, U. S. Department of Agriculture, translated Glinka's volume: "The great soil groups of the world and their development," and it is obtainable in mimeographed form.
SOIL AS AN INDEPENDENT NATURAL BODY

Gustav Walz (1857), director of the Agricultural Academy at Hohenheim, Stuttgart: "The soil consists of disintegrated rocks, and either rests upon these same rocks or on others elsewhere; the transported soil may, nevertheless, have remained the same and corresponds at least to the rocks from which it has its origin." Liebig the chemist, the exponent of the classical "mineral theory," considered soils as the storehouse of the chemical components supplied by the minerals found in the disintegration products of rocks.

Ramann (48, 49), however, had a definite outlook on the genesis of soils and in a way his ideas were similar to those of Hilgard, inasmuch as he also laid down climate as the important factor in the process of soil formation and divided soils according to degrees of humidity under which they exist. Ramann (48) states: "It is my wish that my paper on the problem, which the work of the modern Russian scientists has advanced still further, should be published first in your country, where soil science has attained so vast and independent a development. . . . . The problem related to the origin of certain soil types due to the effect of climatic conditions, has been first studied by Russian scientists, and among them the names of Dokuchaev and Sibirtzev will forever be connected with the development of this branch of science."

Modern definition of soils

A definite step forward in the definition of soils has been made by Marbut (37), the prominent American representative of the Dokuchaev school. His definition is as follows: "The soil consists of the outer layer of the earth's crust usually unconsolidated ranging in thickness from a mere film to a maximum of somewhat more than ten feet which differs from the material beneath it, also usually unconsolidated, in color, structure, texture, physical constitution, chemical composition, biological characteristics, probably chemical processes, in reaction and morphology."

The definition purports to convey the idea about soils in terms of soil characteristics instead of soil forming processes as defined by the great majority of the followers of the Dokuchaev school.

Some of the later Russian investigators had the same viewpoint as Marbut, and Kossovich [Kossowitsch (27)] one of the most prominent among them says: "The sum-total of the physico-chemical and biological processes which act directly in the soil and manifest themselves in various forms is the natural basis for grouping soils. . . . . The construction of a soil classification on the basis of coördinating individual factors of soil formation (parent material, climate, vegetation, position of the soil, age, etc.) as such was carried out by Sibirtzev. This was a great step forward. However, the classification of soils with any one factor alone as the basis does not seem to be promising. The genetic soil classification should be based on the internal properties and characteristics of the soil itself."

No definition of soils based on the internal characteristics of the soil is offered by Kossovich in this paper, but in his book (28) he does define soils:
“All those surface horizons of the hard parent materials in which physico-chemical processes take place under the influence of the atmospheric agencies and in the presence of vegetation and animals.” It may readily be seen that this definition is not as comprehensive as that of Marbut.

It seems to the author of this paper that any definition which attempts to convey the idea of soils as “independent, natural body,” which in turn places the science of soils on the same level as the other natural sciences, should embody this statement. There is another point in connection with the definition of Marbut which one may take exception to, and that is the embodiment of the geologic concept “the outer layer of the earth’s crust.” It is not the “geologic concept part” that one may object to, but the sense of the phrase designating as soil the “outer layer of the earth’s crust.” The term “outer layer” may be synonymous with the term “surface layer” and our knowledge of soils as a natural body tells us that we may have soils not only in close relation to the surface but even below the surface. We have reference here to the buried soils studied by Visotzkii (70), Nabokikh (43), Florov (17) and others. These soils preserved their distinguishing characteristics and are distinct and well-defined soils when analyzed from the viewpoint of soils as a natural, historical body. A study of such soils may reveal the conditions under which the overlying soil formed. These soils may be studied as are other natural bodies buried in the earth’s strata, such as fossils which gave rise to the science of paleontology. Similar to paleontology in geology we may have a branch of soil science which should deal with buried soils and name this branch as paleopedology or paleoedaphology, if the term edaphology is to be substituted for pedology as suggested by Shaw (55). Paleopedological studies of so-called fossil soils may reveal a lot of interesting geological data pertaining to climate.

Brevity of any definition is a desirable feature and it seems to the author that in Marbut’s definition the clause: “ranging in thickness from a mere film to a maximum of somewhat more than 10 feet” may be omitted and instead the phrase “variable depth” substituted. As it stands there is an element of arbitrariness, which is not at all suggestive of the concept “soil.”

The designations: “color, structure, and texture” may be omitted, since these are nothing more than some of the many other physical and morphological characters of soils. The words “probably chemical processes, in reaction” may also be omitted. The fact that the definition states the “chemical composition” (it should also include “properties”) of the soil differs from that of the parent material implies a difference in chemical process. It is also clear that chemical properties of soils include, if anything, the reaction and the words “in reaction” are therefore not essential. With these explanatory remarks the definition of soils in terms of soil characteristics as suggested by Marbut (37) may be as follows: The soil is a natural, historical body, of mineral and organic constituents, usually unconsolidated, of variable depth, which differs from the body of parent material below, also usually unconsolidated, in morphology, physical properties and constitution, chemical properties and composition, and
biological characteristics. The introduction of the phrase "of mineral and organic constituents" in the definition seems to be justified on the ground that the combination of these constituents is the outstanding characteristic component of any soil.

The author is aware that there may be some loopholes in the modifications of Marbut's definition and the definition is presented here at this time with the hope that it might stimulate some other comments and result finally in a comprehensive logical and scientific definition of soils.

The discussion of the definition of the term "soil" would be incomplete without the mention of the one suggested by Shaw (55) in his comprehensive glossary of terms used in soil literature. It reads as follows: "The soil is a natural body occupying the surface portion of the earth, composed of mineral and organic materials and having more or less definitely developed horizons of eluviation and illuviation." The definition is accompanied by an explanation: "This term 'soil,' as defined, includes both the solum and the upper portion of the parent material, the A, B, and C horizons." The explanation as a support to the definition indicates the incompleteness of the definition, which in itself should be inclusive.

The definition as it stands does not convey the sum-total of soil characteristics. It is based on the characteristics of two horizons: eluvial and illuvial. And how about the "gley," the zone of effervescence? Why then include just two characteristics to the exclusion of others?

It has been pointed out that the fact of the usual location of the soil on the surface of the earth does not define soils; it is not a soil characteristic. An oak on the surface of the ground or buried in some geologic strata is an oak just the same. A soil, if buried, as long as it retains its soil characteristics is a soil just the same. Afanasiev (2) one of the leading Russian soil geographers and taxonomists considers the great service of Dokuchaev's views as consisting "in excluding soils from the system of surface cover formations and placing them into a distinct independent system of natural science (see p. 45)."

Morphology of soils

With the development of the scientific appreciation of soils, the methods of studying them have undergone radical changes, have been perfected and broadened. In the early history of soil science the viewpoint prevailing at the time determined the method of studying soils. Thus during the period of the geologic view the petrographic and mineralogical make-up of the soil was of primary importance. The agronomic point of view sought the mysteries of chemical reactions in the soil. Neither one of the soil science schools took

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The term "eluvial" in connection with the A horizon, as the horizon of eluviation "from which material has been removed," is not altogether satisfactory. We must remember that hand in hand with the process of removal there is a process of accumulation also in the A horizon: the mineralization of the organic matter and humus accumulation.
up the systematic study of soils as they are and for this reason the logical
approach to the study of any object; namely, its appearance, features, and
general characters, in short the morphology of soils, had to wait until the
science of the soil had been recognized as an independent science.

It is, therefore, natural that this phase of soil science should have developed
first of all in Russia.

The first one to apply the morphological method in the study of soils, accord­
ing to Zakharov (76), was Ruprecht (52), but the method has been developed
by Dokuchaev and his pupils. Those who are interested in the historical
aspect of the development of soil morphology may find an excellent review in
the English paper of Zakharov (75), probably the most prominent morphol­
ogist among the Russian soil scientists living.

It was the new concept of soils as an independent, natural, historical body
which required not only the description of the surface features of soil but also
the anatomy of it; for this it is necessary to cut a vertical section and thus
obtain a profile view of the exposed vertically dissected body. In this manner
the morphology of soils is being studied.

From a morphological point of view the soil is a body definitely organized
with a definite mode of construction, or build. It consists of a series of geneti­
cally related horizons formed from the parent material, with the aid of organic
residues. As expressed by Tumin (67): "a soil may be looked upon as a body
with a genetic complex of horizons formed in the process of humification and
humus fixation." The morphological type of the soil imparts certain specific
characteristics to the construction and constitution of the horizons; each type,
so to speak, has a constant orderly system of relationships within the profile
between the horizons. Thus in the zone of podzol soils there is a definite type
of soil construction; the profile features are: under the dark leaf-mold layer
we find a light gray horizon known as A1, followed by a lighter gray horizon
A2, under which we find a darker horizon B, into which substances from the
upper horizons are washed (mechanically and chemically), and under this
horizon the parent material designated as C, is located.

Within each zone4 of soil formation the particular morphological type may
develop on various kinds of parent material; we may therefore have podzols
(a morphological term) on loess, on loam, on sands, etc. (mechanical and chem­
ical composition and properties). And even within each morphologic type
on a particular homogeneous parent material there may be subdivisions which
manifest themselves in the soil construction. We may have at the border line

4 The division of soils into zones was original with Sibirtzev (57). It is based on the soil
formation processes within a geographical region. In Russia these zones run parallel with
the climatic belts. Thus the Russian workers separate European Russia and Siberia into:
Tundra zone in the north; in the northern part of the temperate belt there is the podzol zone,
followed by the forest steppe zone, then the chernozem zone, chestnut, and the gray-arid
desert zones. The zonal divisions have been investigated by other workers, and the work of
Afanasiev (1) is the outstanding contribution on the subject.
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of the zonal belts intrazonal groups, in which the podzolization, for example, may not be well developed. This gives rise to a class of podzolized (not true podzols) soils. The leached grayish white horizon so characteristic for podzols is not very pronounced in podzolized soils. The general features of the podzolized group are, however, true to the morphological type of podzol soils.

The difference in the make-up of the horizons is the feature which determines the class or group in the morphological type.

According to Zakharov (75) the construction or make-up of a soil profile gives us three or four distinct genetic horizons: (a) The decomposition-organic accumulation; (b) eluvial; (c) illuvial, and (d) parent material immediately below the illuvial horizon. These horizons are indicated by the first letters of the alphabet, but there is no uniformity in assigning any one particular letter to the respective horizons. Thus Zakharov designates the horizons by A, B, C, and D. Other Russian investigators consider as A any horizon or subhorizon from which material is being washed down mechanically or chemically; B as the horizon of accumulation, compaction, and deposition; and C as the parent material. This latter designation seems to have become popular also among the few investigators on the continent and in the United States.

Stremme (65), one of the prominent representatives of the Dokuchaev School in Germany, credits Orth (47) as having been among the first to study the soil profile. By stretching the point one may agree with Stremme, but the facts of the case are that Orth studied the surface and subsurface of soils and subsoils. He noted the differences in the layers and pointed them out, but this does not mean a study of the profile in the genetic relationships. Such studies as those of Orth were made by many other early soil investigators of the geologic and agronomic school in Europe and the United States.

In recent years the Russian genetic school of soil science has been adopted by a great number of soil workers. The international soil conferences held in Budapest (1909), Stockholm (1910), Prague (1922), Rome (1924), and finally the First International Congress of Soil Science held in Washington (1927) firmly established the validity of the profile studies.

In the United States and Canada some studies on the soil profile have been made, but the outstanding contribution in this field has been made by Marbut (33, 34, 35, 36, 37, 38). In 1921 (34) the first survey was made in which the profile of the soil was described; and in making the report of the survey Marbut (34) justly states, "This report marks a definite step forward in soil study." It was the pioneer work of Marbut that established the study of the profile in the United States and Canada.

Joel (23) discusses the soil profile as a basis for classification and applies the soil profile idea to the soils of Canada. With climate as the basis of major grouping he divides the soils into sub-humid-arid and humid, pointing out the differences in profile characteristics. Fundamentally this mode of division is similar to that expressed by Hilgard, as previously discussed. There is, however, the changing viewpoint with respect to the appreciation of genetic
horizons. This viewpoint is an incomplete simile of the zonal idea developed by Sibirtzev and Afanasiev as shown before.

The profile studies of peat by Dachnowski (6, 7) may be mentioned, but these offer little for the orientation in the profile structure of soils. It is questionable whether one should apply the term horizon, as viewed by the genetic school of soil science, to peat layers. Peats in most cases are geological deposits, and one may speak of peat deposits but not of soil deposits. Peat layers are not a result of an internal arrangement due to a definite type of soil forming process.

A profile study in the podzol soil zone was made by Wheeeting (73). A number of interesting points were brought out by the analyses of some of the physical and chemical properties of the horizons in the profile.

McCool, Veatch, and Spurway (39) report some physical and chemical studies on the profiles of some Michigan soils; McCool and Weidemann (40, 41) report further studies on soil profiles. The title of one of these papers (40) is misleading and really does not in any way touch upon the subject of the soil profile. A study of the profile of forest soil in relation to reaction has been reported by Spokes (61). From this paper it is not clear how the horizons in the profile have been determined. The distribution of nitrogen in the profile of podzol soils has been studied by Edington and Adams (15). Other recent papers dealing with certain phases of the subject are those of Lebedev (30), Norton and Smith (46), and Spurway and Austin (63). Holmes (24a) studied the colloidal properties of several profiles on a silt loam soil.

A series of papers on soil profile studies appeared in the Proceedings and Papers of the First International Congress of Soil Science. Of these the paper by Joel (24) is of interest. It takes up the profile study within the several zones of soil formation; the few chemical analyses presented illustrate the validity of the field studies when made from the morphological standpoint. The micro-relief and origin of parent material introduce within any one zone patches of soil which should belong to a different zone. This has been pointed out by Tumin (67), Kossovich (27), and others.

A very instructive paper is the one by Baldwin (3) on the gray-brown podzolic soils of the eastern United States. A description of some soil profiles in Illinois is given by Norton (45). He attempts to establish a correlation between topography and drainage on the one hand and some soil characters on the other. Shaw (56) sketches the profile development in the secondary (immature) soils of California. Smolik (60) describes and gives the analyses of podzol soils in Czechoslovakia with special reference to the composition and behavior of the eluvial and illuvial horizons. Dachnowski-Stokes (8) makes an interesting comparison between peat profiles and peat soils. He rightly designates as layers or strata (a geologic concept) the profile constitution of peat; whenever the peat has been worked over by the forces of soil forming processes, become humified and mineralized as a result of which an
organic soil is formed with peat as the parent geologic material, he uses the term horizon in designating the profile constitution.

A valuable contribution to the study of the podzols is the paper by Veatch (68); it gives a clear picture of the soil forming processes in the region described. The paper of Wyatt and Newton (74) would have been more valuable if the chemical data included the aluminum and iron content of the soils described and illustrated.

The profile of the unique Cuban soils are lucidly described by Bennett (4). A reaction study of the soil profile in some Oregon soils is presented by Stephenson (64). The profile study of the microbial flora in Iowa, by Brown and Benton (5a) should be mentioned.

A large number of papers on the subject of the soil profile appeared in Russia. A review of only those which have appeared in recent years would necessitate a separate paper. The originals of these papers are in a large number of cases not accessible and besides most of these papers deal with profile studies of the various soil zones from the standpoint of soil classification. As the latter point is not the object of this review, it was deemed advisable to leave the papers out for a more opportune occasion.

The study of the soil profile is at present an indispensable part in any branch of soil science. The soil morphologist, the soil surveyor, the physicist, the chemist, the microbiologist, even the agronomist, all have turned their attention to the soil profile, its constitution and its make-up in horizons, for the study of soils as a natural, historical body is possible only upon exposing the body in its cross-section, which is the same as the profile.

The methods used in the study of the profile of some New Jersey soils and some of the results will be the subject of a forthcoming paper.

SUMMARY

1. A discussion is presented on the development of soil science as an independent science.

2. The ideas on soil and the various schools of soil genesis are reviewed with special reference to the Russian school from the time of Dokuchaev to date.

3. The definitions of soil as given by Marbut and Shaw are critically analyzed and a modification of the Marbut definition is presented.

4. The suggestion is made to consider a branch of soil science to be known as paleopedology or paleoedaphology for the study of buried soil.

5. The soil morphology and the soil profile are discussed and a review of the subjects is presented.

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