CONTENTS

New Series 1925/26

Vol. I

PROCEEDINGS OF THE INTERNATIONAL SOCIETY OF SOIL SCIENCE

N. S. Vol. 1, No. 4 — October-December, 1925.

Papers.

On the question of KCl addition in the case of the electro-metric determination of the soil reaction. II:

CAN THE LIME-REQUIREMENTS OF THE SOIL BE DETERMINED FROM THE REACTION OF SOIL SUSPENSIONS CONTAINING POTASSIUM CHLORIDE?

MAX TRÉNEL.

In the *Internationalen Mitteilungen für Bodenkunde*, Vol. XIV, p. 137, 1924, I showed in collaboration with H. PFEIFFER, that the DAIKUHARA method and the determination of the "real acidity' in suspensions containing KCl, in the case of mineral soils, give proportional values, because in such soils the real acidity is a function of the exchanged aluminium.

The comparison of the "titration acidity" of the soil extract in 1 m. of KCl solution with the electro-metric determination of the P_H of the soil suspension in 0.1 m. KCl solution, was undertaken in order to justify the theory of KAPPEN as to the importance of the "exchange acidity" which was attacked at the Rome Soil Science Congress in 1924.

KAPPEN himself and his colleague reject the determination of the exchange acidity by means of physical methods, because the P_H 'does not always fit in' to the correspondence between titrated "exchange-acidity" and growth of the cultivated plants.

Since H. KIRSTE for example has measured the P_H in a water suspension, it is not surprising that he reaches the same conclusion as KAPPEN. "Titration-acidity" in KCl soil extracts, and P_H values in water suspensions are incommensurable quantities. That the P_H values of the suspensions with KCl content actually do fit into the above mentioned relation between acidity and plant growth, has been shown by the author from copious material which was accumulated by means of soil researches carried out on farms in conjunction with practical farmers (2).

To obviate any misunderstanding it may here be once more emphasized that it is the electro-metric determination of the soil reaction that is in question; in colorimetric methods the addition of neutral salts is undoubtedly misleading on account of the likelihood of errors and should be avoided. If the objectors to the addition of KCl take their stand on the fact that the influence of the potassium chloride depends on the soil reaction from the concentration (3), they are overlooking in that connection:

1. that the natural suspension of soil in water is a water suspension only in name, as HAGER (4) has specially pointed out;

2. that onwards from a certain concentration the influence of the KCl is constant (5).

It is obvious that by the use of fertilisers containing potassium salts the concentration of 0.1 m. is not reached. But since it is precisely the very small KCl concentrations which have the most marked effect, and since, in consequence of the experimental method followed, employment of syphons filled with KCl, it is difficult to prevent the diffusion of KCl in the soil suspensions or even to control it, it seems to me to be practicable to select such a concentration (0.1 m KCl) which, on the one side yields constant maximum values and on the other has no marked effect in diminishing salts in the quinhydrone or hydrogen electrode.

My further researches make it possible to advance a step further and in the direction of the determination, or a closer estimate, of the 'lime-requirement' of the soil. If the electro-metric determinations of the soil suspensions on 0.1 m. KCl solution and the "total acidity' determined by titration in 1 m. KCl soil extracts are shown on a system of co-ordinates, a curve results which makes it possible to draw conclusions as to the lime requirements from the hydrogen index; the natural assumption therefore is that the total acidity as determined by the DAIKUHARA method is a measure of the lime requirement of the soil.

Loamy and clayey soils of a varying, but for the most part small, humus content were employed for the comparative experiments.

The P_H determinations were obtained electrometrically on application of the acidimeter, which I have described on a previous occasion (6), to suspensions containing 0.1 m KCl. The "total acidity" was quite independently determined by Dr. UTESCHER and Dr. HALLER according to the DAIKUKARA method.

The following table gives the results of the comparative experiment, which is represented graphically in the diagram in the text:

The relation between P_H and the "total acidity" is shown by a series of curves (fig. 260), in which the curves become flatter as the

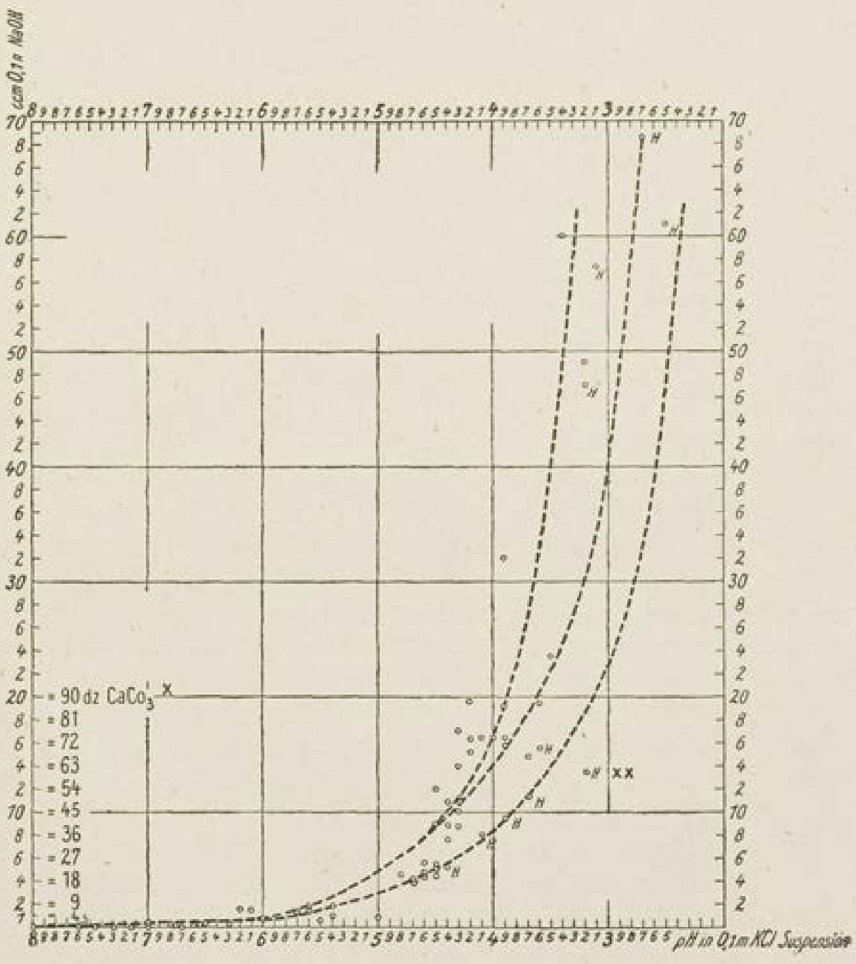

FIG. 260. — The dependence of the lime requirement on the soil reaction.
Explanations : x = Lime requirement per hectare.
xx — H = humus.

TABLE I. — *The Dependence of the Lime Requirement on the Soil Reaction.*

No.	Laboratory number	Actual acidity of the soil suspension PH	Total acidity cc. 0.1 N. NaOH	Remarks
1	9 371	7.3	0.0	
2	8 373	7.0	0.0	
3	9 374	6.4	0.2	
4	9 369	7.15	0.0	
5	9 789	6.55	0.2	
6	9 860	7.45	0.0	Poor soil with 30 % $CaCO_3$.
7	9 861	7.61	0.0	
8	9 939	6.2	1.4	
9	9 940	6.1	1.3	Arable loam soil from the Oder marsh (Gieshof).
10	9 941	5.6	1.8	
11	9 942	5.4	1.5	
12	9 943	5.6	1.4	
13	9 944	5.4	1.9	
14	9 312	4.5	12.0	Sub-soil of forest soil.
15	9 315	4.3	17.2	
16	9 332	6.2	0.6	
17	9 334	6.4	0.4	
18	9 337	4.7	4.0	
19	9 992	6.6	0.0	Loam with 6 % $CaCO_3$.
20	10 019	6.7	0.0	
21	9 989	4.6	5.6	Humus clay.
22	9 990	4.4	10.4	
23	9 991	4.5	9.0	
24	9 993	6.5	0.0	Clay soils 6 % $CaCO_3$.
25	10 028 a	4.4	8.8	
26	(7) 10 028 b	4.8	4.7	Nos. 25-49 are loamy forest soils (7).
27	10 028 c	4.2	19.6	
28	10 029 a	4.3	10.0	
29	10 029 b	4.5	5.2	
30	10 029 c	4.2	16.4	
31	10 030 a	4.0	16.4	
32	10 030 b	4.4	4.4	
33	10 030 c	4.1	16.4	
34	10 031 a	4.0	16.4	
35	10 031 b	4.7	4.0	
36	10 031 c	4.3	14.0	
37	10 032 a	4.3	11.2	
38	10 032 b	4.3	1 .0	
39	10 033 a	4.2	8.0	
40	10 033 b	4.6	4.8	
41	10 033 c	4.2	15.2	
42	10 034 a	4.4	7.6	
43	10 034 b	3.9	19.2	
44	10 035 a	4.3	8.8	
45	10 035 b	4.5	5.2	
46	10 036 a	4.5	4.4	
47	10 036 b	4.5	4.4	
48	10 037 o	3.7	11.8	
49	10 037 b	4.4	5.2	

TABLE I. — *The Dependence of the Lime Requirement on the Soil Reaction.*

No.	Laboratory number	Actual acidity of the soil suspension P_H	Total acidity cc. 0.1 N. NaOH	Remarks
50	10 040	3.9	9.6	
51	10 041	3.2	14.4	
52	9 493	3.5	23.2	
53	9 436	3.6	19.4	
54	T 3	3.9	32.0	Tropical primitive forest soil.
55	9 429	3.2	57.2	Humous forest soil.
56	9 845	3.4	60.0	
57	9 635	3.6	15.6	Humous forest soil.
58	9 428	3.1	47.6	Humous forest soil.
59	9 712	5.0	0.8	
60	9 710	5.5	0.6	
61	9 432	5.7	1.2	
62	9 471	8.0	0.0	
63	9 799	3.7	14.4	
64	9 418	2.5	61.0	
65	9 419	2.7	68.4	
66	10 000	6.75	0.2	Loamy mould.
67	10 001	7.0	0.3	Subsoil at depth of 1 m.
68	10 002	6.0	0.7	Subsoil at depth of 2.2 m.
69	10 003	7.05	0.3	Subsoil at depth of 3.5 m.
70	10 025	6.5	0.4	
71	10 026	6.3	0.4	
72	10 027	6.8	0.2	
73	10 028	6.6	0.2	
74	10 029	6.5	0.2	

content of humus increases: the divergence is not great up to P_H 4.5. Since soils the reaction of which is more acid than P_H 4.5 are on the whole of rare occurrence, the steeper curve practically serves to determine the lime requirement from the quickly ascertainable value in P_H. In the case of obviously humous soils the flatter curve will be suitable for the purpose.

The lime requirement in kg. $CaCO_3$ on 1 hectare (3 million kg.) is reckoned according to the formula: $a \times 3 \times 1.5$ in which a is the titration liquid reckoned in cm. on 100 gm. soil. These figures hold for heavy soils: for medium soils the value should be estimated at about half and for sandy soils at one-third.

As the series of curves approaches the co-ordinates as asymptotes, the questions may be put: What lime requirement has a soil which is in the first place neutral, and in the second more acid than P_H 4.0? In both cases the curve seems to give no answer.

To this it may be replied: in the case of neutral soils the DAIKUHARA method must necessarily fail: a highly probable case is that in which a soil containing no chalk is agitated with KCL solution and shows no acidity that is capable of titration. In such cases other methods must be employed.

In the case of very acid soils the quantities of lime estimated as required according to DAIKUHARA are so large that it becomes impossible on practical grounds to supply the lime deficiency by a single liming.

From the above considerations the following conclusions may be drawn:

1. If the soil is neutral, the lime content of the soil is to be tested either by analytical or geological methods, and accordingly a minimum dose given, the amount of which is to be determined empirically.

2. In the case of slightly acid soils the lime requirement can be determined approximately from the given series of curves; with markedly humous soils the flatter curve is employed for the purpose (8).

3. With soils that are more acid than P_H 4.0, the first thing to do is do apply the quantity of lime which is practically possible; after a certain time to ascertain the result by renewed testing and to make any further liming depend on these tests.

I wish here to thank Prof. Dr. SCHUCHT, Prof. GANSSEN and Dr. HELLMERS for the valuable suggestions they have made.

SUMMARY.

In completion of earlier investigations in regard to the dependence of the P_H, from the "total acidity", the attempt is made to infer the lime requirement of the soil from the P_H determination of the soil suspension in 0.1 m. KCl solution. The dependence of the lime requirement on the P_H is graphically represented: the curve of the humous soils is clearly distinguishable from that of the pure mineral soils and gives for humous soils a lower lime requirement than for mineral soils.

NOTES AND BIBLIOGRAPHY.

(1) *Zeitschr. für Pflanzenernährung und Düngung.* Year 4, pp. 159-171 ; cf. also Year 5, pp. 193 and seqq. (1925).

(2) M. TRÉNEL, " Hat die Bodenreaktion auch in der praktischen Landwirtschaft den Einfluss, der ihr auf Grund von wissenschaftlichen Vegetationsversuchen zugeschrieben wird ? *Zeitschrift für Pflanzenernährung und Düngung.* Year 5, Part 4. 1925.

(3) O. ARRHENIUS, Die Einwirkung neutraler Salze auf die Bodenreaktion. *Mitt. der Intern. Bodenkundl. Gesellschaft,* I, p. 28. 1925.

(4) HAGER. *Zeitschrift f. Pflanzenern. und Düngung,* Year 4, pp. 159-171, 1925.

(5) E. M. CROWTHER, Studies on Soil Reaction. *Journal Agric. Sc.* 15, pp. 201-221.

(6) M. TRÉNEL. *Intern. Ges. für Bodenkunde* XIV, Part 1, 2. 1924.

(7) The soils marked *a* are drawn from humous mould ; those marked with *b* and *c* come from the subsoil.

(8) Th. ARNDT. *Zeitschrift f. Pflanz. u. Düngung.* Section Year 4, pp. 55-72. ARNDT states that the DAIKUHARA method gives too high a value for marshland soils.

TO WHAT EXTENT IS THE LIME CONTENT AND REACTION OF A SOIL RELATED TO THE MANNER OF ITS FORMATION ?

H. NIKLAS and F. VOGEL (Reporter).

The controversy as to how far we are justified in drawing conclusions as to the chemical and mechanical properties of a soil from the geological character of its subsoil, is as old as the science of agriculture itself. There were also two schools of thought as to the estimation of the lime-content of a soil from the character of the underlying matrix. One school believed in its general application, while the other denied it by putting forward generalisations which applied only to large areas.

From a geological standpoint, the principal objection which can be put forward against the derivation of the carbonate of lime content of a soil from its geological relation to the underlying matrix, is that, although this may be true in the case of primary soils, especially when the length of the weathering action on them is known, they occur in much smaller numbers than secondary soils. The above statement is also true, if we leave out of account, in the case of a large number of primary soils, the influence of climatic changes which have taken place, up to most recent times.

Agricultural science was able to prove in the course of the last decade (1) that starting with the same rock, different climatic conditions produce quite different soils, and that the following rule applies : in dry soils the bases remain, in humid soils they are washed out.

In the humid climatic regions therefore, all primary soils must either be deficient or get deficient in bases, or looking on it from a colloid-chemical point of view, they are, or are getting in, an absorptive-unsaturated state, i. e. either have an acid reaction or are passing into acidity.

However, even a considerable number of secondary soils have been and still are undergoing an impoverishment in bases.

The base content of a soil is determined on the one hand by the base content of the original rocks, from which it was formed, and on the other hand by the time during which the varying climatic factors have been changing over the same region (2). But this statement loses considerably in its general applicability on account of the far-reaching climatic changes which have taken place over the whole of our region during the diluvium, and the events since then. The upper layers of the primary soils in the humid climatic zone consist now of the further sub-aerial developments of the then (in diluvium) existing soils, together with the aeolithic and fluvial deposits of the ice-age. Equalising influences caused the prevalence, in this zone, of the brown-earth type, but it must be remembered that the duration of these influences is still too short to produce a chemically homogenous type of soil, especially in countries like Bavaria, where the multiplicity of the geological strata and the multiformity of the orographic arrangements and of their relations on a limited space is so very great. The equalising factors are influenced to a great extent by the mechanical composition of the soil.

In considering the strata, which, when looked upon from an agricultural and forestry point of view, we call soil, we must, among other factors, take account of the influence of plants and animals on it, and must also not forget the influence exerted by man through ploughing, manuring and choice of plants. Correspondingly, the deficiency of a soil in bases, will differ according as it is covered by plants, and it will depend on the kind of plant, whether its physical character will allow the earth-worm to exert its full action, and according as man by his ploughing mixes the layers of subsoil richer in bases, with the poorer upper layers, and according as he adds, through manuring, substances rich in bases, base-fixing or base-liberating.

The last mentioned point, of the chemical changes produced by manuring in the soil, has attracted the special attention of agricultural chemists in the last decade.

Fundamental researches, as *e.g.* those of R. GANS (3), explained the influence of different kinds of weathering on the molecular composition of the zeolithic silicates, and thus gave valuable insight into the nature of the reactions taking place in a soil. They showed that in considering the zeolithic silicates of the soil, decomposable by hydrochloric acid — the aluminium silicates — as chemical compounds, that a soil should be called *neutral*, whose zeolithic silicates are so composed that to each 3 mols. of SiO_2 and 1 mol. Al_2O_3 they contain 1 mol. of a base (CaO, MgO, K_2O, Na_2O), and those are to be considered *acidic* which contain to every 3 or more mols. of SiO_2 less than 1 mol. of a base, and if to every 3 mols.

SiO_2 there are more than 1 mol. $Al\ O_3$, they are to be considered *basic.*

On the results of these investigations were assumed to be based the numerous investigations on the chemical reactions taking place in agricultural soils, whose principal object was the elucidation of the changes produced in those soils by manuring. In all these investigations we are dealing with an object with a definite geological history, and that history left its mark on its chemical character and behaviour; and many a generalisation injurious to the science of manuring was retained in this way.

The use of artificial manures does not go far back, and in the case of Bavaria, certainly not more than a few decades, and the amounts used even now are comparatively small, and some soils did not get any artificial manuring until very recent times. They have in many cases a typical and very often an acid reaction. This may refer to heavy soils. On the other hand, there is at this Institute a large number of unfinished investigations on test-field loamy-soils, which have been receiving considerable amounts of chemically and physiologically acid manures for a number of years and which even now still show their unchanged original reaction. Thus, we have on the one side soils as. *e.g.*, the majority of sandy-soils poor in bases and many loamy-soils, which on addition of large amounts of chlorine-containing or physiologically acid-neutral salts begin to show an acid reaction, which makes them unsuitable for the economic growth of plants, but on the other side we have soils which on account of their geologically based physical and chemical constitution, not only favour prolonged acid manuring, without addition of bases, but even require it. In other words, when considering the chemical reactions of a soil the geological and agricultural aspects must not be omitted. True, in this way many a generalisation in manure-technique would have been missed, but on the other hand many geological and agricultural scientific experiences would have been gained, which would have formed a starting point for many generalisations which, though applicable only within certain limits, could yet be extended from single experimental results to all the geologically similar soils.

These general observations apply to a comparatively large number of systematic investigations on the reactions and lime-requirements of most Bavarian soils, carried out at this Institute for agricultural chemistry, since 1923, after many years of preparatory work. In the following pages it will be attempted to give account of certain of the results obtained, but before doing this, is will be useful to give an account of the procedure of the investigation, from the taking of the soil-sample up to the investigation proper (4).

The party chosen for supplying a soil-sample, for lime-requirement and chemical investigation, receives together with a guide as to the way the sample should be taken, also a questionnaire. The questions are put not only from a manure technical and plant-organisational point of view, but also from a geological and agricultural scientific point of view. The completed questionnaires are returned simultaneously with the soil-samples. Already first experiences have shown that large and small farmers alike answered the different questions very unreliably, and although, no doubt, the answers received do give some information, yet for statistical purposes even, quite disregarding scientific purposes, the material can be used only with great care, if at all. We therefore sought the collaboration of the Bavarian agricultural advisers, and in the course of the first year we managed to interest in our work 42 agricultural stations (5), to supply us with soil-samples for investigation and in most cases, to answer our questionnaire for each soil sample separately. Also in this case it was soon found that on the average the answers are suitable only for drawing of statistical conclusions, but only in few cases are they suitable for scientific use. In most cases special stress is laid on the manuring and plant-organisation answers, for quite obvious reasons, while the agricultural-scientific answers are unsatisfactory. It may be that the unsatisfactoriness of the geological and scientific-agricultural answers is due to the fact that they are given by men expecting immediate practical results, or it may be due no doubt in many cases, to the ignorance of the soil-forming factors and of the disposition of the secondary geological strata, which ignorance cannot be dispelled because of the lack of suitable 1 : 25,000 maps.

After this was recognised, the reporter (F. V.) himself attempted to obtain, with the help of good geological maps, typical soil-samples from different parts of Bavaria, so as to get the necessary scientific basis for the conclusions drawn.

In this way only could the suspicion of a close relationship between the chemical character of a soil and its geological mode of origin be confirmed. These observations will be given in the following pages.

Each sample received was registered, separated according to the size of its particles, and had to undergo a preliminary investigation by different quantitative methods (6). These preliminary investigations were carried out to gain information as to the general character of the chemical reactions of the sample. Next followed the measurement of its hydrogen-ion concentration, the institution of the nitrogen bacteria test, and, if necessary, the determination of its titrational acidity.

In the statistical treatment of the 2255 soil-samples received from September 1st 1923 till August 31st 1924 (7), after their arrangement in different reaction stages — according to the hydrogen-ion concentrations, P^H, as determined in KCl extract — the following were the results:

TABLE I.

P^H reaction	No. of soils	% of the total
Below 4.5	283	12.55
4.5 — 5.0	263	11.68
5.01 — 5.6	175	7.67
5.61 — 6.2	410	11.18
6.21 — 6.7	342	15.16
6.71 — 7.0	281	12.46
Above 7.0	501	22.21

According to this, if we consider only the hydrogen-ion concentrations as measured in a KCl extract, more than half of all soils investigated (P^H below 4.5 up to P^H 6.2) namely 50.17 % may be regarded as physiologically acid, 15.16 % (P^H, 6.21-6.7) as neutral and 34.67 % (P^H 6.71 – over 7.0) as alkaline. Almost all soils with a P^H below 6.2 and a number of those with a P^H of 6.2 – 6.7 must on the results of other different investigations be regarded as deficient in lime. The great majority of soils of P^H 6.2 must be considered as absorptively – unsaturated.

The unexpectedly large number of Bavarian soils found to be acid and deficient in lime, caused us to investigate their relation to the different geological formations found in the country. This appeared necessary in view of the multiformity of the Bavarian geology, if a general conclusion is going to be drawn, applicable to all the other numerous Bavarian soils, which, to form a final opinion, still required investigation, and if a conclusion is going to be drawn as to the distribution of the lime-deficient and non-deficient soils under investigation.

Investigations were therefore undertaken to determine the geological character of the different soils. For this purpose use was made of samples of soils taken from the Institute itself, and of samples of soils sent in, in exceptional cases, with satisfactorily answered questionnaires. These samples, well known, were then united into definite geological and scientific-agricultural groups. It was thus possible, *e.g.*, to separate out distinct groups from the large number of secondary groups forming a soil-group in a given formation, and this was possible in the case of lower-terrace loamy soils, upper-terrace loamy soils, certain diluvial loamy soils of Franconia, and Keuper-sand soils. It is thus proved that the large number of soils grouped under the name " general diluvium " contain a whole series of terrace, gravel and moraine soils, that the group " Keuper general " contains a large number of other soils, *e, g.*, upper " Bunter Keuper ", upper gypsum " Keuper ", etc. The lack of more definite information as to the exact place from which the soil has been taken, or of the proper geological section (profile), caused us, in concluding about each soil, to place it more in agreement with the upper members of a formation than with the lower ones. Thus, while the diversity of the soil material, well known in its geological particulars, diminished considerably, the number of sub-divisions of the larger geological formations increased considerably.

After this preliminary segregation of the different formations, each soil of each group was entered in a definite column in a table according to the results obtained in the hydrogen-ion concentration determination, total acidity and lime requirement determinations. In the case of a considerable number of soils they could not be placed in any definite geological formation and all those were combined, and entered in a column as " Soils with no definite character " (geological). In this way Table II was obtained.

TABLE II. — *The geological character of the soils investigated, in their relation to the hydro*

Geological character of the soils	Number of Samples	Reaction Groups (pH)															
		under 3.5		3.51–4.0		4.01–4.5		4.51–5.0		5.01–5.5		5.59–6.0		6.01–6.5		6.51–7.0	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
General *alluvium*	58	—	—	—	—	1	1.7	2	3.5	2	3.5	1	1.7	4	[illegible]	21	36.2
(*a*) Garden soils	67	—	—	—	—	1	1.5	3	4.5	5	7.5	7	10.4	14	[illegible]	21	31.3
(*b*) River soils	21	—	—	—	—	1	5	1	5	1	5	1	5	3	[illegible]	4	19
General *diluvium*																	
(*a*) Diluvial loams	610	—	—	—	—	21	3.5	52	8.5	41	6.7	98	16.0	143	[illegible]	145	23.8
(*b*) Diluvial loams over Miocene	44	—	—	—	—	—	—	3	6.8	5	11.4	21	47.7	9	[illegible]	5	11.4
(*c*) Loess	17	—	—	—	—	1	—	3	—	1	—	5	—	1	—	6	—
(*d*) Loess loams	20	—	—	—	—	—	—	—	—	—	—	—	—	1	[illegible]	6	30
(*e*) Diluvial sands	33	—	—	—	—	—	—	—	—	—	—	6	17	5	[illegible]	20	61
(*f*) Recent morain gravel soils	10	—	—	—	—	1	—	2	—	1	—	1	—	2	—	3	—
(*g*) Loam over high-terraces	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—
(*h*) Loam over low-terraces	31	—	—	—	—	1	3.2	10	32.2	4	12.9	10	32.2	5	[illegible]	1	3.2
(*i*) Soils of recent valley-terraces	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(*k*) High-moor soils	9	1	—	1	—	1	—	1	—	1	—	—	—	4	—	—	—
(*l*) Low-moor soils	21	—	—	—	—	—	—	—	—	—	—	5	24	2	[illegible]	11	52
Genera *Tertiary*	77	—	—	—	—	2	2.6	7	9.0	3	3.9	14	18.2	16	[illegible]	12	15.6
(*a*) Tertiary sands	20	—	—	—	—	—	—	1	5	1	5	3	15	4	[illegible]	5	25
(*b*) Flysch of the lower Alps	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
(*c*) Brackish-molasse	3	—	—	—	—	1	—	1	—	—	—	—	—	—	—	1	—
(*d*) Miocene fresh-water lime	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
General *Cretaceous*	4	—	—	—	—	—	—	1	—	—	—	3	—	—	—	—	—
(*a*) Lower chalk	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7	—
General *Jurassic*	49	—	—	—	—	—	—	—	—	—	—	—	—	4	[illegible]	15	31
(*a*) Middle Oölite	22	—	—	—	—	—	—	—	—	—	—	—	—	5	[illegible]	9	41
(*b*) Lower Oölite (dogger)	11	—	—	—	—	—	—	—	—	—	—	—	—	2	—	7	—
(*c*) Lower Oölitic iron sandstone	8	—	—	—	—	—	—	—	—	—	—	3	—	—	—	4	—
(*d*) Liass	45	—	—	—	—	—	—	—	—	—	—	—	—	7	[illegible]	15	33
e) Alp-covering loams	84	—	—	—	—	11	13.1	6	7.1	6	7.1	20	23.9	32	[illegible]	9	10.7

…r relatio[n] to the hydrogen-ion concentration, total acidity and lime requirements (See over).

…n Groups (…								Total acidity (Daikuhara) in 100 gms. of fine soil								Lime requirements					
6.01–6.5		6.51–7.0		7.01–7.5		7.5 and over		above 15 cm.		5.1 to 15.0 cm.		5.0 cm.		none		absolute		conditional		none	
No.	%	No.	%	No.	%	No.	%	No	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
4	[illegible]	11	36.2	24	41.3	3	5.2	—	—	1	2	3	5	54	93	4	7	2	3	52	90
14	[illegible]	21	31.3	15	22.3	1	1.5	—	—	1	1	9	14	57	85	9	13	6	10	52	77
3	[illegible]	4	19	9	42	1	5	1	5	—	—	2	10	18	18	3	14	1	5	17	81
143	[illegible]	145	23.8	105	17.2	5	0.8	5	1	11	2	192	31	402	66	139	23	136	22	335	55
9	[illegible]	5	11.4	1	2.3	—	—	—	—	—	—	30	68	14	32	15	34	23	52	6	14
1	—	6	—	—	—	—	—	1	—	—	—	6	—	10	—	5	—	6	—	6	—
1	[illegible]	6	30	10	50	3	15	—	—	—	—	—	—	20	100	—	—	1	5	19	95
5	[illegible]	20	61	2	6	—	—	—	—	—	—	6	18	27	82	3	9	5	15	25	76
2	—	3	—	—	—	—	—	—	—	—	—	3	—	7	—	—	—	7	—	3	—
—	—	3	—	—	—	2	—	—	—	—	—	—	—	5	—	—	—	2	—	3	—
5	[illegible]	1	3.2	—	—	—	—	—	—	—	—	22	71	9	29	17	55	10	32	4	13
—	—	—	—	4	—	1	—	—	—	—	—	—	—	5	—	—	—	—	—	5	—
—	—	—	—	6	—	—	—	—	—	—	—	—	—	6	—	—	—	—	—	6	—
4	—	—	—	—	—	—	—	—	—	—	—	7	—	2	—	5	—	4	—	—	—
2	[illegible]	11	52	3	14	—	—	—	—	—	—	5	24	16	76	—	—	5	24	16	76
16	[illegible]	11	15.6	14	18.1	9	11.7	1	1	1	1	27	36	48	62	14	18	20	26	43	56
4	[illegible]	5	25	3	15	3	15	—	—	—	—	2	10	18	90	3	15	5	25	12	60
—	—	1	—	4	—	—	—	—	—	—	—	—	—	5	—	—	—	—	—	5	—
—	—	1	—	—	—	—	—	—	—	—	—	2	—	1	—	2	—	—	—	1	—
—	—	1	—	2	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	3	—
—	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	1	—	3	—	—	—
—	—	7	—	—	—	—	—	—	—	—	—	—	—	7	—	—	—	—	—	7	—
4	[illegible]	15	31	29	59	1	2	—	—	—	—	1	2	48	98	—	—	2	4	47	96
5	[illegible]	9	41	8	36	—	—	—	—	—	—	—	—	22	100	—	—	—	—	22	100
2	—	7	—	1	—	1	—	—	—	—	—	—	—	11	—	—	—	—	—	11	—
—	—	4	—	1	—	—	—	—	—	—	—	—	—	8	—	—	—	2	—	6	—
7	[illegible]	15	33	22	49	1	2	—	—	—	—	1	2	44	98	—	—	1	2	44	90
32	[illegible]	9	10.7	—	—	—	—	12	14	7	8	15	18	50	60	30	36	36	43	18	21

TABLE II. — (Conclusion).

Geological character of the soils	Number of Samples	Reaction Groups (P															
		under 3.5		3.51–4.0		4.01–4.5		4.51–5.0		5.01–5.5		5.51–6.0		6.01–6.5		6.51–7.0	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
General *Keuper*	35	—	—	—	—	3	9	5	14	2	6	4	11	6	17	11	31
(*a*) Alpine Keuperhät . . .	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(*b*) Rhaetic yellow Keuper.	4	—	—	—	—	—	—	—	—	—	—	1	—	3	—	—	—
(*c*) Upper red Keupperlett.	12	—	—	—	—	—	—	—	—	—	—	—	—	3	—	5	—
(*d*) Stuben and Burg sandstone	40	—	—	2	5.0	3	7.5	4	10.0	2	5.0	11	27.5	13	32.5	5	12.5
(*e*) Blasen and Platten sandstone	80	—	—	—	—	2	2.5	16	200	15	18.8	22	27.5	14	17.5	9	1,12
(*f*) Upper gypsum Keuper.	26	—	—	—	—	—	—	—	—	3	12	4	15	6	23	10	38
(*g*) Schilf sandstone	8	—	—	—	—	2	—	—	—	—	—	2	—	3	—	1	—
(*h*) Lower gypsum Keuper.	12	—	—	—	—	—	—	—	—	—	—	—	—	1	—	4	—
(*i*) Lower Keuper (letten) sandstone	16	—	—	—	—	—	—	—	—	—	—	2	—	2	—	6	—
General *Muschelkalk*	21	—	—	—	—	—	—	—	—	—	—	1	5	4	19	7	33
General *Bunter sandstone* . .	3	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—
Northerly upper Franconian Palaeozoic with older igneous rocks	37	—	—	1	2.7	12	32.4	12	32.4	5	13.5	5	03.5	1	2.7	1	2.7
Recent igneous rocks	2	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—
General *Primary rocks*. . . .	280	—	—	30	10.8	91	32.6	94	33.5	27	9.6	21	7.5	14	5.0	3	1.0
(*a*) Granite	25	—	—	—	—	5	20	11	44	7	28	1	4	—	—	1	4
(*b*) Gneiss and Glimmerschiefe	15	—	—	—	—	—	—	4	—	2	—	4	—	5	—	—	—
Soils from manure experiments	12	—	—	—	—	—	—	—	—	—	—	1	—	3	—	6	—
Soils with no definite	225	—	—	1	0.4	10	4.5	23	10.2	7	32	26	11.5	40	17.7	53	23.6
geological character	106	—		—		5		11		3		12		19		15	
	2.225	1	0.04	35	162	175	7.91	276	12.33	144	6.56	316	14.14	400	17.73	679	21.17

E II. – (Conclusion).

Groups (2)	
6.01–6.5	
No.	%
6	27
—	—
3	–
3	–
13	32.5
14	17.5
6	23
3	–
1	–
2	–
4	19
—	–
1	27
—	–
14	50
—	–
5	–
3	–
40 / 19	17.7
400	17.51

6.51–7.0		7.01–7.5		7.5 and over		Total acidity (Daikuhara) in 100 gms. of fine soil: above 15 cm.		5.1 to 15.0 cm.		5.0 cm.		none		Lime requirements: absolute		conditional		none	
No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
11	31	3	9	1	3	1	3	1	3	12	34	21	60	9	26	7	20	19	54
—	—	1	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—	1	—	3	—	—	—	3	—	1	—
5	—	1	—	3	—	—	—	—	—	2	—	10	—	—	—	2	—	10	—
5	12.5	—	—	—	—	3	7.5	2	5	3	75	32	80	12	30	15	37.5	13	32.6
9	1,12	2	2.5	—	—	2	2.5	2	25	43	54	33	41	35	44	33	41	12	15
10	38	3	12	—	—	—	—	—	—	8	31	18	69	5	19	6	23	15	58
1	—	—	—	—	—	—	—	2	—	—	—	6	—	2	—	5	—	1	—
4	—	7	—	—	—	—	—	—	—	—	—	12	—	—	—	1	—	11	—
6	—	6	—	—	—	—	—	—	—	2	—	14	—	1	—	1	—	14	—
7	33	8	38	1	5	—	—	—	—	2	10	19	90	1	—	2	10	19	90
–	—	1	—	—	—	—	—	—	—	2	—	1	—	1	—	1	—	1	—
1	2.7	—	—	—	—	5	14	7	19	19	51	6	16	30	81	4	11	3	8
–	—	—	—	—	—	2	—	—	—	—	—	—	—	2	—	—	—	—	—
3	1.0	—	—	—	—	80	29	68	24	114	41	18	6	246	88	20	7	14	5
1	4	—	—	—	—	2	8	2	8	21	84	—	—	20	80	5	20	—	—
–	—	—	—	—	—	—	—	—	—	6	—	9	—	3	—	10	—	2	—
6	—	1	—	1	—	—	—	—	—	2	—	10	—	—	—	4	—	8	—
33 / 15	23.6	60 / 28	26.6	5 / 3	2.3	22	10	13	6	51	22	139	62	81	36	45	20	99	44
[illegible]	21.17	384	16.56	45	1.95	—	—	—	—	—	—	—	—	—	—	—	—	—	—

2

The results show that, the number of soils which can be definitely grouped as a geological unit is very large, when compared with the few less known soils of secondary members of those units. This strikes one especially in the case of diluvium where we notice 610 completely known soils and only 201 soils with single separation.

The following considerations apply to the numbers, on the left side of the table.

It is especially important to notice and to remember the series of numbers given under the heading " The total number of investigated soils. " This shows a slow rise up to P^{H} 5.0, then a distinct decrease (8), then again a rise up to P^{H} 7.0, and again a decrease.

If we compare with this the numbers in the column " Soils with no definite character ", we see something very similar. From these and other investigated series of soils the following may be concluded, *that a considerable number of investigated Bavarian soils are neutral to weak acids, and acid to strong acids and that only about a third of them are alkaline to strongly alkaline.* Comparing with these two series of numbers those in the columns " general diluvium ", " general alluvium ", " general tertiary " and " general Keuper ", and taking into account only relative numbers we notice *a fair similarity* between all of them.

These relations can be well illustrated by curves (9). In the curve-table shown in fig. 261 the abcissae represent the steps of P^{H}, while the ordinate represents the percentage of soils of " The total of all soils " (curve *a*), " soil without definite geological character " (*b*), " general diluvium (*c*), " general Keuper " (*d*), " general primary rocks " (*e*), recurring in each P^{H} group. The very nearly parallel character of these curves is unmistakable. *From this we may derive the following rule that, the fact of a soil belonging to a certain geological formation, e.g.* " diluvium ", " Keuper ", " alluvium " " *indicates nothing else but our ignorance of that soil. An exception is that of weathering soils of primary rocks represented in our curve table* (fig. 262).

These soils coming principally from the Bavarian forests and from the Fichtelgebirge are principally weathering products of granite and gneiss, and partly of rocks yielding as their weathering products syenite, diorite, diabase and other lime containing substances. The curve shows in any case that the majority of soils derived from primary rocks are acid and only a small number of them is neutral or weakly alkaline (10).

With these series of numbers of only generally geologically known soils, were compared those of soils belonging to secondary members of formations. What strikes one looking at the table, is the comparatively small number (total) of those soils known.

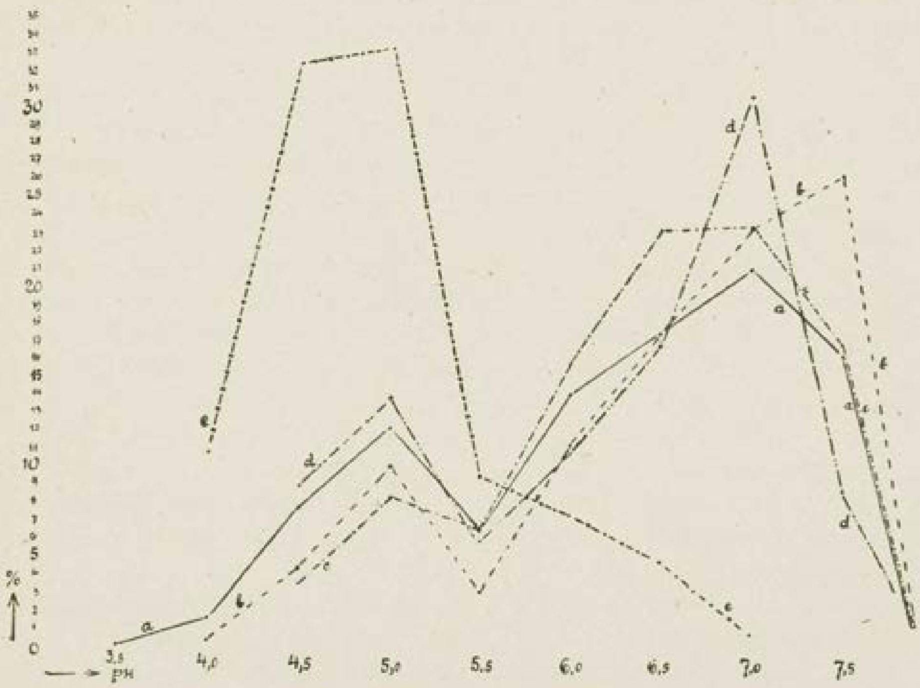

Fig. 261. — Curve-Table I.

a = ———————— Total for all soils.
b = – – – – – – – Soils with no definite geological character.
c = — · — · — · Soils of general diluvium.
d = – ·· — ·· — ·· Soils of general Keuper.
e = –×–×–× Soils of general primary rocks.

In a few cases as, *e.g.*, in the case of "low-terrace soils", "newer valley-terrace soils", "brackish molasse", "miocene fresh-water lime", "lower and upper gypsum keuper" and many other series, the number is at first so very small that they do not indicate anything at all. In other cases, on the other hand, there is a definite tendancy noticeable, the number-series become shorter and closer and are limited only to a certain quite definite and typical P^H region, similar to the case of "general primary rocks".

Several of these typical series of numbers are represented in

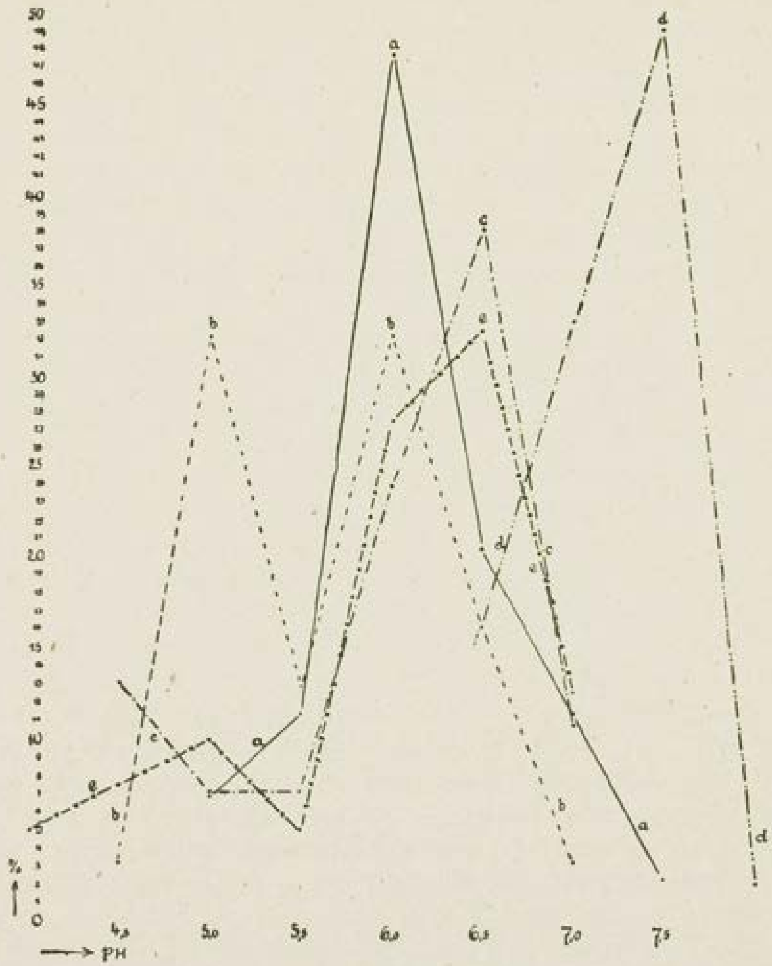

FIG. 262. — Curve-Table II.

a = ——————— Franconian diluvial soils.
b = - - - - - - - Soils of high-terrace loam.
c = — · — · — · Alpine pasture soils.
d = — ·· — ·· — ·· Liass soils.
e = —×—×—× Blasen and Platten sandstone soils.

curve-table II. Only the most numerous soil-series were represented: "diluvium soils in Franconia" (*a*), "high terrace loams" (*b*), " Alpine pasture soils " (*c*), " Liass " (*d*) and " Blasen and Platten sandstone " (*e*). True, the curves in the case of the " alb-covering soils ", which are only slightly homogenous, and in the case of the diluvial soils coming from different parts of south-middle Franconia, and in the case of the partly meadow and partly arable loam soils of the Bavarian upper-terrace still extend over a considerable area, yet in distinction to the curves in curve-table I, show a rapid rise and a typical culmination.

Leaving out of consideration the error due to carbonic acid, the following can be said:

The *Franconian diluvial soils* extend over the range for P^H 4.51-7.0, with a culmination at P^H 5.51-6.0. The sloping branch on the alkaline side of the curve would in the case of a larger number of soils be steeper and come to an end between P^H 6.5-7.0.

The *high-terrace loany soils* lie between P^H 4.01-4.5 and 6.51-7.0 with an apparent double culmination at P^H between 4.51 and 6.0. Also in this case we should get a steeper curve on the alkaline side, if dealing with a larger number of soils.

The *Alpine pasture soils* lie between P^H 4.01-7.0. The culminating point of the curve is between P^H 6.01-6.5. The left acid branch of the curve seems to be greatly influenced by carbonic acid (see note 8). The point of origin of the curve should really have been on the abcissae between P^H 4.5 and P^H 5.0.

The character of the curve for " the Liass soils ", in the right of the co-ordination system, should correspond very nearly with the actual facts, although a larger number of soils would probably cause a narrowing to the right.

The fairly large P^H region between 4.01-7.5 is occupied by the *Blasen and Platten sandstone soils* with their maximum value at P^H 5.51-6.0. It may be that in the case of these sandy-soils as in the case of most of such geological soils their rather wide P^H region may represent also the effects of manuring, for it is a fact that farmers on sandy soils use much more artificial manure than farmers on loamy soils, and moreover slight amounts of manure have a considerable effect in a chemical sense, on sandy-soils.

In segregating the different series of geologically similarly stratified soils it is not only important to take account of the manuring, and it must be pointed out not only that of light soils, but also to a less extent also that of heavier soils, and also the mode of cultivation in connection with its usage. It is quite probable that the considerable distribution within wide P^H regions, which is evident on the curve-table II, is due to the different use of the soils there shown. Already R. GANS (11) believed it to be probable that the non-ploughed soils, *e.g.* pasture-land, pass sooner into a state of absorptive-unsaturation, than those soils where ploughing produces an intermixing of the upper layers, poorer in bases, with the lower ones which are richer in bases. That in this way a constant bringing upwards of the bases takes place, i. e., a kind of renewal may be true, although it still requires proving in the case of certain kinds of soils, as could be done in the case of the upper-Bavarian arable and pasture lands.

It should be pointed out that in considering fig. 262, it must be remembered that though every possible precaution was taken to investigate qualitatively each soil as to its mechanical agreement with geologically similar soils, it is possible that several geologically not quite similar soils were placed together, which, although showing the same or very nearly the same geological origin, differ, however, in the size of their particles.

These differences are in many cases caused by differences of slope, as was described by W. KOEHNE and H. NIKLAS (12) and which is of primary importance in the separation of the different classes of soils.

The weathering, progressing as it does, in the direction of slope, and which constantly exposes fresh amounts of base, together with the washing action of water and the deflating and accumulating action taking place more particularly on slopes, must be considered as very important factors in determining the size of the particles, and by this means influencing the reactions of the soil.

Important results are obtained not only from microscopic rock analysis but also from soil analysis.

Equipped with those methods of investigation we had, in several cases as *e.g.* in the case of the heterogenous covering soils and in the case of the partly loamy and partly sandy Franconian diluvial soils, to undertake yet another separation.

In our opinion, *such a procedure would enable scientific conclusions to be drawn as to the relation between the lime-content and reaction-character of a soil and its geological mode of origin, or its underlying matrix, and also with the help of advanced cartography of scale* 1 : 25,000 *or* 1 : 5 000 *and reaction analyses, to apply the conclusions arrived at to geologically and agriculturally similar soils.*

There is no doubt that taking all necessary precautions in forming general conclusions, it would then be possible to indicate practical lines along which further manuring should take place (13).

From further work, carried out since September 1924, on the reaction character of Bavarian soils, the following may be concluded that the *true Alp-covering soils,* which are recognised only with difficulty by many, on account of their showing all transition stages of the weathering products of Franconian dolomite and of other Jurassic members — *are typically deficient in lime and are of neutral mostly of acidic character, and that the poverty of the clover, Mazagan vetch and especially of lucerne is due to this deficiency. They contrast very strongly in this respect with the different Jurassic weathering soils, which in many cases adjoin them. Similarly, the more sandy or loamy middle Franconian diluvial soils are concentrated in a comparatively narrow region of acid reaction, and finally the loamy-soils of the upper-Bavarian "high-terrace" differ from the soils of the newer "valley-terraces" and partly from those of the "lower-terraces" in that they have in the majority of cases a weakly acid to a strongly acid reaction.*

In recent times investigations were begun on the reaction character of the diluvial loamy-soils and Miocene-sand and gravel lying in the Tertiary belt south of the Danube. The similar investigations of the previous year indicated a considerable heterogenity and a distribution over a large P^H region (see Table II). The results obtained could not have been used as evidence for two reasons, firstly because the number of soils investigated was far too small, and secondly, because the soils investigated were, geologically considered, of a too heterogenous character. This year's investigations on these quaternary soils, after separating out the deeper layers of a Liass character, showed mostly an acid reaction.

In the end, such systematic treatment of the results obtained in the geological investigations of geologically typical series of soils, will enable us, through careful formation of generalisations, to advance the knowledge of the chemical behaviour, which is of such great importance to agriculture.

The amount of care to be exercised depends upon whether:

(1) in taking the sample, attention was paid to the agricultural and manure-technical, as well as to the plant-organisation side;

(2) attention was paid to the geological section (profile) and thus to the mode of formation;

(3) the soil is horizontal or whether inclined and in what direction ;

(4) in summing up the results of the investigations on the chemical character attention was also paid to the differences in the analyses of the different soils, which often occur even in limited spaces.

Only if and when all these points have received the attention they deserve, are we entitled to apply deductively, the conclusions arrived at in the chemical investigation of geologically homogenous series of samples, to corresponding kinds of soils. From our experience we advise very special care in the treatment of samples supplied. *Such systematically carried out investigations will give for homogenous series of soils, a typical series of numbers lying within a constant and limited* P^{H} *region.* In this way it will be possible to prove the existence of many other acid soil-types, *in which the base-deficiency is geologically and agriculturally caused, which showed itself, may be, for a long time in bad harvests or lime-deficiency, or may have existed for a long time in a latent state and became active only through the use of an unsuitable artificial manure.* The recognition of these facts will put in their proper place the very general statements as to the injurious action of acid manures.

BIBLIOGRAPHY AND NOTES.

(1) RAMANN. Bodenbildung und Bodenteilung. Berlin, 1918.

(2) W. KOEHNE and H. NIKLAS. Erläuterung zu Blatt Ampfing, Mühldorf, Baierbrunn, Gauting u. s. w. der geognostischen Karte von Bayern 1 : 25,000 und E. KRAUS, der Blutlehm etc. *Geognostische Jahreshefte von Bayern*, 34. Jahrgang, 1921.

(3) A review of the work, of R. GANS is given in *Internationale Mitteilungen für Bodenkunde*, Vol. III (1913), p. 529.

(4) More details of the organisational work are to be found in *Landwirtschaftliches Jahrbuch v. Bayern*. Jahrgang, 1925.

(5) Since September 1924 a further number began sending in samples.

(6) *Landwirtschaftliches Jahrbuch von Bayern*, Jahr 1925.

(7) This number increased from 1-9-1924 till 28-2-1925 by 2 481 soil samples.

(8) We have to deal here with the influence of carbonic acid. The influence of carbonic acid is strongest in the region of P^H 6-7, although it is felt in the region P^H 5-7.

(9) In drawing the curves we always used the upper value of the P^H interval, from table II, as the abscissae, thus, e, g., for P^H 6.01-6.5 we used 6.5. In this way the curves represent the hydrogen-ion concentration in water extract. It is worth noticing that the shifting caused by the curves in the coordinate system affects unfavourably especially the curves of the acid soils.

(10) These observations are in agreement with the exhaustive investigations on the lime-content carried out at the central agricultural experimental station Munich in the years 1892-96, and which was then under the direction of SOXLETH. The results then obtained show in the case of nearly all soils of the Bavarian forest, deficiency in carbonate of lime.

(11) *loc. cit.*

(12) *loc. cit.*

(13) H. NIKLAS in the explanations to the Mühldorf section of the geological map of Bavaria (1 : 25,000) p. 82, has drawn conclusions from the results of the chemical investigations on the soils as to the their lime requirements, and he and W. KOEHNE — the latter from the results of borings — concluded that the soils of the Pietenburg level require lime urgently, while those of the younger Inn terrace do not need liming. Besides the recognition whether a particular soil requires liming or not, a decisive factor in the choice of a manure is the reaction character of the soil. It would therefore be of great importance to the scientific advisers of the practical farmer if they could indicate, on the basis of a knowledge of the reactions of certain widely distributed soils, the best manures, i. e., yielding optimum results for a given soil.

THE CLASSIFICATION OF SOILS ON THE BASIS OF ANALOGOUS SERIES IN SOIL FORMATION.

D. VILENSKY.

The problem of the classification of soils, the history of which is almost as old as the history of soil investigation itself, has not yet reached a satisfactory solution. In particular, it is not yet completely resolved by the Russian pedologists, though the latter proposed several schemes for classification of soils. Among this classification two were of greater importance in the development of soil investigations in Russia, those of Prof. N. SIBIRCEFF (1895) (1) and Prof. K. GLINKA (1902). (2) The classification of Prof. SIBIRCEFF is based on the principle of *zonality*, that is on the factor characterizing their geographical extension on the surface of the globe. The classification of Prof. GLINKA is constructed according to the factor of *humidity*, because he considers that moisture is the pre-eminent factor in soil formation.

From personal investigations and analysis of material collected by Russian pedologists, it was possible for the author to establish that soils form several genetically independent divisions, whose soil-formation is quite specific. Within the limits of every division the soil passes a determined cycle of development — *progressive* — till the moment of maximal expressiveness of its properties and — *regressive* — from the moment of its beginning to decompose into more simple integral parts. The fundamental stages of this cycle are called *types*. In the first instance there can be named four divisions: *thermogenic, phytogenic, hydrogenic, and halogenic.* In the best investigated phytogenic division found in the temperate zone of the globe, the process of the evolution of soils is conceived as follows:

In the first stage of development, in *desert*, we have a *crust weathering* in different stages of decomposition, not at all subject to the influence of the phytosphere and only in a slight degree to that of the hydrosphere. In the next stage, in the zone of *half-desert*, the soil-cover is represented by a type with scarcely marked morphological signs — *grey-soils*, in which the soil-formation is expressed by washing out of easily soluble alkali-salts, some alkalisation of alkaline-earths and insignificant accumulation of organic matter. Therefore a difference between the soil and the material rock is observed in the chemical composition only; as to the morphology, there are scarcely visible signs of difference. Further, in the zone of *dry steppe*,

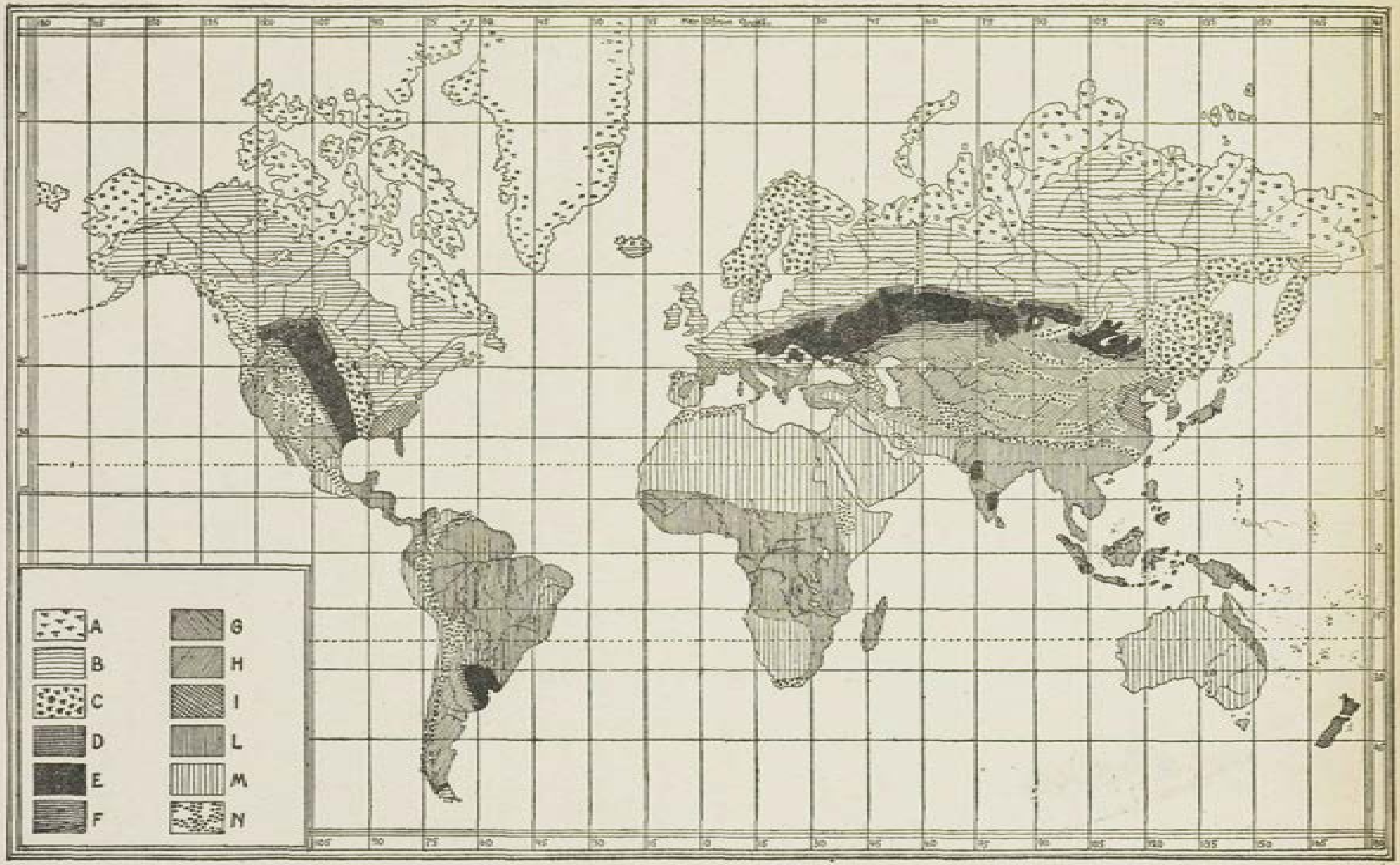

FIG. 263. — Sketch Map of the soil-cover of the world, after Prof. K. D. GLINKA.

A, Tundra soils; *B*, ash-like soils; *C*, bog and ash-like soils; *D*, grey nodular soils; *E*, black soils; *F*, nut brown soils; *G*, brown soils; *H* grey soils; *I*, yellow soils; *L*, red soils; *M*, red soils of tropical deserts and arid savannahs; *N*, mountain soils.

we meet rich *brown* and *nut-brown* soils, in which the process of soil-formation is expressed by alkalization of alkaline-earths, especially in the form of carbonates, which form a distinctly marked alluvial horizon. At the same time a visible accumulation of organic matter is observed, the soil begins consequently to acquire a definite structure consisting of three horizons.

The next, *black-soil zone*, with fertile *chernoziom*, is characterised by the full alkalization of carbonates of alkaline-earths and the maximum accumulation of organic matter. In this stage the soil is at the height of its properties, power and productivity. With this stage finishes the first — *progressive* — period of history of the development of the soil. After this period in the development of soil begins the second stage — that of regression and dying away. This period begins with the *grey forest, nut-like soils*, which form generally, as a consequence of the development of forests on the black soil. At the same time, in consequence of more mobile combinations, the process of humification nearly stops; the former stores of humus are alkalized by the soil solution, continually streaming downwards, because, in consequence of the setting free of absorbed Ca, the humates become mobile and are drawn away by soil-solutions into the depth of the lithosphere. With the decomposition of organic matter its protecting and conservative influence ceases, and an energetic process of further weathering of mineral substance of the soil takes place; it consists now in transferring the oxides deeper into the ground. The carbonic acid, set free in abundance by the energetic mineralization of organic residues, probably plays a great part in this last process of *ash-like soil formation*. This process in course of its development leads the soil to the conclusion of the cycle of its evolution — poor *ash-like soils* (podsol), when all more or less mobile substances are removed and only the inert silica remains in the composition of the soil mass. Such a soil cannot be a source of food material for herbaceous plants, except the simplest forms. It is suitable for trees, which obtain food material from the deeper layers. An analogous cycle of development of the soil-cover is to be found in every division of soil-formation. For instance among the *salted soils* of the temperate zone the division of *halogenic* soils consists of six types, which in their morphology, chemistry and distribution are quite analogous to the above mentioned types (3). It is possible to observe the same series in *thermogenic* soils of the torrid zone *laterites*. Notwithstanding the scarcity of investigations in this zone, it is quite established that, the

TABLE I. — *The Classification of Soils by Prof.* D. VILENSKY.

Series / Division	A Type	B Type	C Type	D Type	E Type	F Type
Thermogenic T	Red soil of tropical half-desert TA	Red soil of arid savannah TB		Red soil Laterite TD	Degraded red soil TE	Ash-like red soil TF
Phytogenic P	Grey soil PA	Brown soil PB	Nut-brown soil PC	Blacksoil (Chernoziom) PD	Grey nodular soil PE	Ash-like soil (Podsol) PF
Hydrogenic H	Tundra soil HA	Half-bog soil HB		Bog soil HD		Ash-like bog soil HF
Halogenic G	Dry salt soil GA	Prismatic soil GB	Pillared alkali GC	Black pillared alkali GD	Nodular alkali GE	Ash-like alkali GF
Thermophytogenic PT	Yellow soils					
Thermohydrogenic TH	Bog soils of torrid zone					
Thermohalogenic TG	Salt soils of torrid zone					
Phytohydrogenic PH		Pasture soil PHB		Black pasture soil PHD	Grey nodular soil PHE	Ash-like soil PHF
Phytohalogenic PG	Alkaline grey soil PGA	Alkaline brown soil PGB	Alkaline nut-brown soil PGC	Alkaline black soil PGD		Alkaline ash-like soil PGF
Hydrohalogenic HG	Light chloride sulphate salt soil HGA			Black carbonate salt soil HGD		
Orogenic O	Greyish pasture soil OA	Brownish-grey pasture soil OB	Sward-pasture soil OC	Black pasture soil OD	Grey nodular soil OE	Ash-like soil OF

process of soil formation in this region begins and finishes by types quite analogous to the corresponding ones of the temperate zone (4). Finally the same is to be observed in the *hydrogenic* division of *bog-soils*, distributed in the cold zone.

The author's classification (tab. 1) has for basis those analogous series in soil formation. Its highest classification unit is the *soil division*. The characteristics of those divisions are:

1. *Thermogenic division.* Distributed in subtropical, tropical and equatorial regions of the *torrid zone*, independently of the quantity of precipitation, that is to say, in half-desert, savannahs and forests. The prevalent factor of soil formation in this zone is the high and constant temperature, favourable to a rapid and complete (to the formation of CO_2) mineralization of organic residues and increasing the energy of chemical weathering of mineral substance of the soil. Enriched by CO_2, the soil solutions bring about rapid and energetic hydrolysis of silicates and alumino-silicates and remove not only the bases, but also the silica (quartz-silica excepted). As products of weathering, the hydrates of the oxides of iron and aluminium chiefly, also Mn_3O_4 and TiO_2 are accumulated and form the greatest part of the soil mass. As admixture, there are found grains of quartz, kaolinite, and incompletely weathered residues of minerals of the mother rock. Under the influence of high temperatures the oxides of iron dehydrate and pass into the form of less mobile anhydrates, *turite* especially, which causes the prevalence of a red colour among the soils of the given division. The intensity and the character of this colour varies in accordance with the content of iron in the maternal rock. The soils of the given division, as well as of all those following, are formed on all kinds of rocks, eruptive and sedimentary, in the primary and secondary (alluvial, eolik) layers. If the process of soil formation is of long duration, the lithosphere can be penetrated to a very considerable depth.

2. *Phytogenic division.* Distributed in all regions of the temperate zone, independent of the amount of precipitation. The predominant factor of soil formation is the vegetation, causing considerable accumulation of decomposed organic matter in the soil. This accumulation is the result of insufficient energy in the decomposition of organic matter, owing to the comparatively low annual temperature and a long period of winter rest, during which the biological processes in the soil are interruped. The organic colloidal complexes (humates), absorbing the alkalized bases, hinder the process of weathering of

alumino-silicate substances of the soil, already delayed by the moderate temperature and the feeble activity of the soil solution. The accumulation of the most characteristic part of this soil, the decomposed organic matter, in consequence of its feeble stability, takes place only in external horizons of the mother rock and the process of soil formation does not reach a great depth.

3. *Hydrogenic division.* Chiefly distributed in the *cold region* — tundra and the adjacent part of the forest zone — but occurs in other zones also, if the special conditions of relief cause the stagnation of surface water, or the rise of soil water. The prevalent factor of soil formation in this division is the water, which acts directly, causing a heightened hydrolitic decomposition of the alumino-silicate part of the soil and indirectly forcing the air out of the soil and causing anaerobic conditions. Under the influence of water with carbonic acid in solution an energetic hydrolysis is produced which sets free large quantities of the elements of the silicates, as well as of organic-mineral substances. Therefore the marshy horizons have always, even in tundra, an alkaline reaction. Under the influence of alkaline water solutions, containing bicarbonates, the weathering of alumino-silicates takes place and brings about the formation of clays and accumulation of alumina, while the bases and oxides of iron are alkalized. The mobility of the chemical combinations of iron is quite evident in this case, because in the bog soils there are conditions suitable for the formation of protoxide of Fe combinations. Consequently in the bog soil there occurs a whole series of chemical compounds of iron, unknown in other soil types, among them: vivianite, sulphur compounds, FeS, FeS_2 (pyrite, marcasite), $FeCO_3$. At the same time, in consequence of imperfect aeration, the decomposition of organic matter proceeds very slowly and remains unfinished. It results in accumulation of a great quantity not only of humus, but also of carbonized organic matter, preserving traces of organisation.

4. *Halogenic division.* The principal factor of soil formation in this division is the saltness of the mother rock, or to be more exact, the *content of the absorbed sodium* in its colloidal part. This salinity can be of different origin: geological (sea-sedimentary), as well as that of soil (salt soils). When the rock is impregnated with sodium salts, an absorption of it takes place by colloidal complexes of sodium. Then, after the washing out of the rock or the salt soils of easily soluble salts, begins the alkalization of absorbed bases, during which soda is formed by the process of exchange of absorbed sodium for

calcium of $CaCO_3$ (5). The enrichment of soil solutions by soda makes them a very energetic reagent, producing first the alkalization of decomposed organic matter and then of oxides, both being in the alkaline solution in the form of zole. Penetrating through cracks and capillary vessels into the depth of the rock, they form not far from the surface, an alluvial horizon, overfilled with colloids, which in the dry state forms distinct prismatic or pillared pieces, and, when moistened, swells, becomes water-tight and creates on the surface of the soil the conditions of temporary saturation. In consequence of very unfavourable physical properties of the soil, of a considerable alkalinity of its external horizons and of the presence at a slight depth of easily soluble salts, the vegetative cover of halogenic soils is, as a rule, poor and sparse, the accumulation of decomposed organic matter insignificant, the greater part of it being immediately alkalized into the alluvial horizon. Being bound by its origin to a particular property of the mother rock, its salinity, which depends upon the origin of the rock and can be met everywhere, the halogenic division is intrazonal.

Nevertheless, as the salinity itself of the mother rock, especially the secondary one, arising during the soil formation, takes place more easily in the conditions of a hot and dry climate, where evaporation prevails over precipitation, those soils are mostly distributed in steppe and half-desert regions.

Such are the properties, origin and distribution of the *fundamental divisions* of soil formation. Between them there may exist, and really do exist, *intermediate divisions*, uniting fundamental properties of the two, though in a very changed form. Those divisions are:

5. *Thermophytogenic division.* It consists of the little investigated yellow-brown and reddish-yellow soils with low content of humus and considerable quantity of oxides. Distributed in South Europe (France), Japan, South-Eastern United States. They are united by Prof. GLINKA in one group, to which he gives the name of *yellow soils* (6). Their types are not yet investigated even approximately.

6. *Thermohydrogenic division.* To this division belong half-bog and bog soils of equatorial, tropical and subtropical regions, very little investigated.

6. *Thermohalogenic division.* To this division belong the salt soils of the torrid zone, whose morphology, chemistry and geography

PLATE XCV.

THE PRINCIPAL SOIL - TYPES OF THE WORLD.

By Prof. D. G. VILENSKY. Drawn by M. Podjakonoff.

THE PRINCIPAL SOIL - TYPES OF THE WORLD.

By Prof. D. G. VILENSKY. Drawn by M. Podjakonoff.

Thermogenic division

T

Torrid zone

A

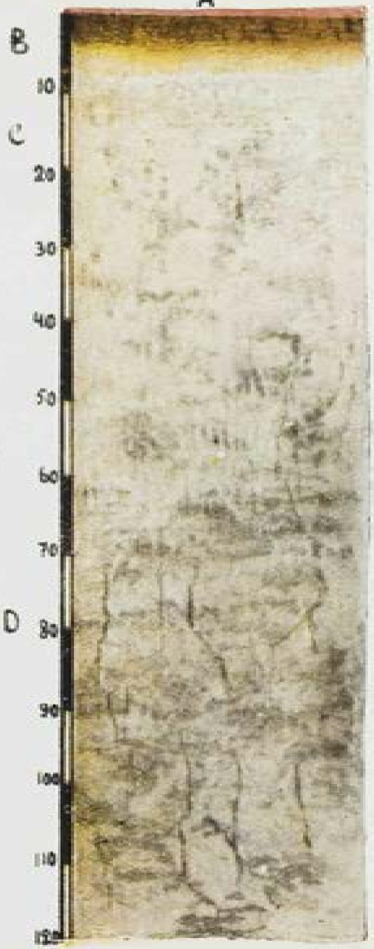

FIG. 264.

Red soil of tropical half desert

B

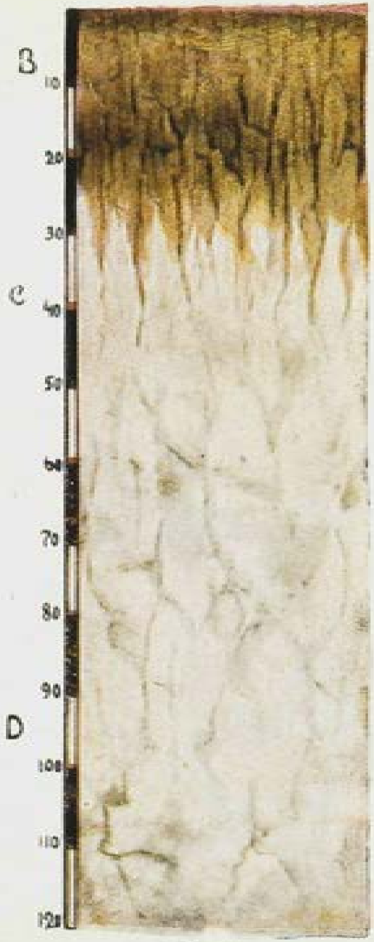

FIG. 265.

Red soil of arid savannah.

C

FIG. 266.

By Prof. D. G. VILENSKY. Drawn by M. Podjakonoff.

Thermogenic division

T

Torrid zone

D

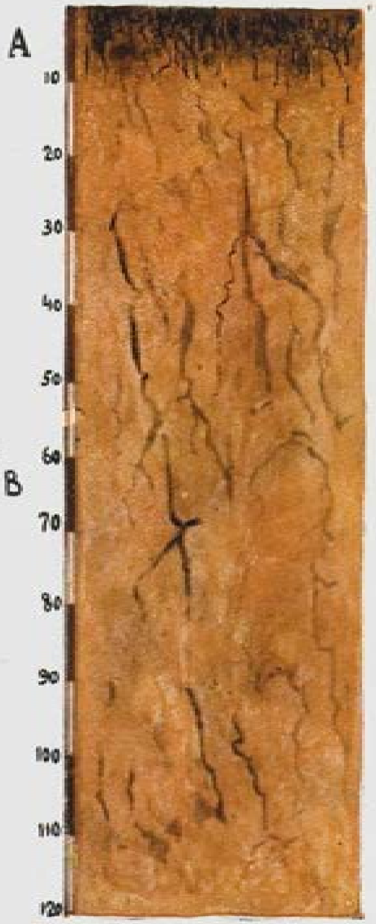

FIG. 267.

Red soil - Laterite soil.

E

FIG. 268.

Degraded red soil.

F

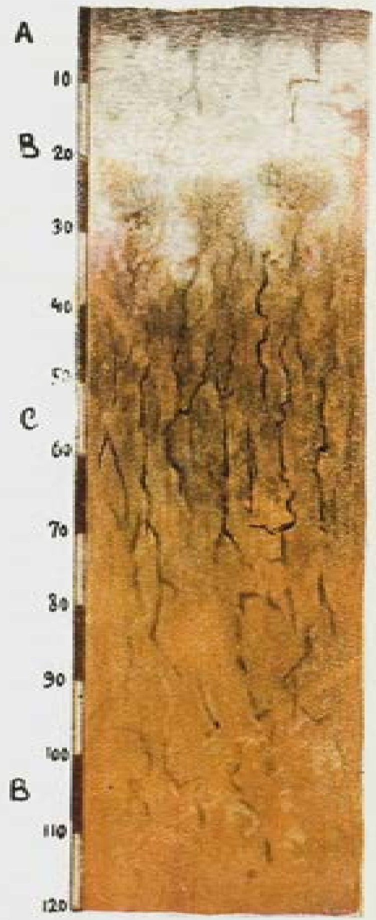

FIG. 269.

Ash-like red soil.

are, from the point of view of contemporary pedology, as little investigated as those of the previous divisions.

8. *Phytohydrogenic division.* To this division belong the soils of the forest region of the northern part of the temperate zone, from the sward-soil to the ash-like and, in particular, the meadow-soil. The process of soil formation in this division, owing to the especially favourable properties of the zone in question for the settlement of tree-vegetation, progresses very rapidly and we often meet there its last stages, the ash-like (podzol) soils.

9. *Phytohalogenic division.* To this division belong slightly alkaline soils, intermediate between phytogenic soils and alkaline. They form types quite analogous to those of phytogenic soils.

10. *Hydrohalogenic division.* Includes *salt soils* which are formed where the conditions of the relief allow the soil water to approach the surface, so that its evaporation from the surface becomes possible. If the soil water contains in solution a considerable quantity of mineral salts, those salts are concentrated on the surface of the lithosphere in gradually increasing quantity. As a rule, in those soils the upper horizon is saturated with easily soluble salts, and the lower horizon has the characteristic of swampness.

The ten enumerated fundamental and intermediate divisions of soil formation embrace, as it appears, the whole number of soil-bodies formed on the surface of the earth in conditions of plain, as well as of mountain relief. Only in regard to the last, the possibility is not excluded of classifying the group of soils, known as *high-mountains soils,* into a separate division of *orogenic* soils, quite independent of others. It might be done in course of time, after investigation of mountain soils in a greater number of regions.

The soils of divisions in the classification table (Table I) form the horizontal rows. Every division is divided into six types and those types form the basal units of the soil cover. The types are analogous in all the divisions and therefore they form the vertical rows in the classification system. Consequently, every type lies at the point of intersection of the two coordinate divisions and series. In the total, with 11 divisions, 66 types find their natural place in the table. Their existence is theoretically quite possible ; in fact, only 42 have been at present investigated.

The characteristics of the principal types described are as follows.

I. Thermogenic division.

T. A. *Red soil of the tropical half-desert.* Is characterized by insignificant thickness of alluvial horizon (B = 6 cm.) (7), yellowish-red colour, slightly foliated structure and friable texture. Under the above mentioned horizon lies the alluvial horizon in separate patches, more often a whole layer of lime and gypsum; effervesces on the surface with HCl. Described up to the present only in the halfdesert of North Africa (in Algeria) by the pedologist DRANICIN (8).

T. B. *Red soil of arid savannah.* Hor. B. about 25 cm. thick, brown-red, structure very slightly shown as a thin crust on the surface. Hor. C. mostly compact, structurless lime flag. Effervesces on the surface with HCl. Distributed in arid alfa (*Stipa tenacissima*) savannah of North Africa.

T. D. *Red-soil Laterite.* Consists almost exclusively of one hor. B, characteristics of A and C. very slightly shown and their nature has been very little studied.

The thickness of B is very considerable. Nevertheless we have no exact knowledge of it in the conditions of the primary layers of the soil. The colour of the horizon varies: red, crimson, orange, downwards generally yellowish, upwards tending to a brown tint. Structure indistinct, cloddy, texture friable, spongy or cellular. The type described distributed in all subtropical, tropical and equatorial regions of the world; nevertheless, its characteristics and nature from the point of view of genetic pedology are almost unstudied, in particular it is even unknown, whether it is formed under the herbaceous, or under the tree vegetation.

TE. *Degraded red-soil.* Hor. A, 20 cm. thick, of brownish-grey colour, friable, in the lower part nodular structured. Hor. B, 20 cm. brownish-orange, indistinctly nodular in structure. Hor. C, 35 cm., orange with brown or tawny-brown spots and veins, cloddy, dense. Under it lies the hor. B of the former red soils. Described by Prof. ZACHAROFF in Georgia near Batoum (9).

TF. *Ash-like red soil,* Hor. A, 4 cm. thick, straw-colored, grey, friable, structureless; hor. B, 30 cm. thick, in the uppper part whitish, slightly nodular in structure, friable, in the lower part whitish-yellow structureless, compact; hor. C, 40 cm. thick, dark brown with red spots, structureless, dense. Under it lies the hor. B of the former red soil. In hor. B and C occur Ortstein particles. Described by Prof.

PLATE XCVII.
THE PRINCIPAL SOIL - TYPES OF THE WORLD.
By Prof. D. G. VILENSKY. Drawn by M. Podjakonoff.

THE PRINCIPAL SOIL - TYPES OF THE WORLD.

By Prof. D. G. VILENSKY. Drawn by M. Podjakonoff.

Phytogenic division

P

Temperate zone

A

FIG. 270.

Grey soil.

B

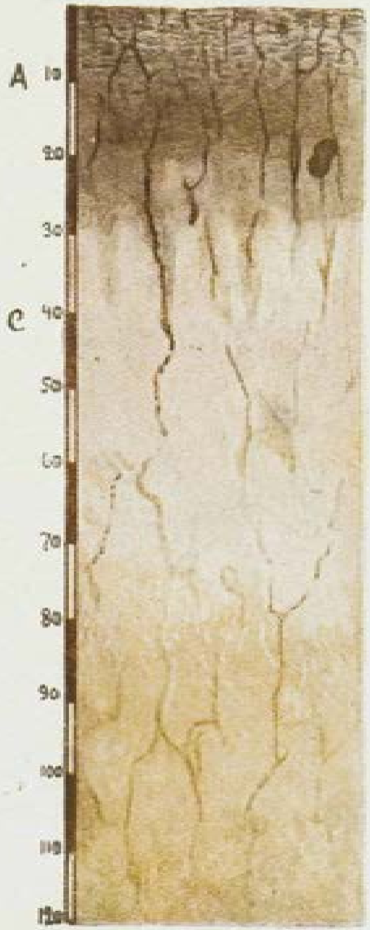

FIG. 271.

Brown soil.

C

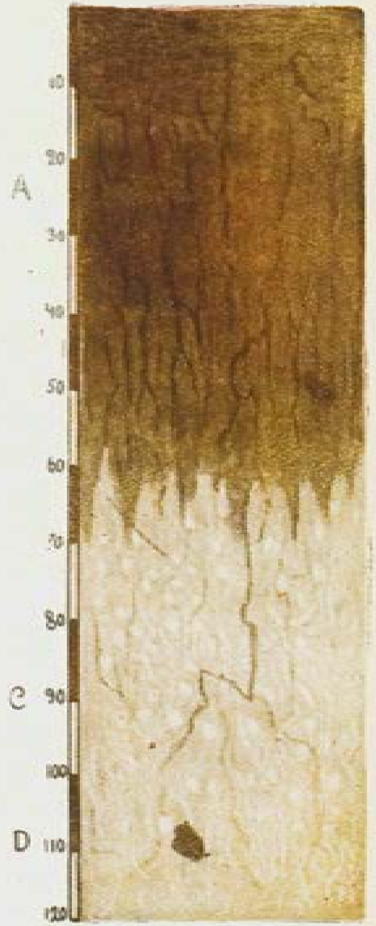

FIG. 272.

Nut brown soil.

THE PRINCIPAL SOIL - TYPES OF THE WORLD.

By Prof. D. G. VILENSKY. Drawn by M. Podjakonoff.

Phytogenic division
P

Temperate zone

D

FIG. 273.
Black soil.

E

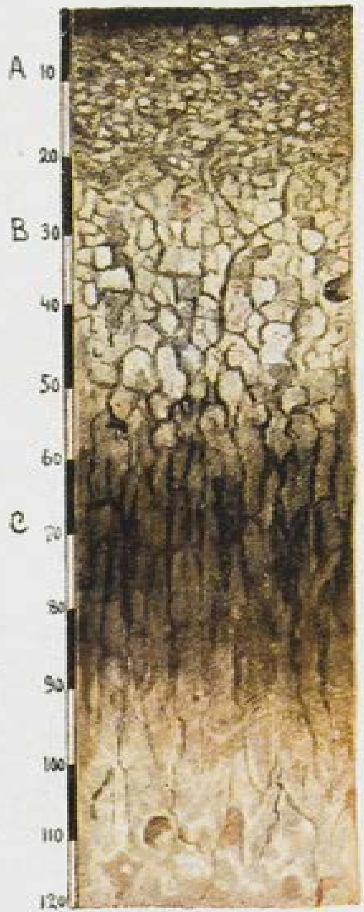

FIG. 274.
Grey nodular soil.

F

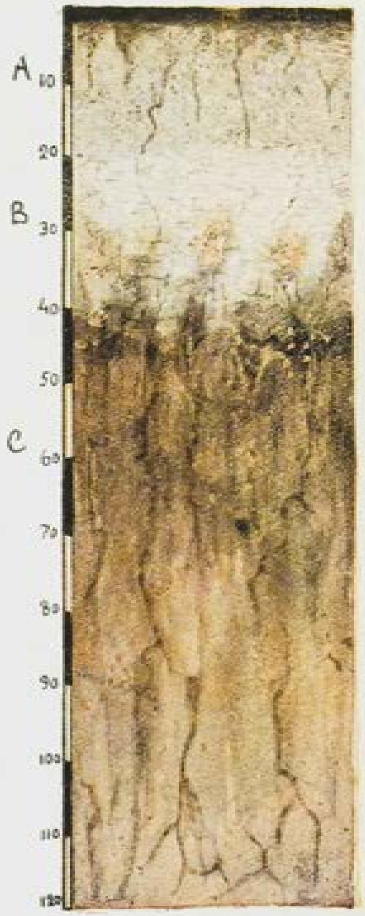

FIG. 275.
Ash-like soil.

THE PRINCIPAL SOIL - TYPES OF THE WORLD.

By Prof. D. G. VILENSKY. Drawn by M. Podjakonoff.

Hydrogenic division

H

Cold zone

A

FIG. 276

Tundra soil.

B

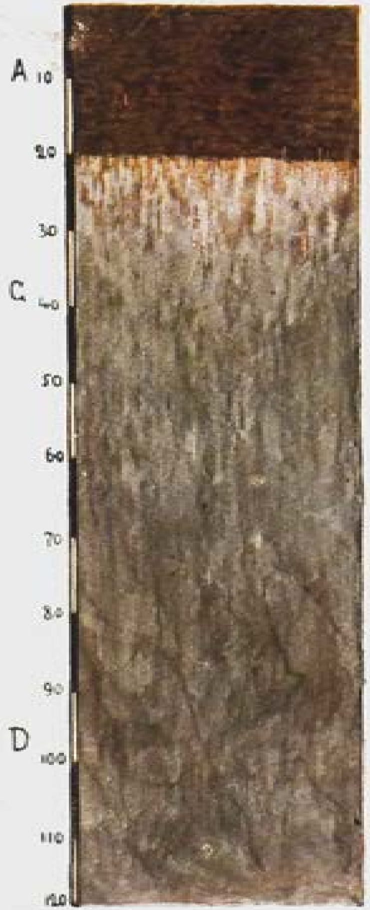

FIG. 277.

Half bog soil.

C

FIG. 278.

THE PRINCIPAL SOIL - TYPES OF THE WORLD.

PLATE C.

By Prof. D. G. VILENSKY. Drawn by M. Podjakonoff.

Hydrogenic division

H

Cold zone

D

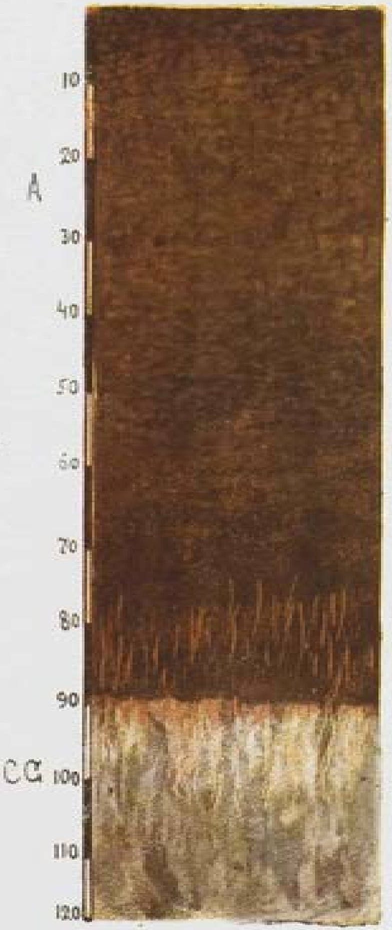

FIG. 279.

Bog soil

E

FIG. 280.

F

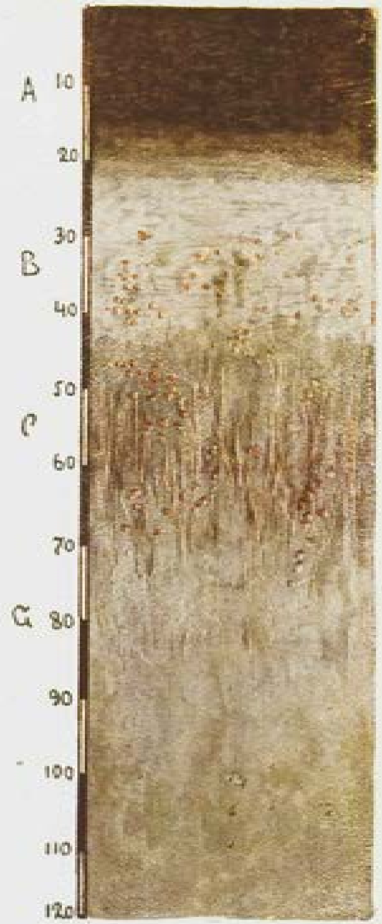

FIG. 281.

Ash-like bog soil

ZACHAROFF in Georgia near Batoum, but there are indications, as to its distribution in many parts of the torrid zone.

II. Phytogenic division.

PA. *Grey soil.* Hor. A about 30 cm. thick, light-grey with whitish-yellow, or brown tint, scaly in structure, with a great number of insects and worm tracks. Hor C 50-100 cm. thick, whitish, very dense, carbonate in upper part, in lower part has veins of gypsum. Effervesces on the surface. This type is zonal in the half deserts of the temperate zone and is distributed in Spain, Turkey, East-Transcaucasus, Persia, Turkestan, Mongolia, the Far West of the United States, Brazil and Argentina.

PB. *Brown soil.* Hor. A, 30-40 cm. thick, brown coloured, slightly foliated in upper part (A_1) more dense and slightly vertically clefted in lower part (A_2). Hor. C, 50-60 cm. thick, whitish, strongly carbonaceous. Usually effervesces in hor. C. Is zonal in South part of arid steppes of temperate zone and is distributed in South-East of European Russia, in Kirgis-district, Hungary and Mongolia. Its distribution on the other continents has nor been studied.

PC. *Nut-brown soil.* Hor. A, 60-70 cm. thick, nut-brown coloured, in the upper part (A_1) slightly foliated, in the lower part (A_2) more dense, roughly cloddy with distinctly shown vertical clefts. Hor. C, sharply shown, pre-eminently carbonaceous, but frequently contains gypsum. Carbonates mostly as completely formed units, most often as white masses. Effervescing as usual in hor C. Zonal in northern part of arid steppes of temperate zone. Distribution: Hungary, Roumania, South Crimea, South-East of Russia, Southern part of Western Siberia to Altai, South Transbaikal and Manchouria.

PD. *Black soil* (chernoziom). Hor. A 70-100, even to 150 cm. thick, in upper part (subhorizon A_1) black with greyish or nut-brown tint, granular structured, in lower part (A_2 beginning at the depth of 40-50 cm.) of lighter nut-brown colour and cloddy-prismatic structure; gradually passes into the next hor. often in tongues, or in streams. Hor. C is rather distinctly shown, consists of sharply formed limy concretions. Effervesces in C. Zonal in northern part of steppes of temperate zone, distributed in Poland (Galicia), Hungary, Roumania, European Russia, West Siberia to Baikal, South Transbaikal, United States of America (on the prairies) plateau of the Far West, and in Argentina.

PE. *Grey nut-like soil.* From above, a forest cover 2-5 cm. thick, under it the hor. A 25 cm. thick, grey, finely nodular in structure. Hor. B 20-30 cm. thick, greyish, or ash-brown with grey silica and dark humus patches; of coarse nodular structure, becoming coarser towards the lower part. The surface of nodules is mealy, silicious, speckled. Hor. C to 100 cm. and lower, reddish brown, very dense, with vertical clefts and dark brown streams over them; 200-120 cm. deep, frequent limy concretions. Distributed under leaved woods in zone transient between forests and steppes — in Eurasia: Poland, European Russia, West Siberia to Baikal.

BF. *Ash-like soil* (Podzol). From above, a forest cover to 5 cm. thick, underneath, hor. A 10-15 cm. thick, light-grey, thinly granular, friable. Hor. B, 15-25 cm. thick, whitish or completely white, slightly foliated, light with misty-brown Ortstein particles. Hor. C, reddish-yellow, with numerous Ortstein particles, very dense, mostly structureless. Distributed in forest districts of Eurasia, on other continents unstudied.

III. Hydrogenic division.

HA. *Tundra soil.* Hor. A-3 cm. thick, grey-brown, consists of humus partly, with some decomposed plant residues. Beneath it lies the hor. G (10) 8-10 cm. thick, of dove-grey colour, very sticky.

It is distinctly separated from the hor. A and D by a yellowish-brown ochreous layer 2-3 cm. thick. Hor. D is compact, brownish-grey, not flowing. At a depth of 79 cm. the permanently frozen layer is often found. This type forms the soil cover of the dry tundra, but its nature and the conditions of its distribution have been scarcely investigated. Described in the tundra of Asiatic Russia by Profs. SUKACHEFF (11) and DRANICIN.

HB. *Half-bog soil.* Hor. A to 20 cm. thick, brownish-black, more or less turfy, distinctly separated from the underlying layer. Hor. G. of varied thickness (15-20 cm. and more), dove-grey with greenish or bluish tint, with brown and rusty spots and veins. This type is usually considered as intermediate between marshy and not marshy soils and has been very little investigated. Largely distributed in the tundra and in the north part of the forest-zone.

HD. *Bog soil.* Hor. A 80-90 cm. thick, in upper half brown-coloured, turfy, in the lower (subhor. A_2), black, rich in decomposed organic matter, abruptly passes into the next layer.

PLATE GI.

THE PRINCIPAL SOIL - TYPES OF THE WORLD.

By Prof. D. G. VILENSKY, Drawn by M. Podjakonoff.

THE PRINCIPAL SOIL - TYPES OF THE WORLD.

PLATE CI.

By Prof. D. G. VILENSKY. Drawn by M. Podjakonoff.

Halogenic division

G

Intrazonal in temperate zone

A

FIG. 282.

Dry salt soil.

B

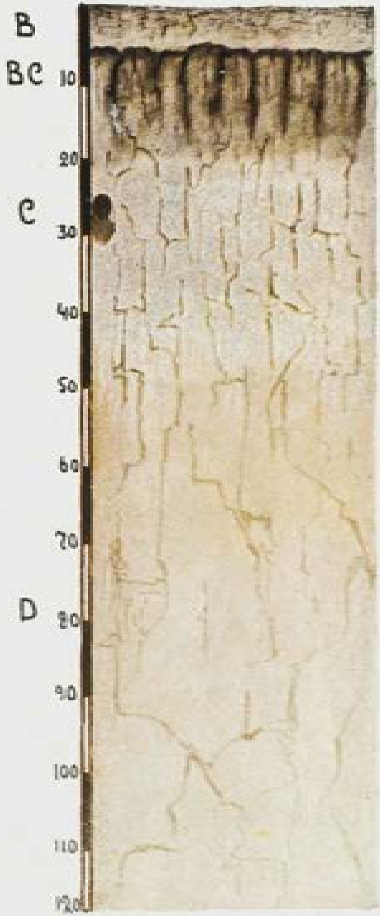

FIG. 283.

Prismatic alkali.

C

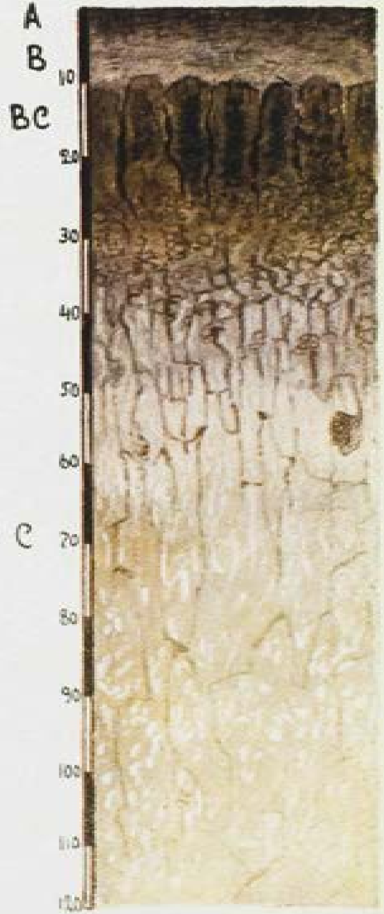

FIG. 284.

Pillared alkali (Solonetz).

THE PRINCIPAL SOIL - TYPES OF THE WORLD.

By Prof. D. G. VILENSKY. Drawn by M. Podjakonoff.

Halogenic division
G

Intrazonal in temperate zone

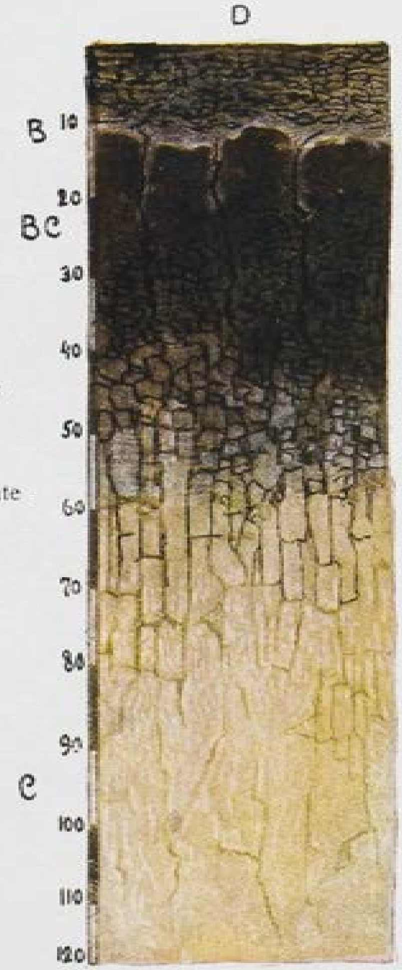

FIG. 285.

Black pillared alkali.

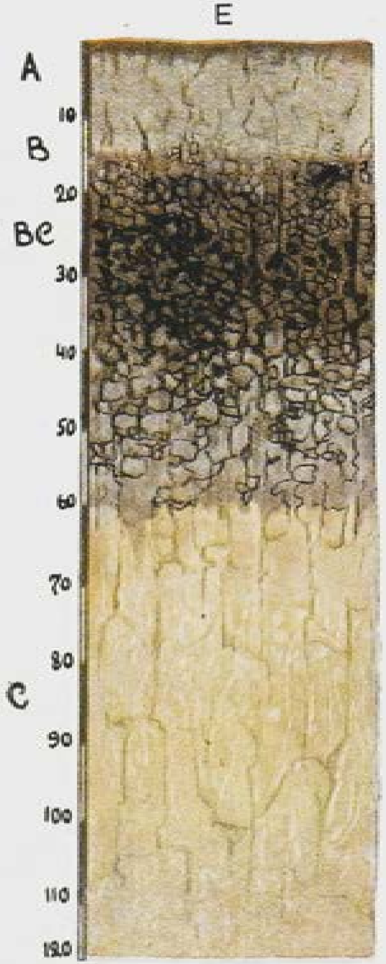

FIG. 286.

Nodular alkali.

FIG. 287.

Ash-like bog siol

Hor. G, of varied thickness, greenish or bluish, with a great number of patches and veins of hydrates of oxides of iron. Largely spread in tundra and in the forest zone.

HE. *Ash-like bog soil.* Hor. A, 20 cm. and more thick, black, half-turfy, in the lower part somewhat lighter coloured and less turfy. Hor. B, 20 cm. thick, dirty-grey, with dark humus patches and compact Ortstein particles, 1-2 mm. in diameter. Hor. G, sticky, dove coloured or greenish, with rusty spots, veins and Ortstein particles. The common type of soil-cover in the north part of the forest zone of Eurasia.

The soils of the hydrogenic division have been in general very little investigated and the types HC and HE were hitherto unknown in this division.

IV. Halogenic division.

GA. *Dry salt soil.* No hor. A. On the surface of the hor. B a very dense porous crust, smooth from above, as if polished, divided by a net work of clefts into parquetry-like partitions. Downwards it acquires a rather distinct scaly and flaggy structure The whole of hor. B is 10 cm. thick. Hor. C, without signs of infiltration, gradually passes into the hor D. Effervesces on the surface. To this type belong the dry salines — " takyri " — (in Kirgiz) of the semi deserts of Turkestan.

GB. *Prismatic alkaline soils.* Hor. B, 1-7 cm. thick, light-brown, leafy structure, friable, porous. Hor BC, 10-15 cm. thick, breaks into pieces of prismatic form, which are easily divided into small clods. In colour, light tawny-brown, is a little darker, than the previous layer, better shown on the sides of the prisms. The density of hor. BC is considerable. Hor. C contains veins and patches of salts not effervescing. Effervesces on the surface. Hor. BC mostly does not effervesce. Distributed in the south of the arid steppe zone of Eurasia among the light-brown and partly brown soils.

GC. *Pillared alkaline soils.* Hor. A of insignificant thickness (1-5 cm.), often completely missing, light-brown, chestnut coloured, or tawny-brown, porous, always covered from above by a thin (1-2 mm.) crust, which cracks on drying into small polyhedrical flags. Hor. B 2-15 cm. and more thick, light whitish, mealy, distinctly foliated horizontally Hor. BD distinctly separated from the previous one, very compact, dark nut-brown, falls to pieces in the form of pillars with a rounded top, 8-13 cm., high and 4-5 cm. thick. Downwards, hor. B grows gradually lighter becomes cloddy, nodular in structure and passes imperceptibly into C. Hor. C. distinctly alluvial, speckled with patches and veins of chlorides, sulphates and carbonates. Effervesces in hor C. Distributed in the region of nut-brown and brown soils of the steppes zone of Eurasia.

GD. *Black pillared alkaline soils.* Hor, A 6-12 cm. thick, black-coloured, foliated, friable. Hor, B 1-6 cm. thick, sometimes absent, light-grey or whitish, distinctly lamellar, porous, rather dense. Hor. BC 55-60 cm. thick, in the upper part consists of very compact polyhedrical pillars 10-15 cm. high and of the same thickness, with rounded tops. The colour of the pillars is intensely black, but from above and along the cracks they are covered with a thin whitish crust. Downwards, the hor. BC gradually grows lighter and in patches and tongues passes into C. Its structure is here nodular. Hor. C has distinctly shown signs of infiltration, as spots, veins and concretions chiefly those of lime. Effervesces at the depth of 35-40 cm. Distributed in the black soil zone of Eurasia.

GE. *Nodular alkaline soil.* Hor. A 10-20 cm. thick, dark-grey, generally structureless, rarely feebly foliated, rather friable. Hor. BC 50-60 cm. thick, composed of dark nodular clods with sparkling sides. Hor. C carbonate, structureless. Found only in the north part of the black-soil zone of West Siberia, where it is considerably distributed.

GF. *Ash-like alkaline soil.* Hor. A 17 cm. thick, in the upper part dark grey, deeper grey or whitish, friable. Hor B 11-25 cm. thick, compact, pillared, almost white, in the upper part finely foliated, in the lower part containing small brown clods. It contains many Ortstein particles, especially in the lower part. Abruptly passes into the next horizon. Hor. BC 25 cm. and more thick, dense, dark, greyish and rusty-brown, falls into pieces of prismatic form, contains a great quantity of ochreous spots and grains. Hor. C structureless, rich in ochreous-rusty accumulations ($Fe_2O_3 . H_2 . O$). No effervescence. Distributed chiefly in the zone between forest and steppe, under birch and aspen forests, but also in the steppe-zone in low-lying areas.

The soil types in their turn are divided into smaller classification units: (1) subtype, (2) group, (3) variety.

The *subtype* characterizes the degree of the soil-forming process in the given type ; the character of the *group* depends on the structure of the mother rock ; *variety* depends on the composition of the fine earth of the soil. In consequence, it is possible to continue the classification scheme in that way. (Tab. No. 2).

As no detailed appreciation of the proposed classification is entered into (12), we will only note the advantages which it has in comparison with the other existing classification of soils.

(1) It is *genetic* in the literal sense of this word, because it is based on the difference in the genesis of soil, while the greater part of other classifications proposed by Russian pedologists are *geographic*, as they took for a basis the distribution of soils.

(2) Being very simple, it is at the same time sufficiently wide and comprehensive, including a considerably larger number of types than has been described until now. Moreover it can be extended, or shortened without any difficulty, so that an augmentation or a diminution of the number of divisions and even of rows will produce no breaking either of principles of construction, or of the scheme of the classification itself.

(3) The disposition of soil under the form of a *periodical system* shows which types are not yet described, evokes the necessity of searching for them and gives the possibility to foretell their nature.

(4) The important advantage of the proposed classification is that it gives *the possibility to adopt a conventional designation of soils by alphabetical symbols under the form of soil-formulas.* We find that it is unnecessary to stress the importance of introducing into a concretely-descriptive classification the designation of described bodies by formulas. In Russia, particularly, there has been felt long ago the inconvenience of the designation of types by composed words, which often becomes not a designation, but entirely a description of the soil. It appears also, that the same inconvenience is felt by Western European and American pedologists, who begin to use for designating certain types the foreign names. Therefore the introduction of an international language into soil-investigations becomes a pressing necessity. The simplest and most intelligible language in science is that of formulas. The principle of the construction of soil-formulae on the basis of the above mentioned classification is very evident. As was already shown the symbols of a type are two (in the intermediate divisions three) letters : a letter of the division and that of the series. The addition of the index 1, 2, 3, to the letter of the series designates the subtype. The group is designated by small letters *a-f* and the genesis of the mother rock by the addition of the index

Type		Brown	Nut-brown	Black soil	Grey nodular soil	Ash like soil	Bog-soil
Sub-type	1	Light-brown	Light nut-brown	Southern	Degraded black soil	Slightly ash-like	Slimy
	2	Brown	Dark brown	Common	Dark grey	Ash-like soil	Turfy
	3	Dark brown	Dark nut-brown	Heavy	Light grey	Ashy-soil	—
		On alumino-silicate fine earth rock *a*	On carbonate fine earth rock *b*	On quarz-sandy fine earth rock *c*	On alumino-silicate skeleton rock *d*	On carbonate skeleton rock *e*	On quarz-sandy skeleton rock *f*
Group	1	Crystalline					
	2	Sedimentary					
	3	Moraine					
	4	Loess					
	5	Diluvial					
	6	Alluvial					
	7	Eolic					
Variety	1	Loamy					
	2	Clayey					
	3	Clayey sand					
	4	Sandy					

1-7 to those letters. The variety is designated by the figures 1-4 in front of the letters (the figure 1 is omitted).

Formulae:	designation:
$2P_3Cb_5$	Clayey, dark nut-brown soil, on the carbonate fine-earth diluvium.
$2P_2D_4b$	Clayey, common black soil on a carbonate, fine-earth loess.
PHF_3a_3	Loamy, ashy-soil, on a alumino-silicate fine-earth morena.
$2TFd_1$	Clayey, ash-like red soil, on an alumino-silicate, crystalline skeleton rock.
GCb_2	Loamy, pillared, alkaline soil on a sedimentary carbonate fine-earth rock.
$4PHF_3c_7$	Sandy ashy-soil, on a quartz-sandy fine-earth, eolic rock.
$2HGAb_6$	Clayey chloride-sulphate, salt soil, on a carbonate, fine-earth alluvium.

The above formulae, already simple, can be further simplified in accordance with the character and object of the investigations. In a brief description it is enough to mention the type and the variety, for instance, 2PD=Clayey black soil, PF=clayish-soil, etc., without indicating the subtype and the group, which requires a more thorough knowledge of the soil.

Summary.

1. *The soil* is a particular body of nature, extending like a fine epithelium over the surface of the lithosphere and forming *the pedosphere*, a particular cover of the terrestrial globe. *The pedosphere is the exterior horizon of the lithosphere, modified by the mutual interaction of the atmosphere, biosphere and hydrosphere.*

2. The soil is a product of the action of soil-forming agents, to which it is bound by functional dependence.

3. There are four fundamental soil-forming agents: *lithosphere, atmosphere, biosphere* and *hydrosphere*, the first being *passive* and the three others *active* agents of soil-formation.

4. The various modifications of the agents themselves as well as their combinations is the cause of variety in soil-formations.

5. This variety is largely connected with the external conditions, the principal of which are the *relief* and the duration of the influence of soil-forming agents (*the age of the soil*).

6. In different climatic zones of the world all the agents enumerated are not equivalent and the dominance of one of them over the others is quite obvious. In *the torrid zone* the chief soil-forming agent is *the atmosphere, in the temperate zone the bio-*, or to be more exact, *the phytosphere, in the cold zone the hydrosphere, the litosphere being an intrazonal agent.*

7. In accordance with the dominance of one or other agent, it is possible to establish four fundamental divisions of soil-formation: *thermogenic, phytogenic, hydrogenic, halogenic* and six intermediate divisions.

8. Within the limits of every division the soil passes through a definite cycle of development, *progressive*, until the moment of maximum expression of its properties and, *regressive*, from the moment of its beginning to decompose into more simple integral parts. The fundamental stages of this cycle are called *types*.

9. The *type* is the fundamental unit of the classification of the soil-cover.

10. The types in all divisions are disposed in *analogous series*, which makes it possible to construct the classification of soils on two coordinates, similar to a periodical system.

NOTES AND BIBLIOGRAPHY.

(1) SIBIRCEFF, N. M. *Bul. of Agricul. Inst. of Novaya Alexanrya*, Vol. IX. 1895-96.

(2) GLINKA, K. D. *Year-book of Geol. and Miner. of Russia*, Vol. V. 1902.

(3) VILENSKY, D. G. Alkali Soils, their Origin, Composition and Improvement. Moscow, 1924.

(4) DRANICIN D. *Works of Pedol. Committee of Dokuchaeff*, v. 3, 1915.
ZACHAROFF S.: *Bul. of Polytechnic Inst. of Tiflis*, v. 1, 1924.

(5) GEDROIZ, K. K. *Journal of Exper. Agronomy*, v. XIII, 1912.

(6) GLINKA, K. *Pedology*, 2 edit. 1915, 354 p.

(7) The Russian pedologists distinguish in soils several genetic horizons, which they designate by letters, namely: A, *accumulative* hor., in which takes place preeminently the accumulation of organic matter (humus); B, *alluvial*,

in which organic matter, bases (R_2O and RO) and oxides of iron and aluminium (R_2O_3) are washed away, and which in consequence is rich in silica (SiO_2) ; C, *alluvial*, in which are found the materials washed out of the upper horizons (A-B) ; D-representing an horizon unchanged by the soil-forming processes, which is called *maternal rock, subsoil* or *ground*. The horizons in their turn are divided into sub-horizons (A_1, A_2, A_3 ; B_1, B_2, C_1, C_2, etc.).

(8) DRANICIN, D. *loc. cit.*

(9) ZACHAROFF, *loc. cit.*

(10) Russian pedologists designate by the letter G the horizon of bog soils ("gley ") in which take place de-oxydating processes and in which are formed protoxide compounds.

(11) SUKACHEFF. *Bul. Ac. St-P.* 1911, N° 1, 51 p.

(12) The detailed explanation is given in the Russian work : " The Analogous Series in Soil-formation and their Importance for Construction of Genetic Classification of Soils ". By Prof. D. VILENSKY, Tiflis, 1924.

Abstracts and Literature.

Soil Physics.

Some Factors influencing the Impermeabiilty of Soil.

BOTKIN, C. W. Paper read before the New Mexico Association of Science. (Chemist, Agricultural Experiment Station, State, College New Mexico). November, 1924.

A new cause for the infertility of certain lands has been discovered. This cause is impermeability to irrigation water. Such infertile soils are hard and dry a short distance below the surface even though water is held on the land for several days. This condition develops in some irrigated soils, which were formerly fertile. The soils are not deficient in plant food, but tend to accumulate alkali, since the irrigation water evaporates without percolation.

It was thought that the impermeability might be caused by deflocculation of the soil colloids produced by basic exchanges in which sodium and potassium of the irrigation water displaced calcium and magnesium from the soils. The soils were found to be high in calcium and magnesium and the ratios of divalent to monovalent bases in the irrigation and drainage water were not such as to strongly support this hypothesis.

Sodium chloride, sodium sulphate, and sodium silicate caused soils to become practically impermeable. Aluminium sulphate, tannic acid, calcium acid-phosphate, magnesium sulphate, manure, and gypsum were found to assist the penetration of water into the impermeable soil. The respective efficiencies of these materials, when one-half of one per cent. (one per cent. of manure) was mixed with a one foot column of the soil of low permeability, are represented by 4, 15, 17, 20, 22 and 23; where 36 represents the number of hours in which a one foot column of the untreated soil took in the first six inches of water. The maximum permeability obtainable with aluminium sulphate required between 0.5 and 1.75 per cent. of aluminium sulphate for the four soils studied. Very small amounts of aluminium sulphate caused marked improvement in permeability, indicating that impermeable soils may be profitably improved by treatment with aluminium sulphate. The increased permeability secured by aluminium sulphate was proved to be practically permanent. Aluminium sulphate up to 2 per cent. was not toxic when mixed with the soils studied, but became insoluble, displacing calcium as sulphate and bicarbonate.

After a five month's irrigation test the soils treated with aluminium sulphate had a porosity suggesting that gas might have formed in the soil and subsequently left in solution in the percolating water. The loosening effect of aluminium sulphate may be mechanical, similar to the baking powder reaction in the making of bread. The persistence of adsorbed air was found to be a factor in causing the impermeability of some dry soils. The cementing effect of calcium carbonate and other materials in solution in the irrigation water, where the soil moisture diminished to a very low value, was another factor contributing to the impermeability.

The study of permeability is being continued. X.

Erosion and Surface Run-off Under Different Soil Conditions.

DULEY, F. L. and MILLER, M. F. *Missouri Agricultural Experiment Station. Research Bul. No.* 63, pp. 50, 1923.

Seven plots, each one-eightieth of an acre in area, were laid out on a phase of the Shelby loam soil. The slope of the land averaged 3.68 feet per hundred. At the lower ends of the plots were concrete tanks for collecting the run-off and eroded soil, which were determined after rain. The results of these experiments showed that grass or clover land absorbed much more water than cultivated land. Deep plowing (8 inches) was only slightly more effective than shallow plowing (4 inches) in preventing run off and erosion. The surface inches of rainfall absorbed by uncropped land, or land in a cultivated crop like corn, was practically constant from year to year, even with considerable variation in the annual precipitation. The character of the rainfall largely determined the amount of soil erosion. A heavy rain was observed to remove more soil within a few hours than was lost during a whole year when the rainfall was well distributed. The loss of important nutrient elements from the soil through erosion may often be more serious than the loss through the removal of crops. The use of a cropping system that includes sod crops a considerable portion of the time, is the most practical means of reducing erosion on rolling land.

AUTHORS.

Methods of Investigation of Soil Moisture.

KACHINSKY, N. A. 2 Ed. Moscow, 1924.

The soil as a body created by several natural processes, is composed of separate, more or less strictly differentiated parts or genetical horizons, and sub-horizons differing in their physical and chemical structure. The regulation of moisture properties depends, besides other factors, upon physical, chemical and other properties of the soil, inasmuch as these properties are different in separate horizons or even sub-horizons. The moisture will be more or less individualized in them. Therefore it is expedient to investigate the moisture regulations of the soil and its other properties according to the separate genetical horizons.

It may be supposed that in separate genetical horizons moisture must vary slightly and change gradually, and vice versa, in passing to the next horizon the change might be more drastic. This can be proved by observation. The following table No. 1 shows clearly that fluctuations of soil moisture are greater between different horizons, than between measurements belonging to the same horizon.

Date of observation	Depths of genetical horizons of the soil						
24-XII-1922	A_2-26cm.	A_2-36cm.	B_1-39cm.	B_1-50cm.	B_2-54cm.	B_2-73cm.	B_3-76cm.
	5.6%	5.0%	9.1%	9.3%	11.0%	12.2%	13.8%

This is particularly evident in relation to moisture when estimated for every cm. of soil depth. It appears that fluctuations in the upper horizon of sandy clay soil of a woodland soil are about 23 times less than in passing from this upper horizon to the next sub-horizon of the first condensation (B_1). Likewise the fluctuations in B_1 are 20 times less then when passing from B_1 to B_2. Finally, for the two last sub-horizons (B_2 and B_3) this relation is 9.

The same kind of fluctuations, according to genetical horizons, are shown in their moisture equivalents.

It is evident that one has to study soil moisture along genetical horizons.

The maximum hygroscopic qualities and the moisture equivalents of soils change also rather abruptly according to separate genetical horizons. As both those properties serve as tests for valuation of the observed absolute data for soil moisture as to its utility for plant growth, we have to value these absolute data separately for each sub-horizon. This valuation might change the whole picture of moisture distribution, as the valuation might seem to have been made out according to the absolute data only.

Therefore, it must be assumed, that data for soil moisture, especially those concerning soils, strictly differentiated into their genetical horizons, have been obtained and arranged according to the generally recognized methods, without reference to the properties of separate genetical horizons.

The investigation on the vigour of the spreading capacity of the root system of rye, oats, and grasses, according to the different genetical horizons and sub-horizons of a sandy clay soil (of a woodland soil) shows that although the depth of the root system may be more than one metre, the chief mass of roots (about 90 %) is concentrated in the upper arable strata.

In reconciling this fact with observations of soil moisture on field plots occupied by those plants it must be pointed out that soil moisture is used by the roots of plants up to the full depth able to convey moisture by capillarity, but primarily the upper arable strata are exhausted of moisture. If the soil is subsequently moistened on the surface, a dry stratum can remain at some depth, whereas this depth and the extent depend upon previous drying and upon the amount of subsequent atmospherical precipitation. AUTHOR.

Soil Chemistry.

Chemical Properties of Soil.

BERTRAND, G. and MOKRAGNATZ, N. Sur la présence générale du Nickel et du Cobalt dans la terre arable. *Annals of agronomical science*, May-June, p. 167 to 171. 1925.

The authors have found from 5 to 39 mgm. of nickel and from traces up to 12 mgm. of cobalt in the soils of France, Germany, Italy, Denmark, Serbia, Rumania, independent of their geological origin.

Granitic sands appear to be the poorest.

The ratio Nickel to Cobalt, is generally from 3 to 5, but varies irregularly from 2 to 8.

PIERRE LARUE (*Gurgy sur Yonne*).

Determination of Phosphoric Acid.

BOISCHOT, P. Influence des sels de calcium sur le dosage volumétrique de l'acide phosphorique. *Annales de la Science agronomique*, May-June, pp. 199-202. Paris, 1925.

The quantity of free H_3PO_4 can be determined in liquids containing mineral acids, even in the presence of lime salts, by titration with alkaline liquid, using helianthine and phenolphthalein.

Helianthine will indicate the quantity of alkali necessary to saturate the strong acid, plus that necessary to saturate the first acidity of $H_3 PO_4$.

The change to phenolphthalein will indicate the quantity of alkali required to saturate the strong acid, plus that needed to saturate the H_3PO_4.

PIERRE LARUE (*Gurgy sur Yonne*).

The Chemical Nature of a Colloidal Clay.

BRADFIELD, D. *Missouri Agricultural Experiment Station, Research Bulletin* No. 60, pp. 60 1923.

The fresh subsoil of Putnam silt loam, the predominating prairie soil of North-East Missouri, was suspended in five parts of water by stirring, the coarser material settled by gravity and the finest colloidal material was separated by means of a centrifugal force of about 30,000 times gravity. This fraction was unusually high in $Al_2 O_3$ and $Fe_2 O_3$, almost all of which was soluble in hot HCl, which indicated that the colloidal fraction might be made up largely of the completely broken down end products of weathering, viz., colloidal $Al_2 O_3$, $Fe_2 O_3$ and SiO_2. A synthetic mixture of these colloids having a chemical composition similar to the natural colloid was prepared and the physico-chemical properties compared. Cataphoresis studies showed that the natural colloid was negative and that the synthetic mixture was positive. The migration velocity of the natural colloid was decreased by traces of acids and increased by traces of alkali; larger amounts of alkali caused flocculation. In no case was the direction of migration reversed. The synthetic colloid had a much stronger buffer action than the natural colloid, due apparently to its high content of free $Al_2 O_3$. The natural colloid was flocculated most readily by polyvalent cations in an acid medium. The synthetic mixture was more sensitive to polyvalent anions and to alkalis. Analyses were made of the fractions of each colloid soluble in dilute acid, and in dilute alkali. The differences were marked throughout. All data obtained indicated that the natural colloid was a complex alumino-silicate, rather than a mixture of the separate colloidal oxides.

AUTHOR.

The Examination of Peat Materials.

DACHNOWSKI, A. F. (Bureau of Plant Industry, United States Department of Agriculture). *Journal of Agricultural Research*, Vol. XXIX, No. 2, pp. 69-83, bibliography. Washington, D. C., 1924.

During the past few years investigations have been made regarding the different kinds of peat, and their position and arrangement relative to one another in different parts of the country.

From the results so far obtained it is concluded that an adequate description of peat land must recognize: (*a*) the differences in type of plot and the profile deposition of the material; (*b*) the water level in relation to the surface zone of oxidation and the lower zone of reducing action; (*c*) the nature of the subsoil and the water supply affecting the quantity and character of salts, such as lime, iron, sulphur, etc.

The results obtained with 20 different kinds of peat indicate the suitability of methods of foodstuff analysis for the investigation of qualitative differences in sedimentary, fibrous and woody peat materials. The value of these methods is limited, but they show that a close connection exists between the botanical and the chemical composition of the main groups of peat. The chief groups of organic compounds may be correlated with structural differences in the profile of peat deposits; the progress of the decomposition in drained surface peat soils may be followed, and the degree of chemical alteration taking place in the layers of peat below the water level may be determined.

The analyses show the wide differences in agricultural value of the several kinds of peat. W. S. G.

Removal of Lime from the Soil.

DEMOLON, A. Décalcification des sols. Laon, *Bull. Ass. d'Anc. élèves — Institut National Agronomique*, pp. 185-187. Paris, 1925.

Arable land loses every year from 600 to 1000 kg. of lime (CaO) per ha.
Fertilizers, in particular slags, add lime but only in small quantities.
The treatment of weeds with sulphuric acid increases acidity.

The treatment recommended is that with ground chalk in amounts of 800 to 4000 kg. per ha., rather than with free lime, the use of which causes the acid reaction to change to a caustic alkaline reaction.

From the physical point of view, lime and chalk have great capacity for flocculating clay, then come calcium nitrate, potash salts, ammonium salts and lastly soda salts. PIERRE LARUE (*Gurgy sur Yonne*).

Quaternary Alluvial Deposits.

DEMOLON, A. Sur la texture des limons quaternaires et des sols qui en dérivent. *Académie des Sciences*, meeting of 9 March, Paris, 1925.

This paper deals with samples of clay from the North of the Oise at Montbrehain, Bohain, Bellicourt and Lequehart, lying on brick earth and then on ergeron to a depth of 120 to 150 metres.

The mechanical analysis by levigation (Kopecky method) is as follows:

	Sand 0.4 mm. to 0.2 mm.	Sand 0.2 mm. to 0.05 mm.	Silt 0.05 mm. to 0.02 mm.	Silt 0.02 mm. to 0.005 mm.	Clay from 0.005 mm.
Arable land	7.7	12.7	44	30.6	2.1
Brick earth	4.4	8.6	45.7	29.6	10
Ergeron	5.0	8.3	48.0	28.2	8.8
Red clay	3.0	10.2	46.1	31.8	7.2
Plastic clay	0.8	10.9	16.3	28.9	41.9

Plastic clay is Tertiary (Sparnatian). The origin of ordinary clay must be connected with this formation and not with the sands of Laon and Fère.

The washing out of lime from the surface layers of arable land has allowed the removal of clay. The plasticity of this soil is due, not to the proportion of plastic clay but to the large proportion of fine clays.

PIERRE LARUE (*Gurgy sur Yonne*).

Composition of Brick Earth.

DEMOLON, A. C. R. Sur la constitution chimique de la terre à briques. *Académie des Sciences*, Paris, 1925.

The author has compared brick earth and ergeron, belonging to the diluvium of the North of France.

He has found no difference, except perhaps in the colour and the proportion of iron oxide, which is respectively from 0.79 and 1.25 in brick earth, as against 0.45 and 0.90 in the underlying ergeron.

Limonite investing the sandy elements constitutes a stain which is fairly easily washed out by water.

There are no bases as in loess, no free aluminium, nor laterite formation. Hence, a simple phenomenon of the washing out of lime followed by oxidation of iron through atmospheric agency.

PIERRE LARUE (*Gurgy sur Yonne*).

Easily Soluble Calcium of the Soil in Relation to Acidity and Return from Liming.

DULEY, F. L. *Soil Science*, Vol. XVII, pp. 213-228, 1924.

Comparisons were made between the amounts of calcium present in different forms in soils and the results obtained in the field from applications of lime. No definite correlation was found between the calcium content of the displaced soil solution and the need for liming. This was due in part to the great variation in the soil solution under different conditions. The calcium soluble in 0.04 N carbonated water, averaged only 553 pounds per acre in the soil from seven experiment fields in Missouri and Wisconsin, where good returns were obtained from liming. The amount was 810 pounds per acre as an average of seven soils that did not give good returns for liming. Since the average acidities of these two groups of soils were approximately the same, the soluble calcium seemed to be a more accurate index to the need for lime than the acidity. Soils of approximately the same acidity varied widely in their soluble calcium content. Marked increases for lime occurred chiefly on relatively infertile soils, but one infertile soil high in soluble calcium gave only slight returns from liming. The carbonated water extracted on the average 0.32 per cent. of the total calcium in the soils studied. AUTHOR.

Base Exchange in Soils.

HISSINK, D. (*Trans. Faraday Society*, see *Zeitschrift für Pflanzen Eernähr. und Düngung.* 4 A, 1925, 137 (Der Sättigungzustand des Bodens. A. Mineralboden (Tonboden).

Certain acid radicals are known to be absorbed by soil more readily than others. Treatment of soil by acid (I) removes absorbed bases, (II) may eventually destroy soil colloids, (III) only in extreme cases destroys structural minerals. Evidence is given in favour of removal of acid radicals, by formation of insoluble salts rather than by adsorption (RUSSELL and PRESCOTT). Only those radicals are removed which form insoluble salts with one or other of chief soil bases. The cycle of changes on adding a salt of one of these acids is, base exchange — liberation of free acid — formation of insoluble salt.

Experiments show that the oxalate radical is only absorbed in the presence of a high concentration of Ca. Soils previously extracted with HCl show no absorption, because insoluble Ca oxalate cannot be formed. Soil phosphates are more soluble in short time extractions of mineral acids than in 24 hour extractions.

The normal cycle of changes is, easily soluble phosphates dissolve in acid — sparingly soluble Fe and Al brought into solution later — precipitation of insoluble Fe and Al phosphates. The amount of phosphate absorbed by soil from a solution of Na_2HPO_4 in varying concentration of HNO_3 increases to a maximum and then falls off as the concentration of HNO_3 increases.

The effect of non-diffusible Al ion is shown by the distribution of H and anion concentrations in a system composed of soil in a diffusion capsule with dilute acid inside and out. H ion concentration increases outside and anion concentration inside. The same effect is produced with soil saturated with acid, with salt solution as a supernatant liquor.

On the basis of such observations, the toxic action of aluminium salts is explained as a result of high H concentration in the cell sap and high anion concentration in the surrounding soil, with consequent interference with the transpiration current and intake of nitrate, etc. T. E.

Absolute Capacity, for Air and the Degree of Acidity, of Forest Soils.

KVAPIL, K. and NEMEC, A. Sur la relation entre la capacité absolue de l'air et le degré d'acidité des sols forestiers. *Académie des Sciences*, Paris, 1924.

The nature of forest soils depends not only on the mother-rock, but also on the type of trees grown.

The authors made more than a hundred physical analyses in the forests of St. Markyta, Jindriche and Zavratec-Tremosnice in Bohemia, all on primary strata.

They determined the acidity by the potential hydrogen (inverse P_H) and the absolute capacity for air, that is, the total volume of the pores of the soil which, after saturation of the soil by water, still remain filled with air.

Amongst conifers: fir, spruce, pine, from 40 to 90 years old, the P_H varies from 4.5 to 5, and the air capacity from 14 to 38.

Amongst deciduous trees; beech, oak, ash, the P_H varies from 5.7 to 6.7 and the air capacity from 23 to 45 per cent.

In mixed plantations of deciduous and resinous trees, for example beech spruce, spruce and oak, intermediary figures are obtained.

The absolute air capacity of closely planted trees with non-deciduous leaves is lowest and decreases with the increase of acidity of the soil.

If the plantation is thinned out, the capacity becomes higher.

In the soils of deciduous forest plantations, the absolute air capacity is higher than for the fir and the spruce. The soils are less acid.

PIERRE LARUE (*Gurgy sur Yonne*).

Experiments on the Control of Wart Disease of Potatoes by Soil Treatment, with Reference to the Use of Sulphur.

ROACH, W. A., GLYNNE, Mary D. BRIERLEY, W. B. and CROWTHER, E. M. *Annals of Applied Biology* 1925, XXII, 152-190.

On light sandy soil contaminated with Synchytrium, it is possible to obtain a clean crop of a susceptible variety of potato by incorporating about 12 cwt. of ground sulphur per acre into the soil. On heavy soil up to 2 tons of sulphur per acre is required to destroy the fungus. These amounts are considered uneconomic on a field scale. P. H. H. GRAY.

The Injurious Effect of Excessive Liming on Podsol-Soils in connection with the Peculiar Character of the Biological Processes, taking place in such Soils.

TINLIN, A. *Transactions of the Institute of Fertilizers*, No. 26, p. 1-143 Moscow 1925.

In order to investigate the causes of the injurious effect of excessive amounts of lime introduced into the soil, experiments were conducted in 1923, in addition to those made in 1922.

Plant experiments were made with three different classes of soil.

(1) With a light loam soil, considerably deficient in bases, in which the injurious effect of excessive amounts of calcium carbonate has been demonstrated by the plant experiments of 1922.

(2) With a medium loam soil, near to the soil first mentioned, but containing more silty particles, with regard to the degree of saturation in bases. This class of soil was experimented with for the first time.

(3) With a heavy loam soil, somewhat deficient in bases where, according to previous experiments, excessive amounts of lime did not cause any injury.

The experimental work of the year 1923 was directed to the investigation of the same factors as the experiments of 1922. The products of biological processes were examined in the presence of different amounts of lime and without lime ; the lime in this case was always applied in the form of $CaCO_3$. The products just mentioned are : ammonia, nitrates, nitrites, humus, soluble in water, and lime, soluble in water.

In addition, the hydrogen ion reaction was accurately recorded.

The investigations were carried out in pots during the vegetative period of the plants (clover, mustard, vetch). The products, soluble in water, were extracted from beneath the plants, often at the beginning of the experiment, and more rarely later on. The extraction was made with water, and the washings were directly analysed.

The extraction of the products, soluble in water, was made as follows : — The pots had an opening at the bottom, which was covered with an asbestos disc, through which pure liquid could pass.

At certain intervals a number of these pots was watered from above, care being taken that the plants should not be injured. The quantity of water was calculated so that one-tenth part of the soil by weight was extracted and transferred to a special receptacle, from which the drainage water was taken for analysis. In addition to the series of experiments bearing on the question as to the effect of different amounts of lime, other experiments, were conducted. In one of these series of experiments the main object was to discover the effect of ammonia. In this case, the salts of ammonia were introduced into the soil in the presence of 1 % of lime as well as without lime, in order to trace the connection between the high concentration of ammonia and its injurious effect. Such a connection seemed to have been demonstrated by our experiments of 1922 (these experiments showed also large amounts of nitrites in the washings).

In this case also, account was taken not only of the decrease or the increase in crop yield, but also of the products obtained by the analysis of the drainage water.

Further, in a third series of experiments, investigation was made as to the influence of other cations upon calcium, in the case of injurious effects. In order to balance the exclusive effect of calcium, we have so far experimented with potassium and sodium on the basis of past experiments with potash, large amounts of which did not produce any injury (according to the experiments made in the laboratory of PRIANISHNIKOW).

Further tests were made with a view to the investigation of those critical periods during which the washing has proved to be very useful in the elimination of injurious effects.

We also studied during the summer of 1923 those periods at the end of which the sowing of seed on an excessively limed soil would not be followed by injurious effects.

The results of this experimental work may be summarised as follows :—

(1) From the three soils tested, an injurious effect after the application of 1 % of $CaCO_3$ has been noted only on a light sandy loam soil (more strictly speaking there was a decrease in crop yield only in this case) ; on heavier soils the same proportion of lime did not cause any injury.

(2) In agreement with the above, biological processes were much more active in a light soil with 1 % of lime than in a heavy one. The analysis of the light soil in its first stage (the first two or three weeks) showed a considerable accumulation of ammonia, of nitrites, of nitrates, of humus soluble in water and lime and soluble in water ; while in other soils, where no injurious effect was ascertained, the liming did not bring about any marked increase in the amount of these products.

(3) A highly alkaline reaction (PH = 7.8) was noticed not only in a light soil with 1 % of lime, where ill effects were noticed, but also in a medium loam soil with the same amount of lime, where no injurious effect was produced. Thus, a given amount of alkali does not in itself cause injury.

(4) Increasing the concentration of ammonia where 1 % of lime is present, by adding 0.1 % and even 0.15 % of chloride of ammonia, by weight, to the soil, retarded the growth of the plants. Thus the presence of ammonia was found to be of great importance with a given amount of alkali. Without lime, by a neutral, or better still by a lightly acid reaction, the salts of ammonia alone did not act injuriously upon the growth of plants, but rather increased the yield.

(5) By washing pots containing retarded plants, their growth was improved when the washing took place in the course of the second and third week from the beginning of biological life in the soil after the application of lime. This special period is characterized by a very active accumulation of ammonia, which was thus removed by washing at the proper time. According to the experiments of 1923, an earlier washing (first week) or a later one (after the lapse of four weeks) could not rectify the injurious effect.

(6) The results of the experiments with washing, were in accordance with the results obtained by the experiments with seeding after a lapse of 4 weeks from the beginning of the experiment, namely in that period, when the total amount of ammonia and of nitrites was already transformed into nitrates. This second sowing of clover, made later in a light soil with 1 % of lime, did not exhibit any signs of reduced growth of the crop, whereas the first sowing (made in the beginning of the experiment) gave a marked decrease in the yield.

(7) The addition of bicarbonates of potassium and sodium to 1 % of lime, eliminated the injurious effect when the total amount of these

salts did not exceed 0.05 %. The analysis was not made in this case, because of the sustained coloring of the washings.

(8) Small quantities of lime, not exceeding 0.2 % did not bring about any decrease of yield on the same light soil, on which there was reduced growth of plants after the application of 1 % of lime. The amount of the products of biological processes, especially the amount of ammonia, was found to be much smaller in this case than after excessive liming.

(9) The accumulation of nitrites, noted in 1922 in the case of a marked retardation of plant growth, brought about by excessive liming, was not recorded in 1923, when the decrease in crop yield was also less marked than in the previous year.

(10) Different kinds of plants do not exhibit the same degree of sensitiveness to the injurious effect of excessive liming. Besides, this sensitiviness is dependent upon the age of the plant, being very great in the early stages, of its growth, and becoming less pronounced in a more advanced period of its life. AUTHOR.

Liming of Soils in France.

Enquiry on liming and the best methods of developing this practice.

Enquête sur le chaulage et les moyens propres à développer la pratique de cet amendement. *Bulletin du Ministère de l'Agriculture* (Office des Renseignements), 5 pp. May, July, 1925. Paris, 1925.

REGION I: NORTH.

Département du Nord. — The silts and clays of Flanders are poor in lime, the percentage being 0.5 to 2.5 per cent. Little liming is done.

Pas-de-Calais. — The Jurassic clays of the Bas-Boulonnais, the siliceous clays and the alluvial soils of the plateaux are deficient in lime. The marine alluvial soils of the Calaisis (the Watringues) have adequate lime. Marling is no longer done as before with chalk.

Somme. — Lime everywhere in the sub-soil: marly loams. In the Arménois, chalky plateaux. In the Santerre, plateau clay from 6 to 8 metres in depth: friable soil suitable for beets, with at least five per cent of lime.

Vimon et Ponthieu. — Siliceous clay, red, poor in lime (5 %), more or less covered over with plateau clays.

Marquenterre and Bas-Champs. — Sandy marine alluvial deposits containing less than 2 per cent. of lime.

All the valleys of the Department of the Somme are peaty.

Aisne. — Clays, brick earth, ergeron, red clay of the Vermandois, and of the Soissonais: the argillaceous soils of the Marlois, the Vervinois, the Tardenois, or three-fifths of the lands under cultivation with industrial crops in the department, an area of 350,000 hectares, are only slightly or not at all calcareous.

Marl is supplied from the chalk or limestone lying immediately below.

Oise. — The less calcareous regions are :— 1. Valois, 2. Moyonnais, 3. the east of the Picardy plateau which is covered with clay or with flinty clay on the South. The lime content is from 1 to 4 per cent.

Seine et Marne. — Proportion of lime according to the geological strata.

Eboulis : 0.3 to 13 : average 1 to 2 per cent.
Recent alluvial deposits : 1.9 to 25, average 8 to 12 %.
Plateau clay : 1 to 8, average 2 to 3 %.
Fontainebleau sand : 0.1 to 2, average 1 %.
Mussel clay and marls : 0.2 to 4, average 3 to 5 %.
Green clay : 0.9 to 67, average 15 %.
Champigny travertine : 1.5 to 39, average 9 to 10 %.

A basin of Jurassic soils and clays, all grass land, and without lime.

Seine Inférieure. — The majority of the soils of the country of Caux, chiefly flinty clay, only contain 3 to 5 % of lime. Chalk is extracted from under the clay.

Eure. — Even the alluvial plateaux of Neuburg and Voxin are overgrown with sorrel, an index of the absence of lime.

Calvados. — The Bocage district : granite, sandstone, schists with proportion of lime 0.04 to 0.3 per cent.

Cacu Champaign. — Clays on Jurassic calcareous rock, 0.5 per cent.

Pays d'Auge : flinty clay and plateaux clays 0.4 per cent.

Manche. — The territory of the department includes 80 per cent of Archaic rocks, 10 per cent. of Trias and Lias, 2 % of Cretaceous formation and 5 % of recent alluvial deposits. The silts however cover the greater part of the primary rocks and contain 4 % of lime. The lime is only sufficient on the Lias and in the polders in the Bay of Mont St. Michel.

Orne. — I. S o i l s v e r y p o o r i n l i m e. Norman Bocage : granite traversing the Pre-Cambrian. Armorican sandstone, May sandstone, schists yielding flinty clays, or acid silico-argillaceous rocks.

Pays d'H ouluce: Vire granite and mica schists.

II. S o i l s o r s t r a t a p o o r i n l i m e. — Flinty clay on Cenomanian chalk, Perche sands, Jurassic strata with lime washed out, blue clays of the Callovian formation, ancient alluvial soils and clays.

Region II : East.

Ardennes. — Primary formation, Devonian, Silurian : quartz sandstone, schists, slates, heaths and birch forests and pasture land, poor in lime : 35,000 ha. Turonian and Senonian chalk rich in lime : fertile cereal land : 100,000 ha.

Lying between the two : Jurassic strata, 25,000 ha. with a band of Albian Greensand, wooded sandstone, etc.

From the point of view of richness in lime considerable variety exists in this districts.

Marne. — Chalk is dominant except in the East (Porthois, Argonne), and in the West (Brie, Tardenois). The lime requirements are very small, as the bare chalk covers two thirds of the department and a part of the remainder is wooded, but everywhere calcareous.

Aube. — Natural regions. Upper Jurassic 'Vignoble' containing up to 50 per cent. of calcareous material.

Lower Cretaceous, moist meadow land, calcareous soils, oyster-bed marls, coloured sands (140,000 ha.). The moist lands would profit by burning the lime of the calcareous soils.

Champenoise Chalk (280,000 ha.), forms the *Champagne pouilleuse*, which continues into the Marne: produces cereals and in particular brewing barleys.

Nogent Eocene, the different cultivated lands of la Brie, amount of lime adequate.

Flint-Clay of the Othe district, poor in calcareous material, can be marled with the substratum of chalk, if not wooded.

Valleys of the Aube and the Seine, alluvial gravels, poor for the most part in calcareous material.

Haute-Marne. — Completely occupied by secondary formations, chalk excepted.

Trias poor in calcareous material in its lower stratum, coloured sandstone. Rich in Muschelkalk of limited area, fairly rich in Keuper marls with 6 to 9 per cent. of chalk.

Lias. — Bassigny and oolitic strata rich in chalk, except for a few ferruginous beds. Light soils on the whole suitable for sainfoin.

Oxfordian Marls formerly cultivated in vines.

Corallion and Portlandian, dry, sometimes with the lime washed out, but poor.

Neocomian, fertile, calcareous, except at the base which yields marl.

Albion. — Greensands and clays, often wooded, always poor in lime.

Alluvial soils with adequate lime, as they come from Jurassic strata.

Haute-Saône. Primary formation occupies three cantons out of 38.

Trias without calcareous material or with lime washed out, except in the Keuper marls, occupies 7 cantons.

Lias extends over 7 cantons. The Lower Lias alone is deprived of lime.

Oolitic limestone occupies 9 cantons with lime content variable. The Tertiary is limited to 3 cantons where silica is dominant.

Moselles. — I. Northern Vosges, light siliceous soils, poor in lime: grows rye and potatoes.

II. Lorraine plateau, Triassic calcareous clay with lime kilns.

III. Liassic superstrata in limestone plateaux.

IV. On the left bank of the Moselle, the edge of the Woevre Jurassic formation is limestone.

V. The alluvial soils of the Sarre are siliceous. Those of the Niode, the Seille and the Moselle are friable soils, fairly rich in lime.

Meuse. — Department entirely Jurassic: the banks of the Meuse and the Barrois in particular are of limestone formation.

The Argonne and the region of the Woevre have in particular undergone loss of lime.

Meurthe et Moselle. — I. Vosges Mts., Vosges sandstone and variegated sandstone, not calcareous.

II. Lorraine Plains. Flinty alluvials of the Moselle and the Meurthe. Muschelkalk, Keuper marls and Lias with sufficient lime.

III. Oolitic plateaux with lime removed, and ferruginous.

IV. A quarter of the cultivable lands in the Department of Meurthe would benefit by liming.

Vosges. — The non-calcareous soils predominate.

La Montagne. Arrondissements de St. Die and Remiremont, i. e. 210,450 hectares; granite or Permian Sandstone.

Lime content always lower than 1 per cent., but much wooded, 41 per cent. forest.

Vôge: 102,993 hectares. Variegated sandstones, containing up to 0.6 and 0.8 % of lime. Very wooded: 29 % forest.

Alluvial soils of the Moselle: 6,000 hectares.

224,000 hectares in mountain and 73.000 hectares in the Vôge might be treated with lime as arable or grass land, but not more.

Bas-Rhin. The- Vosges are crystalline rocks with little lime. Keuper sandstones with varying lime content.

Plain of the Ill and the Rhine. Lias marls. Loess with 10 to 30 per cent. of lime. Gravel poor in lime.

Haut-Rhin. — Vosges crystalline rocks not calcareous.

Foot-hills of the Vosges often calcareous (Muschelkalk and Keuper).

Plain of the Ill and Rhine. — Diluvium or gravel. The arable land is less rich in lime than the sub-soil.

Sundgau. — Loess, the lime similarly removed from the surface, as also in the Jura.

Belfort. — Vosges granitic, igneous and schists without lime. Foothills of the Vosges: Permian sandstones and Vosges sandstone without lime.

Jurassic escarpment and Callovian. Oxfordian plateau, Rauracian and Sequanian, calcareous.

Small Tertiary Tongrian (Oligocene), with lime removed from surface, marls to some depth.

Alluvial soils with no lime.

Region III: West.

A. *Brittany and Vendée.* — Region of primary strata, granite and gneiss and primary rocks, schists and sandstones.

Mayenne. — The geological outcrops of calcareous rock are staked out by the kilns and the lime made in these is sent all over Brittany for amendment. There is a strip of carboniferous limestone from the surface of which the lime has disappeared so that it now contains less than five per thousand of carbonate of lime : next, the Jurassic strip. The 300,000 hectares which could profit by liming on an average application of 300 kg. per annum, or 90,000 tons, only receive 4,450 tons.

Three methods of applying the lime are in use : beds or large heaps near the field ; small heaps covered with earth, which is the so-called English method ; spreading the lime in the form of powder by means of a fertiliser distributor.

Marne et Loire. — The eastern part of this Department is of Tertiary formation of variable character. The western part, beginning from Angers, consists of schists with folds of carboniferous limestone, largely worked where crossed by the valley of the Loire. The lime kilns of Montjean in particular supply the Loire Inférieure.

Ille et Vilaine. — This Department only contains two outcrops of Tertiary calcareous soil. Composts in " beds ", piles of mould, ditch slime, dead leaves and lime are prepared, and from 3000 to 5000 kg. per ha. of these materials are spread every six years.

Côtes du Nord. — Only two calcareous beds. Sand is pumped from the bottom of the sea and sent inland as far as 100 km. from the coast.

Finistère. — The average content of lime on the arable land is only one per thousand, varying from 0.6 to 2.5 per 1000. It would be possible to use with advantage 400 to 500 kg. of lime per ha. per annum.

On the much indented coast use is made of sand containing shells, and tangue combined with wrack. As a result as well as on account of the total absence of frost in winter and the favourable effect of damp climate on early products, a belt of fertile soil (golden belt), worth as much as 50,000 francs per ha. is obtained.

The sands collected at low tide contain from 1 to 85 per cent. lime. From 4000 to 5000 kgs. per ha. are used every four years. The amount of lime imported from Mayenne is between 2000 and 2500 kgs. every four years.

Morbihan. — The strata only contain traces of lime. Between 300 and 500 kgs. would be needed on each of the 450,000 ha. under cultivation. Imported lime is applied to crops of potatoes and winter cabbages at irregular intervals and in amounts varying between 1000 and 1500 kgs. per ha. Calcareous sands are used on the Atlantic coast at Trinité, Belle-Ile, Ploemeur, Locmiquélic, Pouldu, which contain from 58 to 84 per cent. lime.

Loire Inférieure. — The amount of lime in the soil is only between 0.3 and 0.5 at most It is quarried on the Carboniferóus Limestone of Erbray and imported from Montjoan, generally as material of 90 per cent. purity (CaO). Out of the 570,000 ha. of soil, meadows and vineyards, barely 21,000 ha. are limed.

Vendée. — Vendée is formed chiefly of the " Bocage " of ancient rocks, bounded on the South by a fringe of Lias and bog. Three-fifths of the department have had to await the construction of roads in the XIXth century for the cultivation of wheat, clover and lucern to be made possible by the use of lime and phosphates. At the same time the size and weight of animals increased.

B. *Poitou. Deux-Sèvres.* — The lines of lime kilns follow the calcareous layers of Jurassic or the North-West, South-East and South of the Department.

Liming ought to be extended over three quarters of the districts of Brossuire and Parthenay which constitute the prolongation of the "bocage" of Vendée or Gâtinais, and in addition over the Oxfordian marls of the South of Niort and Lozay which rest on a calcareous rock called Egrain or Chiffe, or Pierre Chauffante. The schistous marls of Rauratian or Sequanian should be marled in moderation rather than limed. The ferro-argillaceous red soils with flints of Poitou should be limed, as also the sands and green clays of the Cenomanian of Louzy, which should be marled from the Tertiary beds cropping out in the Valley of the Thouot and given 50 to 65 per cent, carbonate of lime; the variegated sands and clays of Upper Eocene; the terraced slopes of the plateaus of the Poitevin defile so far as they are not wooded: *moor* land similar to the landes covered with heath, ferns, gorse, broom, etc., the peaty valleys.

In the neighbourhood of St. Maixent and la Mothe Heraye, a marl containing 70 to 90 per cent. carbonate of lime, is found at a depth of 50 to 70 cm.

Lime applications are made in inverse ratio to the proportion of humus, that is to say from 2 to 5 cubic metres every five years. Autumn liming is performed in small heaps of 15 or 20 kg., spring liming by distributing the large heaps of compost built up in autumn at the top of the fields and broken down during the winter. The ground lime of Airvault is now coming into use with fertiliser distributing machines.

Vienne. — Out of the 300 communes of the Department, 160 have soil poor in lime. The system of métayage on short leases does much to prevent the use of lime dressings which are especially necessary in the district of Montmorillon.

District IV: Central.

Central part of the basin of the Loire. South of the Parisian basin. Tertiary in the North; Jurassic in the South.

Allier. — The Miocene cropping out in the valleys are the only strata rich in lime. Their total area is 10,000 ha. out of 417,000 ha. of arable land. Either from 140 to 160 hl. of lime grit are scattered every 15 or 20 years or else from 35 to 40 hl. every five years. This process gives opportunity for the use of fertiliser distributors.

A. *Berry. Cher.* — The South of the Department comprises 55,500 ha. of granite, gneiss and Triassic sandstones. The North 140,000 ha. of clay with flints and Tertiary clayey sand of Sologne. Lying between the two, the Jurassic strata provides lime. Oyster beds cropping up in the valleys underneath the clay with flints provide marl. There is a tendency to use ground lime in order to save manual labour.

Indre. — The Tertiary clayey sands of Brenne and the granitic soil of Boischaud, with no lime, represent more than half of the Department and are separated by Jurassic chalk. Marling has been abandoned. Liming is still carried out at irregular intervals at the rate of 2 or 3 m^3 per ha.

B. *Touraine.* — Crossed by the Loire.

Indre et Loire. — Three-fifths of the Department are formed of sandy-clay soil. The plateaux are often covered by flinty clay (« Bournais" soil). The calcareous layer of Brie at one time provided marl. Shell marl or Tertiary shelly sand are chiefly found on the plateaux of Manthelan, Bossée, Louans, Savigné, Courcelles, St. Laurent.

Loir et Cher. — Four fifths of the Department, in particular the Tertiary clayey sand of Sologne in the South and the Secondary sands and clays of Perch in the North should be amended. On the calcareous layer of Beauce there is also " worn out " soil which the use of lime has restored to intensive cultivation. Lime grit for slaking is put in small heaps or else powdered lime is spread by the fertiliser distributor at the rate of 1200 to 1500 kgs. per ha., over land lying fallow prior to the growing of corn.

Marl or chalk are used at the rate of 25 to 60 m^3 per ha. About 20 lime kilns are to be found in the Department.

C. *Orléanais.* — Tertiary and Cretaceous strata predominate.

Loiret. — Beauce is calcareous. In the north Gâtinais consists of chalky slopes, covered with flinty clay and often wooded. Puisaye and Berry contain clay with flints covering the calcareous or ferruginous sands and clays of the Lower and Middle Cretaceous.

Orléanais properly so called consists chiefly of sands, covered with woods.

To the South of the Department is the edge of flinty clays of the Sologne to which enormous quantities of marl from Blancafort have been applied.

D: BOURGUIGNON-CHAMPENOIS BORDERS. *Yonne.* — The Department of Yonne forms the transition between the granite of Morvan and the chalky plateaux of poor champaign land, which are covered with flinty clay.

It is traversed obliquely by the sands and Albian ferruginous clays of the moist champaign land which are often covered with trees. These three zones are separated on one side by the strip of the Burgundian calcareous Jurassic and on the other by the Cenomanian, Turonian or Senonian marly clay. To the South, the Morvan which, moreover, is itself much wooded, uses the lime of the Lias, rich in phosphates.

In the North, the plateaux bordering on Gâtinais use chalk, often with phosphates, and reduced to powder. Marling has been given up. The amount of lime applied is at the rate of 30 to 40 hl. per ha. every 3 years.

V. DISTRICT: CENTRAL MASSIF OF FRANCE (Granite surrounded by Jurassic on the West and by Primary Triassic and Tertiary on the South).

Department of Loire. Granites, schists and mica-schists are deficient in lime. It is only found in appreciable quantity in the Tertiary strata of the Basins of Forez and Rannais (Valley of the Loire).

Department of Puy-de-Dôme. Three parts : (1) Granite substratum of Forez, Livradois and Combrailles, *i. e.* 500,000 ha. representing 5/8 of the surface of the department. (2) Volcanic Chain of Puys and Mont-Dore, 100,000 ha. (3) Valley of the Allier (Limagne), comprising another 50,000 ha. of soils poor in lime, in all 650,000 ha. of which 220,000 only are cultivated.

A suitable addition of lime is admitted to be 1200 kgs. per ha. per year, that is to say 270,000 tons ; the tenth part only of this is in use nowadays. Lime is brought partly from the Department of the Allier, and costs about 100 francs per ton at the arrival station.

Department of Cantal. The Oligocene Chalks and marls have escaped erosion precisely where they meet the granite and the volcanic formation. Lime amendments are coming more and more into use in this district in contradistinction to the rest of France.

Department of Haute-Loire. Continuation of the Granite and the Volcanic formation of Auvergne. Soils containing more than 2 per cent lime are there an exception. The local chalk is only 75 per cent CaO, and is now not much used.

Department of Lot (Quercy). No liming is carried out either on the granites and schists which occupy 100,000 ha, or on the Lias (30,000 ha.) or on the rich alluvium of the Lot and the Dordogne.

Department of Aveyron. Aveyron comprises three districts : the granitic and schistous *Segala* (etymologically : rye soil) ; the " *rougier* "-red Permian soil, poor in lime, and lastly the *Causses*, chalk Jurassic plateaux often with the lime removed from the surface.

Out of a total of 437,000 ha. of cultivated land, 300,000 would profit by liming, at the rate of a minimum of 500 kilograms of lime per ha. and per year.

Liming is in fact effected at the rate of 15 to 20 hl. of lime every six years, on light soil. The amount is double on heavy soil. " Composts ", or mixtures of vegetable debris and lime, are also prepared.

Department of Lozère. Includes both granite formations and the calcareous " causses ". Owing to the altitude, the cultivation of this district is not intensive and transport of lime is laborious.

Department of Tarn. Comprises the East of the carboniferous strata which produces coal for the burning of lime. On the West are Tertiary soils.

Liming is accompanied by a good dressing of manure to prevent the " burning " of the ground and is carried out for clover, sainfoin, lucern. for cereals and for potatoes. The strata which respond most to lime are the primary schists, clay with Tertiary gravel and ancient alluviums, both fine-siliceous and " battantes ", that is to say heaped up and known as " boulbènes ".

Out of 200,000 ha. of cultivated land in Tarn, 150 000 would be benefited by liming.

Department of Nièvre. — The East of the Department is occupied by granitic Morvan (Cantons of Château-Chinon, Montsauche, Luzy, Moulins-Engilbert), and schistous Morvan (Millay, Luzy). The siliceous strata contain little lime.

Bazois and the district of Clamecy are partly occupied by fertile chalk Lias, then by Middle and Upper Jurassic which is calcareous and dry, though sometimes the lime has been removed, leading on through the clays of the Lower Cretaceous and the sands or Middle Cretaceous to end in the clays and sands of the alluvial deposits of the Loire at Cosue.

To the South of the Morvan strata, the Lias is again to be found at St. Saulgé, St. Benin d'Azy and Décize.

To the South of Nevers, between Loire and Allier the strata is siliceous-clay.

Out of 260,000 ha. of arable land, 100,000 ha. would profit by amendments and out of 800,000 ha. of natural meadows, from 10 to 15,000 ha. Lime is used from the kilns established on the Jurassic strata.

Department of Creuse. — Lime has revolutionised the cultivation of this district which is given up especially to root forage crops. These crops occur in rotation every 4 or 5 years and take normally 1500 kg. of lime per hectare, that is to say 70,000 tons (on about 46,000 ha. of hoed crops) coming from the kilns built on Berrichon Lias at the edge of the Granite zone.

Haute Vienne. — Upper Limousin, a stock raising district like Creuse, employing 500 kgs. per ha. on arable land.

VI. District: East Central.

Department of Côte d'Or. — Almost entirely occupied by Jurassic plateaux and the Tertiary and Quaternary plain of Saône. There is no want of lime except in the so-called pasture lands of Anxois, the fine sands of the Valley of the Saône and the soils of Rouget du Châtillonnais.

Department of Saône and Loire. — The siliceous argillaceous breccia of Louhans, the granite slopes of Maçonnais, Autunois, Charollais, the schists and sandstones of Chagny, lastly certain decalcified zones of Jurassic, are all deficient in lime.

The lime burnt at Creuzot is used in September or May, in small heaps covered over with earth, to the amount of 1000 kgs. per ha.

Department of Ain. — The districts of Nantua and Gex are situated in the Jura or on calcareous glacial formations.

The plain of Bresse is formed of argillo-siliceous soil derived from Tertiary sand and non-calcareous yellow silts or loam. The Dombes is a moraine, poor in CaO. Much lime has been used there, but the kilns are now extinct.

Department of Rhône. — The Rhône soils are chiefly granitic, with only a small area of Jurassic strata. The lime residues of the Lyons manufactures are employed as sufficient amendment.

Department of Isère. — The strata of Tertiary, Glacial or Fluvio-glacial origin of the lower cultivated area, as well as the upper valleys of Oisans in the high granitic Alps, are usually deficient in lime.

Department of Doubs. — Although situated in the heart of the Jura the soil requires lime on account of the washing of the lime out of the upper layers.

Department of Savoy and Upper Savoy. — The mountain heights (Mont Blanc) are of granite or schist and little cultivated. They are flanked on the West by the calcareous Prealps.

The plateaux are sometimes decalcified to such a degree that sorrel replaces white clover on Glacial formations and even on Mollasse.

The cultivation of sainfoin (*Onobrychis*) is decreasing.

Basic slags give better results than superphosphate on the glacial plateaux near the lakes of Annecy and Geneva.

There are kilns at Pont du Gy, Vovray, St. Roch, Saint Jeoire le Giffre, but the lime is used chiefly for the electric synthesis of calcium carbide, by the employment of the power of the high waterfalls.

Department of Hautes-Alpes. — Most of the cultivated land is in a chalk district. The valleys are irrigated. Those of Briangonnais and ancient alluviums could alone be amended to advantage.

VII. District: South-West.

Department of Charente. — The granite and schistous formation of the district of Confolens and the Tertiary strata of the cantons of Champagne Mouton, Ruffec, St. Claud, Mansle, la Rochefoucauld, Montbron, Baignes and Brossac, are covered with vegetation : heath, gorse, broom, chestnut, timber. 130,000 ha. of arable land require lime.

Marl is found in the Lias and in the Cretaceous formation, but lime would be more suitable.

Produce-sharing tenants bear a third part of the expense of buying lime but undertake the transport from railway station to field.

Department of Charente-Inférieure. — The soil is deficient in lime and consists of Tertiary strata, marshy fields and lagoons ; total 150,000 ha. requiring 4 cubic metres of lime per ha. There are lime kilns on the Jurassic strata of the two Sèvres and the Vendée.

Department of Gironde. — Eight-tenths of the soil are without lime : 400,000 ha. are Pliocene sand of the Landes, containing 82 per cent. silica, 10 per cent. clay and 8 per cent. humus.

The pine forest extends for 357,000 ha. and the Lande subsists where sandstone Ortstein is found near the surface.

Heavy, clayey, silico-clayey and silico-humiferous tertiary soil would also be benefited by lime.

Department of Landes. — The proportion of sand and of forests of sea pine is greater there than in Gironde. Marling and liming only affect the tertiary slopes of Chalosse and Armagnac which have various crops and soils ; Marl — 10 to 20 cubic metres per ha. every 5 or 10 years ; Lime — 1000 to 1500 kgs. per ha. every 3 to 5 years.

Department of Dordogne. — In the districts of Noutron and Ribérac, the produce sharing tenant pays for a third of the lime.

Department of Lot and Garonne. — In spite of the alternation of calcareous layers in the Eocene and Oligocene outcrops, lime is lacking in the alluviums of Garonne, Lot and Dropt, and of the plateaux, in the sands of the Landes, in the soil of the valleys, that is to say over about half of the cultivated surfaces. Lime kilns, however, no longer yield rich lime.

Department of Gers. — Valleys separated by Tertiary plateaux covered over by Pyrennean siliceous strata : 45 per cent are deficient in lime. Much arable land is available, however, on account of the scanty population.

Department of Basses-Pyrénées. — Jurassic or Cretaceous strata covered over by Pyrennean diluvium or with the lime removed. The Miocene to the North of Gave du Pau is deficient in lime. Lime kilns at Montaut and Arudy, magnesian lime at Coarraz (Béarn) and Osses (pays basque).

Department of Hautes-Pyrénées. — Conditions similar to the preceding. It often happens that the content of the soil in lime is inferior to that of phosphoric acid.

Department of Haute-Garonne. Liming is carried on in the alluvium of the Garonne from Boussens to Toulouse and on the plateaux of Lauragais. The lime comes from Tarn or from Ariège.

Department of Tarn and Garonne. — One third of the total is deficient in lime. It includes the following : recent alluvium of Garonne and Aveyron (content in CaO lower by 5 %) ancient alluvium of Garonne and Tarn, among which is siliceous soil "battante" or "boulbine" with quasi-colloidal silica and acid reaction ; river gravels and plateau clay from Bruniquel to Montbauban ; Molasse of Armagnac with the lime washed out.

Total 66,000 ha. out of 200,000 ha. of arable land of the Department.

Lime comes chiefly from Tarn, Bruniquel, Lexos and Suvillars.

Slaked lime is scattered in the fields in small quantities for lucerne.

Before growing cucumbers in an open field, ground chalk is applied. The amount is 1200 to 1500 kgs. of lime per ha.

Department of Ariège. — The plains cultivated over an area of 10 000 to 15 000 ha. between Mirepoix, Pamiers and Saverdun, as well as the Valley of the Salat, are covered by granite alluvium, and by Pyrennean schists and sandstones ; they are therefore without lime.

PIERRE LARUE,
Gurgy sur Yonne.

Soil Biology.

The Bacterial Inoculation of Sugar Beet.

NEMEC, A. (Biochemical Institute for Plant Protection, Prague). Expériences sur l'inoculation de la betterave à sucre. *Annales de la science agronomique*, Year 41, No. 4, pp. 254-259. Paris, 1924.

Experiments have been carried on for some time past in the adaptation of the bacteria contained in the root nodules of leguminous plants to non-leguminous plants, and it has been noted that the success of the experiments largely depends upon the bacteria of the rhizosphere, or that part of the soil which is in immediate contact with the absorbent root hairs. These bacteria exert a favourable influence upon the penetration of the bacteria into the root hairs and hence upon the formation of the nodules.

The writer in his experiments used the BLUNCK method which is based on the principle of successive adaptations of the bacteria of leguminous plants to the juices of the roots of the plants which have been the object of experiment and of the heightening of their effect by means of repeated transmissions through the same plant. Experiments made on a large scale on this method have always given good results, the increase in the yield varying from 5.6 to 17 %. A negative result was shown only in cases where the yield of the non-inoculated control plots was at a maximum.

Hence bacterial inoculation provides a means of increasing the fertility of a soil up to the point of its maximum productivity. A. F.

Insect and other Invertebrate Fauna of Arable Land at Rothamsted.

MORRIS, H. M. *Annals of Applied Biology*, 1922. IX, pp. 282-305.

A method of taking soil samples for determining the numbers of Insecta, Myriapoda, Oligochaeta, Acarina, etc. present in the first 9 inches of soil is described, and the functions of this inverterbrate fauna discussed. Soil was examined at definite intervals during a year and the numbers present at different depths compared on each of two plots receiving widely different manurial treatments. Of 15 millions of invertebrates per acre on the plot receiving 14 tons of dung per acre annually since 1839, 2.47 millions were insects. The greatest number of all kinds of invertebrates occurs in the first 3 inches of soil. The greater number of invertebrates found in the manured plot does not indicate a greater increase in the number of organisms directly harmful to the growing crop. The larvae of Elateridae, Tipulidae, and Hepialidae occurred in equal numbers in the two plots. It is suggested that the great difference observed between the numbers of insects found in arable land and those found in pasture (reported in a previous paper by the Author), and the greater depth of penetration, is due to the better aeration and drainage caused by cultivation.

P. H. H. GRAY.

The Physiology of *Thiobacillus thioxidans*, an Autrophic Bacterium Oxidizing Sulphur, under Acid Conditions.

STARKEY, R. L. *Jour. Bact.* Vol. 10, pp. 135-163, 1925.

Physiological investigations were carried out with one of the non-filamentous true bacteria isolated from sulphur and soil-phosphate composts by Waksman and Joffe. It oxidizes sulphur and thiosulphate rapidly to sulphate, even under extremely acid conditions. Oxidation was most rapid in the early stages of the process following a short lag period of about two days. The decreased rate of oxidation is not apparently due to any attenuation of the organism, or to the accumulation of toxic organic metabolic products, but rather to the accumulation of sulphuric acid. In the presence of high concentrations of thiosulphate (3 per cent) sulphur becomes precipitated in the medium during growth, probably indirectly and not as a product of the primary reaction of the process. With sodium thiosulphate as source of energy, 50 to 65 parts of sulphur as thiosulphate became oxidized to sulphate per unit of carbon assimilated. In the presence of 1 or 5 per cent. sulphuric acid, the economy of utilization of the available energy was lower than in the absence of appreciable amounts of acid. The ratio of sulphur oxidized to carbon assimilated was not appreciably affected by concentration of potassium phosphate, as high as 5.5 per cent. Growth was but slightly effected by small amounts of salts of heavy metals, reduced pressure, or following substitutions of precipitated or amorphous sulphur for the rhombic form. The organism responded readily to changes in temperature, moisture, and partial pressure of oxygen or carbon dioxide.

AUTHOR.

The Carbon and Nitrogen Nutrition of *Thiobacillus thioxidans*, an Autotrophic Bacterium Oxidizing Sulphur, under Acid Conditions.

STARKEY, R. L. *Jour. Bact.*, Vol. 10, pp. 165-195, 1925.

A continuation of studies on the physiology of one of the true sulphur bacteria was concerned with the effects of some carbon and nitrogen compounds on sulphur oxidation. Dextrose disappears from the medium during growth and there is a general correlation between the amount of acid produced and dextrose removed. This disappearance of dextrose was not due alone to the acid, the suspended cells in a purely physical way, or to exo-enzymes, and the organism cannot use dextrose in the absence of sulphur or some inorganic sulphur compound as a source of energy. It appears that dextrose may enter into the metabolism of the cells in the presence of sulphur as a source of energy. Citric acid inhibited growth at 5.0 per cent. concentration but not in the presence of 2.5 per cent.

Ammonium nitrogen is the only source of the element that has been found available to the organism. The presence of nitrates in even as low a concentration as 0.05 per cent. KNO^3, depressed oxidation and 1.25 per cent. completely inhibited oxidation. The economy of utilization of the energy available as measured by the carbon assimilated per unit of sulphur oxidized was much lower in the presence of nitrate than in its absemce and the depression was greater in the presence of larger amounts of nitrate. It appears that the injury from nitrate is specific for the anion. Oxidation was inhibited in the presence of 2.5 per cent. of peptones and injury was marked at 1.25 per cent. Results indicate that neither urea, peptone, nor amino acids are available either as sources of nitrogen or carbon for the organism.

AUTHOR.

Seed Inoculation of Lucerne (*Medicago sativa*) and its Relation to Mobility of Nodule Organisms in Soil.

THORNTON, H. G. and GANGULEE, N. (Rothamsted Experimental Station). *Nature*, Vol. 114, No. 2878, pp. 932-933. London, 1924.

In their studies of the nodule organism (*Bacillus radicicola*), the method used by the authors consisted in making a suspension of a bacterial culture in a liquid, the suspension being used to wet the seed. There is evidence that after penetrating the root, the bacteria are unable to travel any distance along it, hence, when the seed has germinated, they must progress through the soil in order to reach various parts of the root system, where nodules are to be formed.

It was found that they will progress through light soil at the rate of about 1 inch in 24 hours. When a drop of water containing the bacteria in the rod stage is added to sterile soil, the organisms do not spread until after a considerable interval, which interval is less if the inoculum consists of a suspension in milk. This may explain the successful results obtained in Scandinavia where skim milk is used to make the suspension of bacteria employed for inoculating.

The authors tested the effect of inoculating sterile soil with a suspension of bacteria in skim milk containing 0.1 % CaH_4 (PO_4) . $2H_2O$, and found that the spread of the organism from the point of inoculation began almost immediately. On averages of 10 parallel pots, increases in nodule numbers of 93 % and 73 % were obtained in two experiments by the addition of phosphate to the milk. There was also a favourable effect on the yield of the crop. W. S. G.

The Importance of the Concentration of the Hydrogen-ions of the Soil in the Formation of Plant Substance.

CHODAT, F. Sur la concentration de ions du sol et son importance pour la constatation des formations végétales. *Bull. de la Société Botanique de Genève*, Series II, Vol. XVI, pp. 36 to 143, Geneva, 1924.

The author shows the importance of the concentration of the hydrogen-ions for the biochemical and biophysical processes and the physiological function of the critical state of the amphoteric colloidal substances, a state which has received the name of the isoelectric point.

A relation may be established between the phenomenon of the curves of growth as a function of the reaction of the environment ; from investigations of this type it appears that the curves present two maxima and certain plants are proved to be entirely unsuited to soils with a definite reaction.

There is difficulty in classifying plants and plant associations into those requiring acids, those requiring neutral substances and those needing bases, until there is a clearer understanding of the corresponding reaction to the physiological neutrality, *i. e.*, to the iso-electric point of the plasmic tissues of the plant itself. It is thus convenient to substitute for the qualitative theories of " lime avoidance " and " lime requirements " that quantitative idea of range of accomodation to the reaction of the soil, in so far as the actual acidity of the soil has, in the greater number of cases, more influence on the distribution of the species of plants than the mineral components.

If, for example, we taken *Eupteris aquilina*, which has been always regarded as showing reaction to soils that are deprived of lime, it is seen that it can also thrive under other conditions, within a range of P_H from 5.5 to 7.6 and which therefore goes beyond neutrality. Contrary to current opinion, it is observed that marsh plant formations do not necessarily require an acid environment, although it is true that *Phrag-*

mitetum and *Scirpetum* belong to a group of formations which thrive in an alkaline environment.

The same values of P_H may however characterise soils carrying most varied plant associations: in this case the differences are determined by other factors, such as the geographical situation, the altitude, and climate. These formations differ among themselves in the strength of their vegetative growth and the specific type of their inflorescence and take the name of "homologues". Homology is displayed in a physiognomy special to these plant associations, a certain common element of floral type and a resemblance in the edaphic conditions.

This last characteristic makes it possible to classify the homologous formations into the acid type, passing from *Quercetum suberis* to *Ericeta varia*, *Calluneta*, to *Vaccinietum* and to the alpine tundra varieties, and the alkaline type which passes from *Quercetum ilicis* by degrees to the steppes on neutral and almost acid soil. To these two classes, the aquatic isomerous plants correspond: (A) wet moors, *Vaccinietum uliginosi*, *Sphagnetum*; (B) *Alnetum glutinosae*, *Eupatorietum*, *Caricetum*, *Phragmitetum*, *Scirpetum*.

The author then examines the genesis of *Sphagnetum*, which must be considered as a parasitic formation, taking root because favoured by the acidity of the forest and the moor land, and may find its way from either habitat and invade the *Caricetum*. This progressive movement may be traced and an examination made of the reaction of the pools of bog water and of peaty earth: and it is thus possible to observe a horizontal stratification of P_H. Gradually as one passes away from the forest on to acid soil, one passes from a maximum acidity corresponding to the *Sphagnum* zone to diminishing P_H values and to the *Caricetum* with a distinctly alkaline reaction. The waters of the two formations differ as does the P_H, at one metre apart the variation may be from 4 to 7.3. In certain localities (Lossy), the alteration in the course of a brook with an alkaline reaction has resulted in the disappearance of *Sphagnetum* and replacement by *Phragmitetum*.

On virgin soils of non-calcareous moraines, the plants first making their appearance bring about acidification, which is transferred to the successors.

The *Quercetum roboris* of the glacial soils of the Canton of Geneva shows an acid reaction of the soil, which explains the abundance of *Lathyrus montanus* and the patches of *Calluna vulgaris*, *Teucrium scorodonia*, *Genista germanica*, *Potentilla erecta*, which were at first considered as colonies rom other localities. A. F.

Soil and Vegetation.

The Effect of a Varying Supply of Nutrients Upon the Character and Composition of the Maize Plant at Different Periods of Growth.

DULEY F. L. and MILLER, M. F. (1921). *Missouri Agr. Res. Bul.* 42.

Maize plants were grown in sand cultures with PFEFFERS's nutrient solution of normal and N/20 concentrations. The growth period was divided into three thirty day periods and all possible combinations of the two concentrations of solution were used. The second 30 day period was by far the most important for the production of dry weight. The top growth was always increased by an optimum supply of nutrients while a low supply of nutrients was conducive to increased root weight and to fibrous root development particulary during the last period. The ratio between the weight of roots and tops became wider as the crops grew older or as the concentration of the nutrient solution was increased. With low nutrient at the end of the first 30 day period the roots made up 61.18 per cent. of the total weight of the plant, but with plants having a high concentration of solution and 90 days old, the roots made up only 12.29 per cent. of the total weight of the plant.

Where there was a copious supply of mineral elements present at the end of the second period, the leaves and stalks contained enough material to produce fair ears even where the third period had minimum nutrient. The per cent. of nitrogen and potassium in the plants was approximately proportional to the supply of nutrients during the period just previous to harvest.

In all treatments and in each period, a minimum supply of nutrients allowed a greater proportional storage of nitrogen, phosphorus, and potassium in the roots than did optimum treatment. A minimum nutrient supply changed somewhat the character of growth, particularly by reducing the length of the internodes. This was most marked where the plants had received optimum treatment during the first period.

Comparative Value of Alfalfa and Sweet Clover on Soils.

HOLTZ, H. F. and SINGLETON, H. P. *Journal of American Society of Agronomy*, Vol. XVII. No. 6, pp. 326-333. Geneva, N. Y. 1925.

The arid soils of the State of Washington contain sufficient mineral plant food elements, but are deficient in organic matter and nitrogen. When these soils are brought under irrigation alfalfa is generally grown to supply the nitrogen deficiency.

Soil samples were taken from fields which had grown alfalfa and sweet clover respectively for three years in succession, and other samples were taken from land that had grown these plants for three years followed by one year of maize. In addition, two other soils were selected, one virgin land never irrigated, the other an irrigated soil but which had never grown a leguminous crop.

In the experiment a comparative study was made of the carbon dioxide evolution and nitrate nitrogen accumulation.

Soil from sweet clover land had 102 % greater carbon dioxide evolution and 95 % greater nitrate nitrogen accumulation than soil from alfalfa land.

The yield of maize silage per acre was 14.92 tons on sweet clover land and 8.25 tons on alfalfa land.

Both virgin arid soil and the same soil after irrigation and cropping with non-legumes for two years, showed low carbon dioxide evolution and nitrate nitrogen accumulation, owing to their low content in organic matter.

There is a greater carbon dioxide evolution during the first ten days and a greater final nitrate nitrogen accumulation from sweet clover than from alfalfa, whether they are grown in the field or applied as a residue.

For purposes of supplying available soil nitrogen to new land for establishing a short rotation, for seeding a pasture, or an orchard cover crop, sweet clover is especially suitable, because of its high nitrogen content and rapid decomposition when returned to the soil. W. S. G.

Regional Soil Science.

The Geology of Istria.

CUMIN, G. Appunti geologici sull'Istria montana. *Proceedings of the R. Accademia nazicnale dei Lincei*, Vol. XXXIII, No. 5 pp 174-177. Rome, 1924.

Orographically it is possible to distinguish three mountain systems in Istria, viz. in the West the undulating high table lands, in the centre an area characterized by mountain ridges, in the East the chalky plateau of the Valsecca of the Castelnovano. The prevailing soils are for the most part calcareous, and there is a relatively small amount only of sandy soils, marls and schist clays.

The earliest formations are represented by the Cretaceous, always of the calcareous type. The oldest layer is Cenomanian sometimes combin ed with Turonian, which in this area is represented by grey calcareous breccia with a marl or dolomitic cementing, showing no fossils. This is covered by a blackish grey dolomitic mass. The dark Turonian chalks are in ridges varying from 0.80 to 1.50 metres in depth, over which lie strata of varying geological formation corresponding to the rubble rocks of Nabresina. There is no Cretaceous formation such as is typical of the Triestine Carso.

The base of the tertiary formation is represented by Liburnian, which in the lower strata is a lagoon, and in the upper a marine, sediment, consisting of black carbonaceous and dark-grey calcareous material. This merges without any definite dividing line into Lutetian, formed by light grey, white or more rarely blackish chalk, containing a numerous but not particularly varied fauna making it possible to distinguish different layers, which however do not exhibit any marked geological differences.

Above the calcareous system lies an intermediate formation, partly breccia, partly marl, over which lies the sandy marl layer of Bartonian Liburnian, a highly composite formation, consisting mainly of sandy marl and sandy flint schists with a calcareous cementing, and clay schists in variously alternating and shallow layers. Among these clastic rocks are found chalk ridges, particularly developed in Southern Istria.

The red soil belongs to the early quaternary period and partly to earlier periods ; it lines the bottom of the Carsic and Doline pockets, but is never found over extended surfaces. A. F.

Goethe and the Sicilian Red Earth.

FISCHER, Herm. (Munich). Goethe und die sizilianische Roterde. *Revue Internationale de Pédologie*, Nos. 3-6 1924.

In Lower Italy and Sicily red earth is not the prevailing type of soil; on the contrary, as a typically climatic soil it occurs only in an isolated manner and is only to be found to any extent near Palermo. Even there its occurrence is limited to the chalk and dolomite mountains. Red earth occurs as a secondary stratified deposit, i. e. in the plains. It is only formed above very fine, crystalline carbonate rocks. A higher proportion of clay in the rock seems to prevent its formation. The red colouring iron compound may be due to the original content of the non-decomposed rocks in iron sulphide and iron carbonate. The approximate extent of red earth round Palermo has been illustrated by a sketch map, in the article. It follows that, owing to the nature of the rocks (Noric dolomite) and the climatic conditions (high summer temperatures with sufficient precipitation) the coastal district of Cefalu near Trapani is favourable to the formation of red earth. In the interior of the country red earth is seldom to be found, and it is confined to the southern side of the mountains.

As early as 1787 GOETHE, on his journey to Sicily, followed the line of occurrence of red earth near Palermo. Red earth in primary stratification is found: (1) at Mount Pellegrino, (2) at San Martino, and (3) behind Monreale. The zone of outcrop of dolomite was also observed by GOETHE. Starting from beneath Monreale, the author has submitted to chemical analysis the non-decomposed dolomite, the zone of white, friable, deposit and the red earth lying above it, and has found that, in decomposing, dolomite loses a greater percentage of magnesium than lime. The sesquioxides increase fifty-five times more in red earth, as compared with their proportion in dolomite. On the heights of the mountains surrounding Palermo red earth is not formed, but a deposit occurs, which is poor in humus, and externally somewhat resembles brown earth. AUTHOR.

The Soils of Moistad Experiment Station, Hedmark, Norway.

GLOMME H. Meldinger fra Norges Landbrukshøiskole, No. 1, 1924, pp. 33-92, bibliography, 1 map. Oslo, 1925.

The article gives a detailed description of the soils occurring at Moistad Experiment Station, Hedmark; similar investigations are to be made at the Norwegian Station.

The investigations have been carried out by means of borings made to a depth of 1 metre, the character of the soil being examined at different horizons. Samples are submitted to mechanical analysis, determination of water capacity, volume weight, specific gravity, pore space, chemical analysis and determination of H-ion concentration and buffer effect.

The bed rock is formed of Ordovician limestone and slates, and the soils consist, from a geological point of view, of moraine residues and peat and similar organic soils. W. S. G.

Soils of Pays de Gex.

Gravigne, Gillet and Denizet. Étude scientifique des terrains, des fourrages et des laits du Pays de Gex. *Congress on Alpine Pasture at Gex*, pp. 35. Dijon, 1924.

Pays de Gex consists of an arrondissement of the Department of Ain on the Swiss frontier. It is a mountain range stretching from South-East to North-West over an extent of forty kilometres and rising to from 1300 to 1600 metres in height.

It is formed of the Middle Jurassic strata, viz., Astartian, Sauracian, and upper (Portland) limestone, flanked by Lower Cretaceous rocks (Urgonian) or marls (Valangian).

On the West lies the valley of the Valserine, a tributary of the Rhone. On the East is the plain of Geneva, which is relatively a plain, and of glacial formation with alpine erratics and Molasse outcrops rising to a height above 600 metres.

Going from East to West however, it has been possible to distinguish the following bands or zones : Alpine erratics zone with variable lime content. Soil called " battante ", having fine sandy constituents piled up under the action of rain, and without any nitrogenous matter.

Glacial Zone with outcrops of Molasse, clayey, content variable as to limestone, scarcely " battante. "

Intermediary Zone between the plain and the mountain, the same strata dominated by the Lower Cretaceous at the foot of which the towns are built.

On the slopes, the soils are tenacious and argilo-calcareous . In the South they are less clayey and not calcareous. Zone of the Valserine clay soils rich in nitrogen and phosphoric acid, prevail.

On the plateaus are friable soils.

If the proportion of grasses G., leguminous plants L. and sundry plants D., be reduced to 10, the following result is obtained for the plain *meadows* (height 500 to 700 m.).

$$5 \text{ to } 6.5 \text{ G} + 1 \text{ to } 3 \text{ L} + 2 \text{ to } 3 \text{ D}.$$

On the unwatered slopes, from about 700 to 900 m., are found : 1 or 2 G + 3 L + 5 or 6 D ; in other words, the proportion of grasses decreases.

On alpine pastures at a height between 130-150 metres there is a still greater increase in the proportion of diverse plants of which a large number are decorative (Orchids) or medicinal (Gentian, Thyme, Veronica).

The richest milks come from the most fertile zone at the foot of the mountains (Lower Cretaceous), where the fat content is 41 grams instead of the average 39 in the plain and 38 ½ in the Valserine.

Pierre Larue,
Gurgy sur Yonne.

Beetroot Soils in Bohemia.

JANOTA. R. Sur les sols betteraviers en Bohême. *Publication of the Ministry of Agriculture*, pp. 79. Prague, 1923.

The cultivation of beetroot in Bohemia is carried on mainly in a district where the soil is more favourable than the climate to its growth. The amount of rainfall is a limiting factor for the development of this crop, and hence there is an intimate connection between rainfall and yield.

Beetroot soils are : calcareous and non-calcareous loess, alluvial and Permian clays and lastly the sandy clay of the carboniferous stratum. The physical properties, and above all, the air and water capacity of these soils make them well suited to beetroot. The author has studied the variations of the physical condition of the soil profile under all its aspects, and draws the conclusion that beetroot requires deep tillage to ensure a sufficient quantity of water. Czech beetroot soils have the following content in nutritive matter (in 10 % HCl).

P_2O_5	0.1 %
CaO	0.5 to 1.5 %
K_2O	0.25 to 0.3 %
N (total)	0.15 to 0.3 %
Humus	0. to 4.0 %

SMOLÌK.

Soils of Overflow Meadows on the Banks of the Volxhov and Lake Ilmen.

PRASSOLOV, L. Untersuchungen des Flusses Wolchow und dessen Bassins, Bul. IV, pp. 5-24, with 7 maps. Leningrad, 1925.

The overflows of the Volxhov and Lake Ilmen have a total extent of over 1500 square km. The chief meadow areas are the deltas of the Lovat and the Usta on Lake Ilmen as well as the great flood plain of the Volxhov at the Grusino. In the flood plain of Lake Ilmen alluvial sub-clayey and sub-sandy stratified soils prevail. However, the greater part is occupied either by swampy meadows of low level, or by peat bogs. High overflows also include large forest areas. In the valley of the Volxhov, clayey, alluvial soils are found, sometimes covering the whole area. In the riverside part of the plain unstratified, alluvial meadowy soils of granular texture. Their area is however not large. The low level areas are generally, either clayey swampy soils, or peat-bogs. In the region of Grusino, elevations of two kinds are encountered ; some of them are no more than 1-2 m. in height and are narrow and elongated, the so-called " weretye " (roller) with clayey alluvial, but clearly podzol soils. Others are higher, not overflowed by high water (25-35 m. above sea level), consisting of glacial deposits. Sandy undulations and hillocks may also be seen either along the tributaries of the Volxhov, or on the banks of ancient lakes. A considerable part of the flood plain of the Volxhov, mainly on its left side, is covered with forest. Soils here are swampy podzol. Similar soils are encountered under a stratum of new alluvium and in the meadow part of the valley, together with " buried " peat-bogs.

To estimate the effect upon the soils of the valley of the Volxhov, produced by the rise of its waters due to the dam under construction, continuous observations were undertaken in 1924 on the level of the soil water and the humidity of the soil (together with observations on vegetation).

The soil of the flood plain of the Volxhov and the lake Ilmen are in their present natural state of different value grading from best soils of highest value (such as riverside granular soils) to those of low value and useless marshes. In respect of area, the soils of middle and low quality prevail, many of them however, might be improved and have perhaps, a great " potential " value. AUTHOR.

Geology of the Sarthe.

WELSCH, JULES. Esquisse géologique des régions naturelles du Département de la Sarthe, pp. 30. I map in colour, scale I/320.000. Le Mans, 1924.

The primary stratum forming the Western part of the Armorican massif is frequently vertically inclined and is crossed by Granites, Porphyries, Amphilolites, Diorites, Diabases and Petrosilex which only play a secondary part in agriculture.

The schists give a deep siliceous soil often covered with heath. The Silurian magnesian limestone is valuable.

Sandstone intercalations (Armorican sandstone) occur in the middle of the schists, covered with heaths and pine forests.

The Devonian and the Carboniferous layer yield lime for agriculture. The kilns from which lime was exported to Brittany are still to be seen along the face of these strata.

Secondary strata are represented by Jurassic and Cretaceous formations.

Jurassic. — Marl Lias only appears to a certain extent in the North.

Middle Jurassic (Bajocian, Bathonian, Collovian, Oxfordian) form the *Champagne du Maine*.

The term " Champagne " or " Campagne " is used in France to designate the calcareous treeless plains belonging to Middle or Upper Jurassic and to Upper Chalk.

In the Sarthe and the West of France, the arable land, which is pebbly and from which the lime is washed only to a shallow depth, is called " groie ". It is red and argillo-calcareous. These are districts with dry, cereal-producing valleys. Certain strata of Bathonian contain flints.

The more marly Oxfordian is the formation of Saosnois and Belinois which are surrounded by heaths and pines of the Forest of Perseigne on one hand, by ferruginous Cenomanian sands on the other, and by the valley of the Huisme which meets the Sarthe at Le Mans. These tenacious marly soils are well suited for artificial meadows and cereals.

The Cretaceous rocks begin by Cenomanian, which took its name from

Le Mans (Cenomanum) and is generally silico-ferruginous with glauconite : Perche sands with reddish coloured sandstone : soils suitable for rye and potatoes occur in woods of Scotch or Baltic pine.

Marly chalk beginning in the Cenomanian layer continues in the Turonian and the Senonian in the South-east of the Department. It forms the sides of the valleys which are lined with clay containing flints washed out of the chalk : it is also the tufa of Anjou, sometimes containing flint nodules or shale and provided the marl for applying to the soils of the siliceous plateaus. Content in calcium carbonate : 50 to 95 %.

Cretaceous layers cover 200 000 hectares of varied aspect out of the 624 000 hectares of the Department of the Sarthe. Clay with flints covers 80,000 hectars.

Clay can be brought up again to the surface, which makes it more easily worked and there is a scarcely perceptible transition to the clay of the somewhat calcareous argilo-sandy plateaus of Pliocene origin.

Ancient alluviums cover from 50 000 to 60 000 hectares. They are generally siliceous, with the exception of those of the Saosnois Orne which cross the Jurassic calcareous strata. They are for the most part dry and bear pine and oak.

Recent alluviums (50 000 hectares) are richer and moister : meadows, vegetables, poplar trees.

PIERRE LARUE,
Gurgy sur Yonne.

The Agricultural Regions of North Dakota.

WILLARD, Rex E. *Bulletin* 183 *North Dakota Agricultural Experiment Station*, pp. 168, figs. 64, tables 20. 1924.

The Bulletin gives the location and description of the Black Earth Belt (Eastern), the Farming Grazing Belt (Central) and the Grazing Forage Crop Belt (Western), the climate, soils, land utilization, and general trend of both yield and acreage per farm. The area, size of farm, climate, soils, crop areas, crop yields, crop damage, extent of live stock per farm, position as regards production of the State and the agricultural districts of each county are stated. Yields of wheat, oats, barley, rye, flax, corn, potatoes, and hay are given for 1911 to 1922, inclusive.

T. CHAPMAN.

The Principal Results and Fundamental Problems of Soil Investigation in Georgia.

ZACHAROV, S. A. *Annals of the State Polytechnic Institute, Tiflis*, Vol. 1, pp. 1-56. 1924.

The soils of Georgia (formerly Tiflis and Kutais departements) have not as yet been subject to systematic investigations. Short descriptions exist and sketch maps of the low part of Western Georgia and Adahzaristan only, but investigations of Eastern Georgia, and mountain district are scarce and occasional. This short essay is to be considered as an attempt to make use of scattered information about the soils of Georgia to summarise them and give a temporary classification of the soils, divide the country into areas, and point out the essential theoretical and practical problems that the soil investigations in this country have to resolve.

The soil of Georgia varies greatly in accordance with the combinations of the soil forming agencies, among which the relief is of prevailing importance: it influences the soil directly, and also indirectly, and is reflected in climate and vegetation.

The predominant types of soil formations in Georgia are:

1. Laterite soils;
2. Podzol soils (white ash-coloured and very much leached);
3. Forest soils;
4. Maroon brown soils (soils of herbaceous steppes, maroon brown colour);
5. Brown soils (soils of worm wood — herbaceous steppes);
6. Mountain meadow soils (alpine meadows — " Eylags ").

Besides the completely developed, or normal soils, incompletely developed soils are largely found in Georgia. Their formation has been disturbed by geological processes: denudation, " diluvium " and " proluvium ", resulting in the formation of rough, skeleton (stony) soils, in which the local soil-forming process is not fully expressed.

According to distribution of soils Georgia may be divided into areas as follows:

I. Soil area of Western Georgia (Kolchida).

1. Marsh-podzol zone of Kolchida lowland, below 1000 feet, with rainfall of 1200-1700 mm. Alder forest with lianas.

2. Laterite-podzol zone of lower mountains of Kolchida, 50-3000 feet elevation, with rainfall of 2400-1200 mm. Forest with lianas.

3. Zone of forest soils of Western Georgia-middle, mountains 2000-6000 feet elevation, with rainfall about 1200 mm. Oak, beech and fir forests.

II. Soil region of Eastern Georgia (Kartli and Kakheti).

4. The zone of tchernozem and maroon coloured soils occupies the lowest and dryest parts of valleys, lower mountains and plateaux below 3000 feet, with rainfall, about 600 mm.; covered with halophytes — worm wood — herbaceous and mixed herbaceous steppes.

5. The zone of forest soils occupies a part of the valleys and central mountains of 2000 to 7000 feet elevations, rainfall 500-800 mm. Elm, oak, beech, pine and mixed forests.

III. The mountain zone — tchernozem occupies the plateau of Little Caucasus, 5000-7000 feet; with rainfall of 500-600 mm.; meadowy mountain steppes with Stipa.

7. Zone of mountain soils of the ridges and summits of the Little Caucasus with Festuca-steppes.

IV. The high Mountain soils, region of Georgia occupie the areas above 6000-7000 feet to the snow-line. It is characterized by a local climate and local soils. It can be divided in following districts:

8. Zone of high mountain soils of the Great Caucasus, with rain-

fall of 1200 mm., with alpine and richest sub-alpine tall herbaceous meadows (swaneti).

9. Zone of high mountain soils of the Adzhjaro-Jmereti and Trialety chain with rainfall of more than 800 mm. and with alpine and sub-alpine meadows.

Among the theoretical problems, which are to be resolved next, we mention the following:

(*a*) The vertical distribution of soils;

(*b*) The origin of laterites and of their residual character;

(*c*) The origin and the conditions of brown forest soils, original soils of Georgia;

(*d*) The geography and topography of mountain meadow soils;

(*e*) The history of the soil mantle of Georgia in connection with the presence of degraded, buried and fossil soils.

Practical problems of study of soils are the following:

(*aa*) The study of carboniferous soils of vineyards and the nature of carbonates, in order to extend the use of American *Phylloxera* resistant stocks;

(*bb*) Manuring and tillage of laterite soils;

(*cc*) Manuring and tillage of podzol soils;

(*dd*) The study of mountain meadow soils in order to use them in the most scientific way;

(*ee*) A detailed division of the country into soil regions;

(*ff*) Soil testing.

The new Faculty of Agriculture, represented by professors and students — future agriculturists — is willing to do its utmost with respect to the study of soils in Georgia. AUTHOR.

Bibliography.

G e n e r a l.

HISSINK, D. J. Introductory Paper, *The Faraday Society*, December 1924.

Revista Muzeului Geologic-Mineralogic al Univesitatii din Cluj, Cluj, 1925. Institutul de Arte Grafice « Ardealul » Str. Memorandului 22.

S o i l P y s i c s.

FISCHER, Karl, Die Verdunstung des Weserquellgebietes, in methodischer Hinsicht betrachtet. *Meteorologische Zeitschrift*. Part, 7, 1924.

FISCHER, KARL. Der Sinn der Gleichung: Niederschlag = Abfluss + Verdunstung, + Versickerung. *Meteorologische Zeitschrift*. Part. 8, 1924.

HISSINK, D. J., VAN DER SPEK, Jac. Studie von en Proefnemingen op Slempige Gronden door het Rijkslandbouwproefstation, Groningen. February 1925.

KLANDER, F. Ueber die im Buntsandstein wandernden Verwitterungslösungen in ihrer Abhängigkeit von äusseren Einflüssen. *Chemie der Erde*, Vol. 2, pp. 49-82, 6 diagrams. Jena 1925.

NOSTIZ A. v. Neue Gesichtspunkte und Hilfsmittel zur Uebertragung physikalischer Bodenuntersuchungsergebnisse in die Praxis. *Landwirtschaftliches Jahrbuch für Bayern*. Nos. 7-8. 1925.

REINAU, E. H. und KERTSCHER, F. Die Umwandlung der Sonnenenergie des Wassers und des Kohlenstoffes in der Landwirtschaft. *Aus der Versuchs- u. Lehranstalt für Bodenfräskultur der Siemens-Schukkertwerke G. m. b. H. zu Gieshof*, Publisher, Julius Springer. Berlin, 1925.

Soil Chemistry.

BLANCK, E. und RIESER, A. Ueber die chemische Veränderung des Granits unter Moorbedeckung. Ein Beitrag zur Entstehung des Kaolins. *Chemie der Erde*, Vol. 2. Part. 1. Jena 1920.

DOBRESCU-CLUY, J. M. Die Dynamik der Kaliassimilation kalihaltiger Silikat-Minerale. *Chemie der Erde*, Vol. II, pp. 83-102, 1925.

COMBER, N. M. The Role of the Electronegative Ions in the Reactions between Soils and Electrolytes. *The Faraday Society*. December 1924.

FISHER, E. A. Base Exchange in Relation to the Swelling of Soil Colloids. *The Faraday Society*, December 1924.

FISHER, E. A. Base Exchange in relation to Adsorption. *The Faraday Society*, Secember 1924.

GORSKI and W. JANKOWSKA, Analyse de deux profiles des loess des pays-bas de Bug. Czcionkami Drukarni Uniwersytetu Poznanskiego. *Institut de chimie agricole à Dublany*. Poznan 1923.

HEADDEN, W. P. The Effect of Nitrates on the Composition of the Potato. *The Colorado Experiment Station, Bulletin* No. 291, Fort Collins, 1924.

HEADDEN, W. P. Some Orchard Conditions affected by Arsenicals, Marls and other Factors. *The Colorado Experiment Station, Bulletin* No. 294, Fort Collins 1924.

HISSINK, D. J. Das Wesen, die Bedeutung und die Bestimmungsmethoden der Bodenazidität. *Zeitschrift für Pflanzenernährung und Düngung*, Section A, Year IV, Part. 4.

HISSINK, D. J. De verzadigingstoestand van den grond. A. Minerale gronden (Kleigronden). *Rijkslandbouwproefstation, Groningen*, 20. Nov. 1924.

HISSINK, D. J. Der Sättingungszustand der Böden. A. Mineralböden, *Zeitschrift für Pflanzenernährung und Düngung* IV. Section A, Year IV, Part 3.

HISSINK, D. J. Base Exchange in Soils. *Transactions of the Faraday Society*, Vol. XX, No. 60. Section 3, 1925.

PACE H. J. und WILLIAMS, W. Studies on Base Exchange in Rothamsted Soils, *Transactions of the Faraday Society*, Vol. XX, No. 60, Section 3, 1925.

PAGE, H. J., M. B. E., B. Sc., A. I. C. Soils and Fertilisers. *Society of Chemical Industry. Reports of the Progress of applied Chemistry*, Vol. IX. 1924

PAGE, H. J., M. B. E., B. Sc. The Chemistry of Soils and of the living plant. *Annual Reports of the Chemical Society*, Vol. 21, 1924.

PAGE, H. J. und WILLIAMS, W. Studies on Base Exchange in Rothamsted Soils, *The Faraday Society*, Dec. 1924.

RAMANN, E. Die chemisch-physikalischen Wirkungen von Aetzkalk und kohlensaurem Kalk in Mineralböden. *Zeitschrift für Pflanzenernährung und Düngung*, Year III, Section A. Part 4.

ROBINSON, G. W. und WILLIAMS, Rice. Base Exchange in Relation to the Problems of Soil Acidity. *The Faraday Society*, December 1924.

SAINT, S. J. The Relation between the P_H value, the Lime Requirement, and the Thiocyanate Colour of Soils. *The Faraday Society*, December 1924.

Soil and Vegetation.

WIESSMANN, H. Hat Kieselsäure bei unzureichender Phophorsäureernährung einen Einfluss auf den morphologischen und anatomischen Bau des Roggenhalmes? *Zeitschrift für Pflanzenernährung und Düngung*. Year IV. Section IV. Parts 1-2.

Classification.

VILENSKY, D. The Analogical Series in Soil-Formation and a new Genetic Classification of Soils. With a coloured diagram showing 20 of the most important soil types. Kharkow 1925.

Regional Soil Science.

BRUNNER, J. Die geologischen Verhältnisse Unterfrankens und ihr Einfluss auf die dortige Landwirtschaft. *Mitteilungen der D. L. G.* Meeting of Sept. 1924, pp. 684-686.

GOLONKA, Z. Czcionkami Drukarni Uniwersytetu Poznanskiego. Die Böden der Waldreviere Bobrek bei Oswiecim, Wojewod-schaft Krakau. (Russian). Poznan 1924.

HEADDEN, W. P. A peculiar Soil Condition in the San Luis Valley. *Bulletin of the Colorado Experiment Station* No.286. Fort Collins, 1923.

NOMMIK, A. Ueber den Boden Estlands. *Veröffentlichungen des Kabinettes für Bodenkunde und Agrikulturchemie der Universität Tartu* (Dorpat) Esthonia, No. 2, 1925.

Communications.

International Society of Soil Science. — The number of members is now 592, of whom only about 400 have paid their subscriptions and entrance fees for 1925. This made it necessary to send out a reminder to nearly 200 members, involving considerable time and expense.

I should like to take this opportunity of once more pressing on my colleagues the desirability of forming national sections, which could take over a part of my work, for example: the sending of notices, etc. to new members, the collection of subscriptions, recording of change of address, etc. A proportion of the annual subscription of 6.50 francs, either 0.50 or 0.75 fr. could be placed at the disposal of the national sections for the purpose of covering expenditure.

As you will be aware, on Circular 4 of May 1925 I requested the members to inform me whether they wished to receive the Proceedings of the International Soil Science Conference in Rome (May 1924) at the reduced price of 80 francs, the price for the general public being 150 francs. A number of members have misunderstood the circular and have sent me the 80 francs. I have therefore to ask them to note that the matter is in the hands of the International Institute of Agriculture (Villa Umberto I. Rome [10], Italy) and that I have forwarded all money sent to this address. Members who have made enquiries as to the date of publication of these proceedings are also referred to this address.

Members are again requested to remit the annual subscription in Dutch guilders, either by post office money order or to the Geldersche Crediet Vereeniging, Groningen (Holland), paid to the account of the International Society of Soil Science. In either case it is essential to add my name.

By arrangement with the editor, Prof. SCHUCHT, the list of members will appear in the first part of the new year 1926. Members are therefore requested to be so good as to send me word of any change of address in good time.

Dr. D. J. HISSINK,
Acting President and General Secretary.
Herman Colleniusstraat 25, Groningen (Holland).

Brief statement concerning progress made in the organisation of the First International Congress on Soil Science. — (1) The personnel of the Organising Committee has been completed. It consists of: F. J. ALWAY (University of Minnesota, St. Paul), F. E. BEAR (Ohio State University, Columbus), G. S. FRAPS (Agricultural and Mechanical College, College Station, Texas), R. HARCOURT (Ontario Agricultural College, Guelph, Ontario), S. B. HASKELL (Massachusetts Agricultural College, Amherst), D. R. HOAGLAND, (University of California, Berkeley), T. L. LYON (Cornell University, Ithaca, New York), C. F. MARBUT U. S. Department of Agriculture, Washington, D. C.), A. G. MCCALL (University of Maryland, College Park), W. H. MCINTIRE (University of Tennessee, Knoxville), M. F. MILLER (University of Missouri Columbia), F. T. SHUTT (Dominion Experimental Farm, Ottawa, Canada), F. A. WYATT (College of Agriculture, Edmonton, Alberta), J. G. LIPMAN (Director, Experiment Station, New Brunswick, N. J.).

The personnel of the Exhibits Committee has also been completed. It consists of: E. TRUOG, (Chairman, University of Wisconsin, Madison), C. H. SPURWAY (Michigan Agricultural College, East Lansing), S. D. CONNER (Experiment Station, Lafayette, Indiana), R. M. SALTER (Ohio State University, Columbus), H. J. HARPER (Iowa State College, Ames), F. W. PARKER (Experiment Station, Auburn, Alabama), W. W. WEIR, (U. S. Department of Agriculture, Washington, D. C.).

(2) The Secretary of Agriculture, Mr. JARDINE, has promised to see that a resolution is introduced after Congress convenes in December. This resolution will authorize the President to invite foreign governments to send delegates to the Congress.

(3) The itinerary of the field excursion, which is to follow the meetings in Washington, has been prepared by Dr. MARBUT. Arrangements will be made to dig pits at certain locations in the United States, and possibly also in Canada, in order that the soil profiles may be clearly shown to members of the Congress.

(4) Funds are being collected for financing the field excursion. It is hoped that enough money will be available so that the field excursion, which will last about four to five weeks and which will carry the party from the Atlantic to the Pacific shore, will be without cost to the foreign delegates. Very substantial contributions toward the expense of the field excursion have already been promised.

(5) It is expected that by next November, when a formal meeting of the Organizing Committee will be held in Chicago the necessary funds for financing the field excursion will have been subscribed. At that time final arrangements will be planned for the program and for the appointment of such other committees as will be necessary to insure the success of the meetings in Washington, etc.

(6) The National Research Council. The Association of Land Grant Colleges and the American Society of Agronomy have also pledged their co-operation. The American Association for the Advancement of Science and the National Fertilizer Association will also offer such co-operation as they may be able to give us.

(7) Additions to the membership of the International Society of Soil Science are constantly being made. It is expected that by next fall there may be possibly as many as two hundred members in the United States.

J. G. LIPMAN.

Etat de l'étude et de la cartographie du sol dans les divers pays. — This volume, published under the direction of the late Professor MURGOCI is now printed in full, with the exception of three colour maps which cannot appear therefore this winter. Since the last International Soil Science Conference, Professor MURGOCI added many photographic illustrations and plates to this volume.

Those who, previous to the last International Conference, received the incomplete volume, may apply for the work in its final form to Prof. PROTO-

POPESCU-PAKE, Institutui Geologic al Romaniei, Sectinea Agrogeologica, Soseana Ardealului (Kiselef) No. 2. Bucharest, Rumania.

Appeal for Cooperation in the Work of the Sixth Commission on the Application of Soil Science to Scientific Agriculture. — The utilization of the soil of the national territory so as to cover most completely the subsistence requirements of a country, proved during the war in every country to be one of the most important tasks of public economy. In consequence, close attention was given during the war by all circles and even more has been since given to the improvement of the soil with a view to intensification of the production of necessaries. There has been accordingly a development beyond all anticipation in the technique of cultivation, directed towards such treatment of the soil as will ensure a better agricultural utilisation. In close connection with this the need is felt for establishing this branch of technique on scientific lines, which would also have the effect of rendering the relations between the soil and the means for its improvement, the subject of practicable scientific research.

The Third International Soil Science Conference, held in Prague in 1922, recognised the interrelation between these facts and took them into account so far as to appoint a sub-committee of the Commission for the Study of Soil Physics and Mechanics, which should make a special study of the application of soil science to scientific agriculture. This sub-committee took upon itself for the Fourth International Conference in Rome in the year 1924 a task of some magnitude, which consisted in the application to scientific agricultural schemes of mechanical analysis of soils by decantation.

The Commission drew up a number of conclusions on the basis of proposals and discussions, and among these the following may be specially mentioned:

A. The Organisation of Soil Science Service.

(1) A complete and scientifically sound knowledge of soils is the essential basis for an effective and economical solution of all amelioration problems. Hence all measures for soil and land improvement should be based on absolutely reliable soil and hydrological investigations.

(2) It is essential that provision be made for the organization of facilities for soil investigations in their relation to land cultivation. It is recommended to the respective governments that, where this has not already been done, suitable committees be appointed to serve in an advisory capacity as regards the organization of a soil science service. An effective organization of this sort has been created in Czechoslovakia.

(3) Research on land reclamation and water supply problems is urgently needed for the development of land cultivation methods.

(4) It is necessary that the college curriculum in agricultural engineering should be based on the natural sciences with special reference to soil science.

(5) In order to avail ourselves promptly of the definite results from the accumulated comparative experiments in the various countries under the most variable conditions, it is important that all societies, institutions, bu-

reaus and other bodies interested in soil science, should become affiliated with the "Committee on the application of soil science to scientific agriculture" of the "International Society of Soil Science."

(6) This International Committee met for the first time in Rome in May 1924. The working programme accepted for the soil science service in Czechoslovakia and also the plans proposed for Germany were submitted. These projects may be considered as the basis for a programme of soil science service in each country.

B. The Programme for the future work of the Committee.

(7) As topics for consideration at the next conference the following should be studied:

(*a*) Working methods of the Soil Science Service.

(*b*) Organization of experiments on methods of soil improvement.

(*c*) Data on the influence of the improvement of various soil types.

(*d*) Results of the experiments in land cultivation in reference to the "drainage theory" (depth and distance). In order to obtain comparative results it is desirable that the Committee members should receive from the various countries descriptions of the established drainage experiments of characteristic soil profiles.

The next meeting of the Commission, which will take place in Washington on the occasion of the First International Soil Science Congress in 1927, will be devoted to these and other important questions of soil science and scientific agriculture and will attempt their solution on an international basis.

It is obvious that there will be a fuller realisation of the end in view in proportion as experts both on the scientific and the practical side become members of the Commission and in proportion as more countries are represented on it. The more varied the scope of the work of the Commission, the greater value will attach to the results of its investigations.

The Commission therefore makes an appeal to all experts, who are engaged in scientific agriculture either on the purely scientific or on the practical side, to join the Commission and to take an active part in its work, and the State authorities who administer the service of scientific agriculture, are invited to appoint representatives on the Commission.

It is our firm conviction that our work will be of great value to all countries and we are of opinion that for this reason we may count on some consideration of this invitation to join the International Society of Soil Science and in particular to join this Commission.

Groningen and Zurich, 25 September 1925.

For the International Society of Soil Science: The Acting President and General Secretary,
DR. D. J. HISSINK,
Herman Colleniusstraat 25, Groningen.

For the Sixth Commission for the Application of Soil Science to Agricultural Science:
Chairman of the Commission,
J. GIRSBERGER, *Ing. Agr.*
Zurich.

The conditions for admission to the International Society of Soil Science are as follows :— Any individual or body corporate engaged in the study of soil science, is eligible for ordinary membership.

Members of the Society are entitled to receive the Review post free on payment of the annual subscription.

The subscription for 1925 is 6.50 Dutch guilders, with an entrance fee for new members of 2.50 guilders.

Proposals for membership must be sent to the Acting President and General Secretary of the International Society of Soil Science, Dr. D. J. HISSINK, Herman Colleniusstraat 25, Groningen (Holland), or to the Chairmrn of the Sixth Commission for the Application of Soil Science to Scientific Agriculture, J. GIRSBERGER, Ing. Agr., Zurich, Switzerland.

Proceedings for 1926. — We kindly ask the readers of our paper to be patient with us if the various issues do not appear as punctually as is desirable There are many technical difficulties to overcome, but these seem to be eliminated now after a conference of the undersigned editor with Dr. G. A. R. BORGHESANI, which took place in August 1925 in Rome. For technical reasons the size of the present number, 4, had to be cut down slightly, but from January 1926 on, the paper will again be edited with increased contents and, above all, will appear punctually.

F. SCHUCHT,
Editor.