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Vol./Bd. VII 1940 No 1/2

Results of the investigation of the seven Standard Soil Samples No. I—VII of the International Society of Soil Science

by

D. J. Hissink

I. Object of the investigation

At the Congress at Oxford (1935) Dr. H. Greene (Sudan) pointed out the desirability of comparing methods of determining exchangeable bases. Dr. E. M. Crowther (England) suggested that this object could best be attained by collecting a limited number of Standard Soil Samples at a particular place, to be sent on request to those persons who wished to make cooperative studies in the domain of exchangeable bases. The Congress charged me to collect and distribute a series of standard soil samples for this purpose.

The main object of this cooperative work is to obtain a satisfactory expression for the exchangeable base content of the natural soils. This seems to necessitate studying the displacement of bases by a variety of methods as e. g. treatment with neutral salts or weak acids in various amounts and at various soil-water ratios.

The second objective of the cooperative work is to measure the exchangeable base content of the soils when brought to "saturation" by some specified treatment. This treatment may involve the strongly alkaline conditions produced by a hydroxide (e. g. barium hydroxide, Hissink), less alkaline conditions, such as were used by Bradfield and Allison (1933, Transactions International Society of Soil Science, Commission 2, Volume A, Copenhagen), or a range of pH conditions, giving a titration curve.

Determinations may be made either by recognized methods or by new ones, but in every case the precise details should be given clearly. It is not sufficient merely to give the name of the original author of

the method. Other determinations, mechanical analysis, humus, calcium carbonate, pH etc., may of course be included at the discretion of the investigator.

The following Standard Soil Samples are at present available for distribution at the Institute of Soil Science, Groningen, Holland:

SS I Gezira (Sudan), heavy clay surface soil, passing 1 mm. sieve, pH between 9 and 10; contains neither sulphates nor chlorides soluble in water;

SS II Young Dutch marine heavy clay soil, with about 8% $CaCO_3$, pH about 7.7. Contains neither sulphates nor chlorides soluble in water;

SS III Old Dutch marine clay soil, free from $CaCO_3$, pH about 5.5. Contains neither sulphates nor chlorides soluble in water;

SS IV Roseworthy (Australia), fairly sandy clay surface soil of the Mallee type, with about 10% $CaCO_3$, pH about 9. Contains a small amount of salts soluble in water;

SS V· Curlwaa (Australia), very heavy clay surface soil, being a River Murray alluvium from a fruit-growing irrigation area, with less than 1% $CaCO_3$, pH about 8. Contains sulphate and chloride soluble in water;

SS VI Podzol from Russia, from the upper layer (1—13 cm.), passing 2 mm. sieve;

SS VII Fairly heavy Tschernozem from the Woronesch region, Russia, from the uper layer (1—12 cm.), passing 2 mm. sieve.

In the Proceeding of the International Society of Soil Science (green Journal), Vol. XII (1937), No. 2, p. 66—67, it was stated that 2½ kilograms of any of these samples would be forwarded on request to those interested, on payment of the expenses connected therewith. Furthermore it was agreed that the results should be communicated to me for publication in order that the samples may become standards by which members can compare their own methods or technique with those of other workers. After my departure from Groningen, these results are to be sent to my new address (Dr. D. J. Hissink, Ruychrocklaan 164, The Hague, Holland).

So far requests for the S. S. Samples have been received from some 8 colleagues. Of these 8, two, viz. Dr. Liatsikas, Athens, and Dr. Meyer, Hamburg, have furnished particulars of the results of their investigations. Now that in the meantime the investigation of the 7 samples at the Institute of Soil Science in Groningen has been concluded, it would seem advisable first to publish the results obtained

in Groningen. I now do so, with thanks to the late Mr. M. Dekker, under whose supervision the investigation was carried out, and who also worked out the results.

Although therefore, as stated above, all that is required is a communication of the methods of investigation employed and of the results obtained, it seemed desirable to add here and there a few remarks regarding the figures found.

II. Methods employed at the Institute of Soil Science Groningen

The methods of investigation are given in the "Erster Bericht über die Arbeiten und über die Tagung der Arbeitsgemeinschaft zur Prüfung der Laboratoriumsmethoden für die Bestimmung des Kali- und Phosphorsäurebedürfnisses der Böden", Transactions of the 2nd, 3rd, and 4th Commissions of the International Society of Soil Science, Meeting July 1936, Königsberg, pp. 135 and 136. As this Report is written in the German language, and moreover is in the possession of a small number of members only, a translation is given here.

Notes on Tables V to VIII by D. J. Hissink (Transactions Königsberg)

$CaCO_3$. This was determined by Passon's volumetric method, modified by the Institute of Soil Science at Groningen. The carbonic acid is expelled with hydrochloric acid (2 vol. HCl spec. grav. = 1.195 + 1 vol. H_2O) at room temperature. For the correction of differences of temperature and air-pressure a standard determination with a known amount of $CaCO_3$ is made at the same time in the case of each series.

Humus. This determination was made by means of Ter Meulen's elementary analysis (1). For the recalculation of the amount of carbon (C) found on the basis of the humus content, the C-content of the humus was assumed to be 58 %.

Clay and sand. By clay and sand was understood particles with a diameter of less and more than 16 micra respectively. For the pre-treatment of the soil see the Communications of the International Society of Soil Science E (2). The separation of clay and sand was performed by washing in the Atterberg cylinder. The duration of sedimentation for particles with a diameter larger than 16 micra is 7½ minutes per 10 cm. By means of a sieving method the sand is divided into 12 subfractions. From these the U-value per 100 gr sand was calculated. For further particulars see S. B. Hooghoudt (3).

Nitrogen. This was determined by the Kjeldahl method and refers to the organically bound nitrogen. The table also mentions the number of grammes of nitrogen (N) per 100 gr humus.

Phosphoric acid. See Int. Agr. Wiss. Rundschau, 2, 364, 1926.

Potassium. See Intern. Mitteil. f. Bodenkunde, V, 1, 1915.

Weathering silicate A. For this method of determination see Hissink's paper: „Über die Bedeutung und die Methode der chemischen Bodenanalyse mit starker heißer Salzsäure" (4). The analytical part has been altered here and there.

Inter alia boiling is now carried out in a glycerine bath at 125 to 130 degrees C. In the hydrochloric acid extract the sum of $Al_2O_3 + Fe_2O_3 + P_2O_5$ is determined gravimetrically. Then follows the determination of the P_2O_5 (according to Lorenz) and of the Fe_2O_3 (titrimetrically with $KMnO_4$, after reduction with zinc powder). This sum minus $(Fe_2O_3 + P_2O_5) = Al_2O_3$. In addition to the content of Al_2O_3, SiO_2 and Fe_2O_3 in percentages, the table shows the number of millimoles of these constituents per 100 gr dry soil. From these latter figures, finally, the molecular ratio is calculated.

Exchangeable bases and S-value, T—S-value, T-value and V-value. For the method for the determination of exchangeable bases see Hissink's paper: „Beitrag zur Kenntnis der Adsorptionsvorgänge im Boden" (5). This table gives the amount of exchangeable CaO, MgO, K_2O and Na_2O in percentages of dry matter. From this the number of milligram-equivalents (mge) of these bases per 100 gr dry matter is calculated. The sum of the number of mge $CaO + MgO + K_2O + Na_2O$ gives the S-value in mge per 100 gr dry matter. Finally the molecular proportion (to S = 100) was calculated from these results; in cases where the S-value is less than 4, this proportion was not calculated.

The method for the determination of the T minus S-value is described i. a. in "Base Exchange in Soils, a general discussion held by the Faraday Society", December 1924, pp. 560—562. The sum of S and T—S = T. From this V is calculated according to the formula:

$$\frac{100\ S}{T} = V$$

pH. This was determined with the quinhydrone electrode in a suspension of 10 gr soil + 26 cc distilled water free from carbonic acid.

The following additions can be made here.

Mechanical Soil Analysis. The time for sedimentation of fraction II (particles with a diameter of from 2 to 16 μ) is 8 hours per 10 cm. The syphoning off of fraction I in the Atterberg cylinders gave rise to some difficulties in the case of sample No. V. After decanting of the electrolytes with water, this soil flocculated again with $NH_4OH + NaOH$. The result was that the syphoning off of fraction I of this sample took from 3 to 4 weeks.

Fractions I and II of samples II and V were also determined by the pipette method. After washing out the electrolytes we do not in that case treat the soil with $NH_4OH + NaOH$, but simply with NH_4OH. In the following table the results obtained by both methods are given.

No.	Smaller than 2μ		Up to 16μ	
	pipette	Atterberg	pipette	Atterberg
II . .	44.8	47.4	65.3	65.8
V . .	43.5	43.5	58.1	57.4

The agreement of the results is on the whole very satisfactory. Sample No. II, however, shows a lower content of particles smaller

than 2 μ by the pipette method than by the Atterberg method. Presumably the electrolytes had not been sufficiently washed out in the pipette method and still had a certain flocculating effect.

Organic matter. It was difficult completely to analyse the organic matter of sample No. VII by dry combustion. With the elementary analysis this sample therefore required an abnormally long period of ignition. The humus content of No. VII was also determined by the "loss on ignition" method, the content of water bound being assumed to be 6 gr per 100 gr clay (particles smaller than 16 μ). The humus content according to this latter method was found to be 11.9%, as against 11.8% as found by the Ter Meulen method (elementary analysis).

Soil Acidity. The pH was determined not only with the quinhydrone electrode, but also with the glass electrode. In both cases measurement was performed in a suspension of 10 gr soil and 25 cc distilled water free from carbonic acid. With the quinhydrone electrode samples V and VI showed a marked drift in the alkaline direction. With the exception of No. VII, all the quinhydrone figures are higher than those obtained with the glass electrode; the differences are largest in the case of nos. V and VI.

Exchangeable Bases. For the purpose of determining the contents of exchangeable lime and magnesia, 15 gr instead of 25 gr of soil were used from samples I and VII. In spite of this the 2nd litre of the extract of sodium chloride of No. VII was found still to contain lime. As this sample is free from calcium carbonate and the lime found in the 2nd litre therefore does not come from the calcium carbonate, this lime should not be deducted from the lime of the first litre, but should be added to it, which was in fact done. The exchangeable potassium and sodium were determined by newer methods (6). In so far as the samples contained sulphates and chlorides soluble in water, the analysis of the sodium chloride and the ammonium chloride extracts yields the sum of the exchangeable bases and the bases soluble in water (CaO, MgO, K_2O and Na_2O). The bases soluble in water should in such cases be determined separately. For this investigation only the samples IV, V, and VI called for consideration. In our salty Zuyder Zee soils this determination is at present made by a method worked out by Dr. Zuur, in the press-juices obtained from fresh, fairly moist samples. The S. S. Samples IV, V and VI are, however, in an air-dry condition. Before pressing out, therefore, a certain amount of water had to be added; to 1200 grammes of air-dry soil enough distilled water was added to bring it to the water content shown in the second column of Table II,

1st part (30.8—34.2—32.8). Soil and water were well kneaded several times in a dish and after a period of about 48 hours, the soil solutions, with the constituents dissolved in it, were pressed out in a hydraulic laboratory press at a pressure of 400 atmospheres.

Determination of T—S. During the determination of the T—S value by the baryta method, sample VI behaved differently from the others. A white, flocculent precipitate was produced during the retitration of the excess baryta with hydrochloric acid, approximately at the neutralisation point. This precipitate was found to consist of iron, aluminium and presumably of still other constituents. This sample was investigated in triplicate, and the points of the three T—S lines drawn were on the whole less satisfactory.

Potentiometric lime titration. In the three acid reacting samples III, VI and VII a potentiometric lime titration was performed. For the method here employed see pp. 72 to 93 of Vol. B of the Transactions of the Second Commission of the International Society of Soil Science, Groningen Meeting, 1926. In the method of investigation there described an alteration was made; instead of making use of a particular amount of soil, a particular amount of adsorbing material was employed. For clay soils this amount is 2.25 gr clay + humus (as clay) and for the organic soils 0.5 gr humus + clay (as humus). To this, as before, 20 cc liquid was added in all cases, whilst the period of action was fixed at three days. Another difference from the method previously used is that the pH was not determined with the quinhydrone electrode, but with the glass electrode.

N, P_2O_5, K_2O. The investigation of the contents of nitrogen, phosphoric acid and potassium caused no difficulties. The extract for the determination of the potassium soluble in 0.1 normal hydrochloric acid was prepared by shaking 60 gr soil with 600 cc 0.1 normal hydrochloric acid for 1 hour. Additional hydrochloric acid was also added in amounts equivalent to any calcium carbonate present.

III. Results of the investigation

The results of the investigation will be found collected in Tables I to V inclusive. Each of these Tables will be discussed separately below.

a) Table I; mechanical composition

In so far as the figures of this supplement express specific percentages, they call for no further remarks. We shall restrict ourselves to a discussion of a few figures derived from them.

From the contents of fractions I and II their relative proportions were calculated (column 9). These proportions vary greatly, viz. from 0.14 to 2.0. The clay fraction (fractions I and II) of samples I and IV is, relative to the other samples, very rich in fraction I (1 : 0.14 and 1 : 0.18). A similar preponderance of fraction I is so far not found in our Dutch clay-soils. For our marine clay soils a proportion between 0.4 and 0.6 (as in Nos. II and III) is normal. The proportion for No. VII is of the same nature (0.51); that for No. V (0.32) is somewhat lower than that for the Dutch marine clay soils. Quite a different picture is shown by No. VI, with a proportion of 2.0; in this podsol fraction II occupies by far the most important place (fraction I = 13.4; fraction II = 27.1). It is obvious that these great differences in the relation between fractions I and II must have an effect on the adsorptive capacity for bases of what I have called the clay substance (fraction I + II). When discussing this subject I will deal more fully with this point also.

Column 10 of Table I shows the connection between the content of humus and that of clay (fractions I and II). This shows that the tropical soil from the Sudan (No. I) and the "Curlwaa" from Australia (No. V) are very poor in humus in proportion to their clay content (1.0 and 1.7). From this point of view the Russian Podsol is likewise fairly poor in humus (No. VI with 3.2 %). For Dutch marine clay soils from 5 to 7 gr humus per 100 gr clay (fractions I and II) is a normal figure. Samples IV (Australia) and VII (Chernozem, Russia) are comparatively rich in humus.

U-values of the sand fractions. The U-values of the sand fraction (particles between 0.016 and 2.0 millimetres diameter) vary from 113 to 360. According to a classification made for Dutch soils the sand fraction of No. IV (U = 113) is very fine, that of the other samples extremely fine (7).

b) Table II. Constituents soluble in water

Before pressing, the air-dry soil samples IV, V, and VI were brought to water contents of 30.8—34.2—32.8 (see table II, first part, column 2). Slight amounts of bicarbonate were found in the press-juices (about 46.0—62.8 mg per 100 cc press juice). Similar small amounts also occur in soils which are absolutely free from chlorides and sulphates. We take it that the water containing CO_2 dissolves small quantities of lime out of the calcium carbonate or out of the clay-humus complex and forms calcium bicarbonate with these. We therefore include this calcium bicarbonate not in the salts which are really soluble in water,

Table I

No. S.S.S.	Percentages in oven-dried soil (105° C)							Ratio fraction I : fraction II = 1 :	G humus per 100 g clay substance
	water-soluble substances	$CaCO_3$	Humus (dry combustion; Ter Meulen-method)	Fraction I; particles smaller than 2 μ	Fraction II; particles from 2—16μ	clay substance (fraction I + II)	Sandfraction (particles from 0,016—2 m M)		
I . . .	0	2.4	0.7	64.3	8.8	73.1	23.8	0.14	1.0
II . . .	0	8.7	3.2	47.4	18.4	65.8	22.3	0.39	4.9
III . . .	0	0	5.1	47.1	23.4	70.5	24.4	0.50	7.2
IV . . .	0	11.9	2.7	17.2	3.1	20.3	65.1	0.18	13.3
V . . .	0.3	0	1.0	43.5	13.9	57.4	41.3	0.32	1.7
VI . . .	0	0	1.3	13.4	27.1	40.5	58.2	2.0	3.2
VII . . .	0	0	11.8	47.3	24.0	71.3	16.9	0.51	16.5

and do not deduct the amount of CaO equivalent to the bicarbonate from the sum of the CaO soluble in water plus the exchangeable CaO. It is obvious that this reasoning does not hold good in the case of typical soda soils, but no soil of that kind is present in the collection of the Standard Samples.

Table II

Water-soluble constituents of the press juice

No.	g H_2O per 100 g oven-dried soil (105° C) before pressing	Milligrammes per 100 cc press-juice					
		HCO_3	Cl	SO_3	CaO	MgO	Na_2O
IV . .	30.8	62.8	14.6	4.0	33.9	9.8	7.4
V . .	34.2	51.8	229.9	338.2	111.6	83.5	241.7
VI . .	32.8	46.0	9.4	6.0	21.2	10.0	7.6

No.	g per 100 g oven-dried soil (105° C)								
	calculated from the above mentioned data						water-soluble (after correction		
	HCO_3	Cl	SO_3	CaO	MgO	Na_2O	CaO	MgO	Na_2O
IV .	0.019	0.004	0.001	0.010	0.003	0.002			
V .	0.018	0.079	0.116	0.038	0.029	0.083	0.028	0.027	0.077
VI .	0.015	0.003	0.002	0.007	0.003	0.002			

Mechanical Composition

Subfractions of the sandfraction (diameter in micra)											U-value (specific surface) calculated per 100 g sandy fraction
16—43	43—74	74—104	104—147	147—208	208—295	295—417	417—589	589—833	833—1168	1168—1651	
9.4	5.0	2.9	1.8	2.0	1.4	0.9	0,3	0.1	0	0	224
14.2	5.5	1.1	0.4	0.4	0.3	0.2	0.1	0.1	0	0	307
18.9	2.6	0.9	0.7	0.6	0.4	0.1	0.1	0.1	0	0	336
6.5	7.0	10.3	12.5	14.6	8.1	3.9	1.6	0.6	0	0	113
16.6	11.0	7.3	4.0	1.8	0.3	0.2	0.1	0	0	0	239
49.7	5.6	0.4	0.3	0.3	0.3	0.4	0.5	0.4	0.3	0	360
12.8	1.0	0.6	0.5	0.7	0.5	0.3	0.3	0.1	0.1	0	323

It is now necessary to calculate the CaO equivalent to the bicarbonate. For Nos. IV, V and VI, with respectively 0.019 %, 0.018 % and 0.015 % HCO_3 of dry soil (table II, second part, col. 2), this is 0.009 %, 0.008 % and 0.007 % CaO. Practically all the CaO (respectively 0.010 % and 0.007 %; see table II, second part, col. 5) found in the press-juices of Nos. IV and VI is therefore present in these in the form of calcium bicarbonate. The press-juice of these two samples further contained only a few thousandths per cent MgO and Na_2O (0.003—0.002), whilst analysable quantities of K_2O were not found in any of the three press-juices. It will perhaps also be possible to find such small amounts of bases in a press-juice of a soil that is practically free from chloride and sulphate. The content of bases soluble in water (CaO, MgO, K_2O and Na_2O) of samples IV and VI may therefore safely be taken as nil.

Soil Sample No. V, on the other hand, does contain chlorides and sulphates soluble in water. The amounts of CaO, MgO, and Na_2O (where necessary that of K_2O also) equivalent to these were calculated as follows. From the 0.038 % CaO found in the press-juice, 0.008 % CaO must be deducted (equivalent to the HCO_3, i. e. $28 \times 18:61 = 8$). The remaining 0.030 % CaO and likewise the 0.029 % MgO and 0.083 % Na_2O must now be corrected for the so-called "negative adsorption". For if soil is put into a salt solution (e. g. of NaCl), a zone poorer in anions forms around the particles. The result of this is that the solution itself becomes richer in sodium chloride. This increase of the concentration in NaCl will depend on the proportion of soil to liquid. When the ex-

changeable bases + those soluble in water are calculated, the soil is lixiviated with considerably more water than it contains when pressed. Per 100 gr soil No. V, when pressed (present 34.2 cc water; see table II, first part, col. 2), 0.079 gr Cl were found, whilst when 100 gr soil No. V were shaken with 1200 cc water, after filtration 0.073 gr Cl was found (8). The amount of bases, 0.030 % CaO, 0.029 % MgO and 0.083 % Na_2O found in the press-juice of No. V was therefore multiplied by the factor 73 : 79 = 0.92. In this way we calculated that soil sample No. V contained 0.028 % CaO (0.92 × 0.030 = 0.028), 0.027 % MgO, and 0.077 % Na_2O (table II, second part, last columns) as bases soluble in water. The sum of the CaO, MgO and Na_2O soluble in water plus the exchangeable CaO, MgO and Na_2O found with the extraction was reduced by these small amounts. When the contents of exchangeable bases of soil sample No. V, as shown in table III (0.274 — 0.182 — 0.046 — 0.039) were calculated, this reduction had already been taken into account.

c) Table III. Soil Acidity (pH) and Adsorption Values (S, T, V).

With the exception of sample No. VII, the glass electrode invariably yielded a lower pH value than the quinhydrone electrode. The difference was greatest with samples V and VI, which showed a marked drift in the alkaline direction with the quinhydrone electrode. In these cases the values found with the glass electrode are certainly to be preferred. As a matter of fact this holds good in general, and especially with those samples of which the pH is higher than 8. Three of the samples (III, VI, and VII) show an acid reaction; the others an alkaline one. There are, however, no abnormally strongly acid or strongly alkaline reacting types, such as soils containing Fe-Al-SO_4 or alkali soils.

The remaining figures of the first part of this table refer to the content of adsorptively bound bases. These are expressed in percentages of dry soil, in milligramequivalents (mE) per 100 gr dry soil, in percentages of clay + humus (as clay), and in mE per 100 gr clay + humus (as clay) respectively. The sum of the mE of exchangeable CaO + MgO + K_2O + Na_2O gives the S value, which is therefore expressed per 100 gr dry soil and per 100 gr clay + humus (as clay) respectively. The base binding capacity of the humus substance was assumed to be 4.545 times larger than that of the clay substance (fraction I + II). The 3.2 gr humus of sample No. II therefore has a base binding capacity equal to 3.2 × 4.545 = 14.6 gr clay substance (fraction I + II); for the clay + humus of sample II the base binding capacity is equivalent to that of 65,8 clay substance + 14.6 clay substance = 80.4 clay substance (fraction I + II) (9).

This conversion is only approximately correct, and it will be advisable not to apply it to soils with too much humus; it would, for instance, be better not to take into account sample No. VII, with 11.8 % of humus.

The second part of Table III contains the relative proportion of the exchangeable bases to S = 100. Then follow the values T—S and T, expressed in mE per 100 gr soil and per 100 gr clay + humus (calculated as clay). Finally comes the value V (= 100 S : T).

Value T. The calculation of the value T per 100 gr clay substance (+ humus) therefore gives the total base binding capacity of 100 gr clay substance (fraction I + II) in the 6 mineral soils (samples I—VI). If this 100 gr clay substance (fraction I + II) in all the 6 mineral soils possessed the same total base binding capacity, the values T would be equal. They are, however, not so; these values range from 139.5 to 43.2. It is worth while trying to determine the cause of these very great differences. It is not very likely that these are to be ascribed to inaccuracies in the small correction for the humus contents. It should much rather be sought for in what I have called the clay substance (fraction I + II), that is, in differences in the mineral soil complex. As far as the available data are concerned, these differences are only manifested in the proportion figures of fraction I and fraction II (see table I, column 9). It is perhaps still clearer to indicate how much per cent fraction I is of the clay substance (fration I + II); that is: 88—72—67—85—76—33 for the six mineral soils respectively.

In table III (second part) an attempt has been made to split up the total T values in 100 gr dry soil (106,5 — 66.8 — etc.) into the T values for the humus substance, for fraction I and for fraction II. The data for this splitting up are, however, taken from investigations of Dutch soils, and even for these soils they are only comparatively accurate. They were calculated in the following way.

According to an investigation of a large number of Dutch soils of various types, an average of 519 mE of bases are bound by 100 gr humus, with a total saturation (T), or 1 mE base by 193 mg humus (10). Sample No. I contains 0.7 gr humus per 100 gr dry soil, which therefore bind 700 : 193 = 3.6 mE bases when totally saturated. For the other mineral soils this is 16.6 — 26.4 — 14.0 — 5.2 — 6.7.

For the clay fraction II (particles from 0.002—0.016 mM diameter) the base binding capacity per 100 gr fraction II with total saturation (T) is assumed to be 14 mE (11). The sand fraction (particles greater than 16 μ) also possesses the power of binding bases (see same paper), but the figures concerned are too divergent to admit of an average

Table

Exchangeable bases (S-value); total base binding

No. S.S.S.	pH in aqueous suspension		gr clay-substance + humus (calculated as clay) per 100 gr oven-dried soil (105° C)	excheangeable bases per 100 gr oven-dried soil (105° C)								
				in grammes				in milligrammequivalents				
	quin-hy-dron electr.	glass-electr.		CaO	MgO	K_2O	Na_2O	CaO	MgO	K_2O	Na_2O	Som = S
I	8.9	8.6	76.3	1.248	0.159	0.073	0.137	44.6	7.9	1.6	4.4	58.5
II	7.8	7.5	80.4	0.742	0.056	0.057	0.010	26.5	2.8	1.2	0.3	30.8
III	5.4	5.2	93.7	0.452	0.124	0.038	0.009	16.1	6.2	0.8	0.3	23.4
IV	8.3	8.1	32.6	0.451	0.105	0.030	0.009	16.1	5.2	0.6	0.3	22.2
V	7.9	7.5	61.9	0.274	0.182	0.046	0.039	9.8	9.1	1.0	1.3	21.2
VI	5.5	4.9	46.4	0.026	0.012	0.002	0.014	0.9	0.6	0.1	0.5	2.1
VII	6.3	6.4	124.9	1.376	0.164	0.035	0.007	49.1	8.2	0.7	0.2	58.2

No. S.S.S.	relative proportion of exchangeable bases per 100 mE bases are present mE				mE per 100 gr oven-dried soil (105° C)		mE per 100 gr clay + humus (calculated as clay)		V = 100 S / T
	CaO	MgO	K_2O	Na_2O	T—S	T	T—S	T	
I . . .	76.2	13.6	2.6	7.6	48.0	106.5	62.9	139.5	55
II . . .	86.1	8.9	4.0	1.0	36.0	66.8	44.8	83.1	46
III . . .	68.8	26.4	3.6	1.2	48.5	71.9	51.8	76.8	33
IV . . .	72.3	23.5	2.9	1.3	21.5	43.7	66.0	134.4	51
V . . .	46.3	43.1	4.7	5.9	34.5	55.7	55.7	89.8	38
VI . . .	—	—	—	—	18.0	20.1	38.8	43.2	10
VII . . .	84.4	13.9	1.3	0.4	63.5	121.7	50.8	97.5	48

being calculated for the sand fraction. Moreover the share which this fraction has in the total base-binding capacity of the soil is only a very slight one. For these reasons the sand fraction is here left out of account. Sample No. 1 contains 8.8 gr of fraction II per 100 gr dry soil, to which with total saturation (T) $0.14 \times 8.8 = 1.2$ mE bases are bound. For the remaining samples this is 2.6 — 3.3 — 0.4 — 1.9 — 3.8. For fraction I there then remains: 101.7 — 47.6 — 42.2 — 29.3 — 48.6 — 9.6.

In the last column but one of table III the T value of the mineral particles (Fraction I + II = a) is calculated per 100 gr fraction I + II. There is a striking connection between these latter T values (141 — 76 — 65 — 146 — 88 — 33) and the ratios of fraction I to fraction II, resp.

III

Capacity (T-value); degree of saturation (V-value)

exchangeable bases per 100 gr clay + humus (calculated as clay)								
in grammes				in milligrammequivalents				
CaO	MgO	K_2O	Na_2O	CaO	MgO	K_2O	Na_2O	Som = S
1.636	0.208	0.096	0.180	58.4	10.4	2.0	5.8	76.6
0.923	0.069	0.071	0.012	33.0	3.4	1.5	0.4	38.3
0.482	0.132	0.041	0.010	17.2	6.6	0.9	0.3	25.0
1.384	0.322	0.092	0.028	49.4	16.1	2.0	0.9	68.4
0.443	0.294	0.074	0.063	15.8	14.7	1.6	2.0	34.1
0.056	0.026	0.004	0.030	2.0	1.3	0.1	1.0	4.4
1.102	0.131	0.028	0.006	39.4	6.5	0.6	0.2	46.7

mE per 100 g oven-dried soil (105° C)				T-value of fraction	
adsorbed at total saturation (T) in				I + II (= a) calculated per 100 gr fraction I+II	I (= b) calculated per 100 gr fraction I
the humus	in fraction I + II (= a)	in fraction II	in fraction I = b		
3.6	102.9	1.2	101.7	141	158
16.6	50.2	2.6	47.6	76	100
26.4	45.5	3.3	42.2	65	90
14.0	29.7	0.4	29.3	146	170
5.2	50.5	1.9	48.6	88	112
6.7	13.4	3.8	9.6	33	72
61.1	60.6	3.4	57.2	85	121

the percentages of fraction I of the clay substance (fraction I + II), as is shown by the following.

As the percentage of fraction I increases the T value of the mineral particles (calculated per 100 gr fraction I + II) rises. This must obviously be the case. The T value depends, at least partly, on the base binding surface of the soil particles and this base binding surface occurs, at any rate for the greater part, in the finer particles of fraction I. The differences in the T values, for instance of samples No. I (141) and No. II (76) are, however, too great, to be ascribed only to the differences in the percentages of fraction I of the clay substance (fraction I + II), viz. 88 and 72. Now the data of table III permit us to calculate the T

Sample	I	IV	V	II	III	VI
ratios fraction I : fraction II	0.14	0.18	0.32	0.39	0.50	2.0
fraction I as percentage of fraction I + II	88	85	76	72	67	33
T value (of fraction I + II) per 100 gr fraction I + II	141	146	88	76	65	33
T value (of fraction I per 100 gr fraction I	158	170	112	100	90	72

values of fraction I per 100 gr fraction I (see table III, last column), which are 158—100—90—170—112—72. From these latter data follows that the base binding capacity of 100 gr fraction I of samples I (158) and IV (170) is a good deal larger than that of 100 gr of fraction I of samples V (112), II (100) and III (90) and of sample VI (72). Not only therefore do samples I and IV contain more fraction I per 100 gr clay substance, but this fraction also has a larger base binding capacity. This latter value finds its expression in the T values of fraction I calculated per 100 gr fraction I (158—100—etc.) (12).

The six mineral soil samples can be assembled into three groups, namely:

Sample	I and IV	V, II, III	VI
ratio fraction I : fraction II	0.16	0.40	2.0
fraction I on % Fraction I + II	86	72	33
T value (fraction I + II) per fraction I + II	144	76	33
T value (fraction I) per fraction I	164	101	72

It follows from the above that the total base binding capacity (T value) of the mineral soil complex neither calculated per 100 gr clay substance (fraction I + II), nor per 100 gr fraction I, has a general significance. For Dutch soils, which — as far as our investigations show — have a fairly regular composition of the mineral soil complex, both as regards the mechanical and the chemical composition, this is approxi-

mately the case, but thisholds good both for a calculation per fraction I + II and per fraction I. For practical reasons a calculation per fraction I + II was chosen; for soils with fairly high percentages of fraction II (about 60 to 50% of fraction I + II), as S S S VI, this seems to me more correct even on principle.

Value S. The S values per 100 gr dry soil are between 58.5 and 2.1. These S values depend on the composition of the base adsorbing soil complex and on the degree of saturation of this complex with bases. Table III (first part, last half) contains the calculation of the contents of exchangeable bases and of the S values on clay (+ humus). The same objections hold good with regard to the S values per 100 gr clay (+ humus) as against the T values per 100 gr clay (+ humus). The influence of the degree of saturation on the S value is best seen from the S values of the two Dutch clay soils, which are of the same type. The young soil No. II (pH = 7.5), which is well saturated with bases and contains $CaCO_3$, has an S value (per 100 gr clay) of 38.3, which is about the normal value for Dutch soils of this type; soil No. III (pH = 5.2), which already gives an acid reaction, has an S value = 25.0. Samples I and IV give the very high S values 76.6 and 68.4 (per 100 gr clay). These S values, which from the point of view of Dutch soils are high, can be partly explained by the fairly high pH values (8.6 and 8.1), which will doubtless be connected with the more or less arid climate; but the mechanical, and possibly also the chemical, composition of the mineral soil complex also no doubt play a part in this. Sample No. VI gives a fairly strong acid reaction (pH = 4.9) and has the extremely small S value of 4.4 per 100 gr clay. Such low S values do not occur in the Netherlands with soils with pH values of about 5; here, too, the mechanical composition of the mineral soil complex (high content of fraction II) probably plays a part.

Value V. The degree of saturation (value V) expresses the percentage of the bases which the soil can bind (T) which are present in exchangeable form (S). As far as I can judge at present, this V value is independent of the mechanical and chemical composition of the mineral adsorbing complex. The V values range between 55 and 10. For the Dutch clay soils (sample No. II), which are well saturated with bases, a V = 46 is a normal value; the other type (No. III) gives an acid reaction (pH = 5.2) and has a V = 33. According to Dutch ideas samples I and IV have fairly high V values (55 and 51); this will no doubt be connected with the more or less arid climate.

There must be a connection between the V values and the pH values. But the nature of the bases also has an effect on the pH;

if the adsorptively bound CaO is replaced by Na_2O, the pH rises. This means that also the relative proportions of the exchangeable bases (per 100) plays a role.

Relative proportion of the exchangeable bases. Only two samples (I and V) contain more than small amounts of exchangeable Na_2O (7.6 and 5.9). Samples III and IV, and especially V, further contain a good deal of MgO.

Relation between V and pH. This relation is shown by the following table:

No. SSS	VI	III	V	II	IV	I
pH	4.9	5.2	7.5	7.5	8.1	8.6
V	10	33	38	46	51	55

The high pH value of sample V (7.5), with a V value = 38, can be accounted for by the fairly high content of Na_2O (5.9).

d) Table IV. Potentiometric lime titration

The adsorption of lime by potentiometric lime titration was determined only in the case of the acid samples III, VI, and VII. In the first part of table IV, columns 2 to 6 inclusive contain particulars of the manner in which the investigation was carried out and of the pH values found on giving the successive doses of lime. With the aid of these pH values titration curves were plotted, the dose of lime being set out on the horizontal axis in mE CaO per 100 gr clay (+ humus). It was then determined where these titration curves and the pH lines 6.5 — 7.0 — 7.5 — 8.0 intersect. In the case of sample III this occurs with an adsorption of lime of 5.5 — 9.4 — 13.3 — 17.1 mE CaO per 100 gr clay (+ humus) respectively. These results are included in table IV, first part, columns 7 to 10 inclusive.

In the second part of table IV the S values in mE per 100 gr clay (+ humus) are first of all repeated. The next 4 columns contain the sum of these S values and the number of mE CaO which must be adsorbed to reach a pH value of 6.5 — 7.0 — 7.5 — 8.0 respectively (thus in the case of sample III, 25.0 + 5.5 = 30.5; 25.0 + 9.4 = 34.4; etc.). These figures therefore indicate new S values, which these soils would possess if their pH were 6.5 — 7.0 — 7.5 — 8.0 respectively. It should be remarked that these pH values were determined with a different ratio of soil to water (2.5 — 4.9 — 1.9 — gr soil with 20 cc H_2O) from that for the ordinary pH-determination (10 gr soil with 25 cc H_2O).

Table IV
Potentiometric lime titration

No. S.S.S.	gr air-dry soil used (= 2,25 gr clay + humus as clay)	cc lime solution (n = 0,0433) added	cc water added	column 3 expressed as mE CaO per 100 gr clay+humus (as clay)	pH (glass-electrode)	Lime adsorption, in mE per 100 gr clay + humus (as clay), to reach pH			
						6.5	7.0	7.5	8.0
		0	20.0	0	5.65				
		2.5	17.5	4.8	6.41				
III	2.519	5.0	15.0	9.6	7.02	5.5	9.4	13.3	17.1
		7.5	12.5	14.4	7.65				
		10.0	10.0	19.2	8.27				
		0	20.0	0	5.16				
		2.5	17.5	4.8	6.09				
VI	4.933	5.0	15.0	9.6	6.78	7.7	11.3	14.9	18.2
		7.5	12.5	14.4	7.41				
		10.0	10.0	19.2	8.16				
		0	20.0	0	6.71				
		1.0	19.0	1.9	7.00				
VII	1.962	2.0	18.0	3.8	7.33		1.9	4.7	7.2
		3.0	17.0	5.8	7.73				
		4.0	16.0	7.7	8.09				

No. S.S.S.	S in m.E. per 100 g clay + humus (as clay) (see Table III)	Sum of S and lime adsorption in m. E. per 100 gr clay+humus (as clay) to reach pH =				T in m. E. per 100 gr clay + humus (as clay) (see Table III)	V (= 100 S : T) with a pH =			
		6.5	7.0	7.5	8.0		6.5	7.0	7.5	8.0
III	25.0	30.5	34.4	38.3	42.1	76.8	40	45	50	55
VI	4.4	12.1	15.7	19.3	22.6	43.2	28	36	45	52
VII	46.7		48.6	51.4	53.9	97.5		50	53	55

This causes a certain difference in the pH values. The following remarks with respect to the new S values may also be made. Sample No. III, with a pH = 7.5, has an S value = 38.3 mE per 100 gr clay (+ humus), which happens to be exactly the same S value as is possessed by sample No. II, which is of the same type and itself has a pH = 7.5. The S values of No. VI and No. VII differ fairly considerably from those of

No. III with the same pH values. The composition of the clay and the humus fractions plays a role here.

With the aid of the T values it is possible to calculate the V values with the pH values 6.5 — 7.0 — 7.5 — 8.0. The S value of sample No. III, for instance, with pH = 7.5 is 30.5; the T value is 76.8; this gives V = 100 × 30.5 : 76.8 = 40 (see table IV, last columns). Since none of the three soils has more than a small amount of Na_2O, so that the nature of the bases has no influence, I had expected practically equal values here. In the pH region from 7.0 to 8.0 this is pretty well the case; the differences are not great. Sample No. III has a V = 50 with a pH = 7.5, whilst the same type No. II, which in itself has a pH = 7.5, shows a V value of 46. This comparatively slight difference may be caused by a difference in the method of pH determination. Sample No. VI, with a pH = 8.0, has practically the same V-value (52) as samples III and VII. With lower pH values the V-value of No. VI is lower, and this difference becomes larger according as the pH falls. The reason for this behaviour is unknown to me.

e) Table V. Nutrient Elements (N, P_2O_5, K_2O)

Nitrogen. The content of nitrogen is expressed in grammes per 100 gr dry soil and per 100 gr humus. In the Dutch clay soils, with a normal humus content (an average of about 6 gr humus per 100 gr clay = fraction I + II) from 5 to 7 gr nitrogen per 100 gr humus is found as a rule, so that the nitrogen content of the humus, 6.8 and 6.2 gr respectively, found in Nos. II and III, would be normal for Dutch soils. Not only is the tropical soil No. I absolutely poor in nitrogen (0.026 %), but the humus also is poor in this constituent (3.7). Sample No. VII, which is rich in humus, contains a high percentage of nitrogen per 100 gr soil (0,540 %), hut the nitrogen content of the humus (4,6) is smaller than that of Nos. II and III. In Dutch soils, however, with a similar humus content, the last mentioned value is also as a rule no higher.

Phosphoric acid. The contents of phosphoric acid were determined by dissolving in 12.5 per cent HNO_3, after igniting the soil (the so-called total P_2O_5) and in 1 per cent citric acid. From this the relative solubility of the P_2O_5 is calculated (for sample I, that is, 0.048 × 100 : 0.141 = 34.0). On these P_2O_5 values Lemmermann's well-known limit figures are based, by the aid of which conclusions can to a certain extent be drawn as to the P_2O_5 requirement of the soil. In connection with this it may be remarked that soil No. II will be able to yield a large agricultural crop for at least 200 years, without any phosphoric

Table V

Nutrient elements (N, P_2O_5, K_2O)

No. S.S.S.	gr per 100 gr — oven-dried soil (see Table I)			gr nitrogen (N) per 100 gr		gr P_2O_5 per 100 gr oven-dried soil soluble in		relative solubility of the P_2O_5	gr K_2O soluble in 5% HCl per 100 gr			gr K_2O soluble in 0,1 normal HCl per 100 gr		
	humus	fraction		oven-dried soil	humus	$12^1/_2$% HNO_3	1% citric acid		oven-dried soil	fraction		oven-dried soil	fraction	
		I + II	I							I + II	I		I + II	I
I. . .	0.7	73.1	64.3	0.026	3.7	0.141	0.048	34.0	0.47	0.64	0.73	0.048	0.066	0.075
II. . .	3.2	65.8	47.4	0.218	6.8	0.193	0.039	20.2	0.49	0.74	1.03	0.052	0.079	0.110
III. . .	5.1	70.5	47.1	0.314	6.2	0.192	0.027	14.1	0.46	0.65	0.98	0.030	0.043	0.064
IV. . .	2.7	20.3	17.2	0.123	4.6	0.045	0.013	28.9	0.37	1.82	2.15	0.014	0.069	0.081
V. . .	1.0	57.4	43.5	0.060	6.0	0.044	0.007	15.9	0.67	1.17	1.54	0.027	0.047	0.062
VI. . .	1.3	40.5	13.4	0.064	4.9	0.068	0.008	11.8	0.09	0.22	0.67	0.004	0.010	0.030
VII. . .	11.8	71.3	47.3	0.540	4.6	0.182	0.008	4.4	0.57	0.80	1.21	0.022	0.031	0.047

acid fertilization. It should, however, be pointed out that the crops on the plot in question can draw their nutriment from a layer of at least 1 metre thick. The plot of sample No. III already receives from time to time a P_2O_5 manuring. Samples I, IV, V, and VI are poorer in total P_2O_5 than the two Dutch soils, and this is especially the case with the soils from Australia and with the Russian Podsol. In No. I the solubility in citric acid, and therefore also the relative solubility of the phosphoric acid, is high; in Nos. V and VI these values are low. Sample No. VII is fairly rich in total P_2O_5, but poor in P_2O_5 soluble in citric acid, so that the relative solubility is extremely low (only 4.4). According to Lemmermann's ideas, soils III to VII inclusive must, for normal agriculture, require phosphoric acid.

Potassium. Two potassium contents were determined, viz. soluble in 5 per cent hydrochloric acid at boiling point and in 0.1 normal hydrochloric acid at room temperature. By the former method only part of the potassium dissolves out of the weathering silicate; when boiled with 25 % hydrochloric acid a good deal more potassium is dissolved. The contents of potassium determined by both methods are expressed in gr per 100 gr dry soil, per 100 gr clay (particles smaller than 16 micra) and per 100 gr fraction I (particles smaller than 2 micra). From these figures — in as far as the potassium soluble in 5 % hydrochloric acid is concerned — it can be concluded that sample No. VI is poor in potassium. Calculated as percentages of fraction I, the difference from the other samples, however, is not so large. The potassium figures (5 % HCl), calculated per 100 gr clay (fraction I + II) and per 100 gr fraction I, of No. IV and V are very high (2.15 and 1.54). The content of potassium soluble in 5 % hydrochloric acid is determined in order to obtain a general impression as to the content of potassium; conclusions with regard to the potassium requirement of the soil are not, however, drawn from these figures. Advice as to fertilization is based by the Bedrijfslaboratorium voor Grondonderzoek, Groningen, on the content of potassium soluble in 0.1 normal hydrochloric acid. Definite norms for this have, however, not been fixed.

The Hague (Holland), November-December 1939.

Notes

1. Spithost, C.: Verhandl. d. II. Komm. d. Intern. Bodenkdl. Gesellschaft, Teil A, 113, Kopenhagen 1933.
2. Washington, Conclusions of the 1st. Commission, Method A, Proceedings Intern. Soc. Soil Science IV, 216—218, 1929.
3. Hooghoudt, S. B.: Trans. 1st. Comm. Intern. Soc. Soil Science, entitled "Physique du Sol", 213, Versailles 1934.
4. Intern. Mitteil. f. Bodenkde., V, 1, 1915.
5. Internat. Mitteil. f. Bodenkde., XII, 104, 1922.
6. Bepaling van het uitwisselbare magnesium, kalium en natrium in den grond volgens nieuw toegepaste analyse-methoden, door Dr. Jac. van der Spek en M. Dekker, Verslagen Landb. Onderzoekingen, No. 44 (13) B.
7. See my paper in the Transactions of the First Commission of the Int. Soc. of Soil Science, Bangor, Vol. A, 1938, p. 7—13 (see § 4, p. 11—12).
8. Because of the negative adsorption less Cl is found by greater dilution (0,073 gr Cl by a concentration of 1200 cc H_2O per 100 gr soil against 0,079 gr Cl by a concentration of 34,2 cc H_2O per 100 gr soil). For SO_3 was, however, found 0,142 against 0,116. This latter figure cannot be correct. Probably not all the SO_3 ($CaSO_4$, $MgSO_4$) has gone into solution by the concentration of 34,2 cc H_2O per 100 gr soil.
9. See further my paper in Soil Research, Volume I (1928), No. 1, p. 33—34.
10. Soil Research, Volume I (1928), No. 1. The figure (170) given on p. 25—26 is not calculated correctly, viz. without taking the adsorption of the clay substance into account; the correct figure is 193 (100000 : 193 = 519).
11. This figure is taken from table IV, p. 50—51 of Soil Research Volume V (1936), No. 1: Der mineralische Bodenkomplex.
12. It would be interesting to know the reason of the differences in the base binding capacity (T values) of fraction I per 100 gr fraction I. Is this only a question of the base binding surface, or do the chemical and mineralogical composition of this surface play a role also? For this reason it would be instructive to determine the surface of the particles of fraction I of the six soil samples. If the soil particles were massive spheres, it would be possible to estimate this surface accurately. The soil particles are, however, of more or less fantastic shapes, and presumably also have hollows and cracks and fissures, so that the surface can be determined only approximately. For a few Dutch soils we have tried to do this; see Soil Research, Volume V (1936), p. 30—32. Furthermore Dr. S.B. Hooghoudt, Verslagen van Landbouwk. Onderzoekingen, No. 41, B, (1935), p. 589—615.

The Zagreb film-lacquer method of taking pedological soil profile samples

by

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Introduction

After the investigations of the Russian and American pedological schools have reliably proved that soils are neither mere heaps of materials accumulated without any law and order nor only mixtures of solid, liquid, and gaseous particles, but individual evolutionised natural bodies „sui generis" with definite characteristic features and qualities, the pedological investigators have given their full attention to the examining of all sections and layers of the pedosphere and its natural units — the soils. Soils as all the other natural bodies live their own "life", and under the influence of vital factors gain typical qualities which reflect not so much on their outer as on their inner surface profiles. To understand the origin and development of soils it is not sufficient to known their surface layer only, but also the whole profile and each of its horizons. This knowledge brought about the development of pedophysiography, the science which examines the main natural features of soil, and pedophysionomy which endeavours to detect the laws of origin and development of such features by the study of them. These sciences are a great help to dynamic, systematic and historical pedology while they have most of all contributed to the consideration that the pedosphere is the natural evolutionised sphere of the earth's crust and also to the discovery of the fundamental laws of life and development of soils. Modern pedology pays therefore greatest attention to the physiography and physionomy of soils. On the soil profile can be noticed many signs which are characteristic and which indicate the processes of their genesis and development. In the same way as the main phases of material and physical life can be guessed from the faces of mankind so the main phases of development of soil can be detected by its physiographical signs. The importance of the pedological profile studies was the reason that the pedologists have for a long time tried to find a convenient method of making monoliths and of taking soil profile samples which would enable us to study the physiographical signs of the main soil types in laboratories, museums and elsewhere on any occasion and

at any time. Good profile samples of typical soils are of extraordinary didactic and scientific value. At the International Conference of the Commission for Cartography of Soils (International Society of Soil Science) in 1937 in Vienna the importance of making monoliths of typical soils for the international pedological cooperation was especially emphasized. The President of the Conference Dr. Till even made a proposal to entrust Dr. Pinkert — who has his own method of conserving soil profile samples — to prepair a greater number of typical monoliths from different countries for Pedological Institutes especially interested. Inspired by this proposal of Prof. Till we endeavoured to find some method of taking soil profile samples to obtain perfectly true soil profile, which would at the same time avoid the imperfections of other methods besides being cheaper than the method of Voigt. It was possible to elaborate such a procedure and we make it known here in order that also others interested in pedological profile samples may make use of it. This method will prove useful also for geological stratigraphists because by this method geological profile samples can also be easily taken if the supstrat is loose or if the stone on the surface is destroyed.

A short survey of existing methods

Before it was recognised in Western Europe that the soil is a natural-evolutionised body, some other pedologists had already found that it was necessary to take soil samples in their natural state both for physical and chemical analysis (Kopecky, Ismailovski and others). And so the first socalled monolith-method of taking soil samples was invented. It consisted of cutting out a cylinder or prism of soil in its natural state. The soil-cylinder was usually only taken from the parts of certain horizons, whereas the soil-prism was taken out of the whole or the greater part of the soil profile: the first was mostly used for the study of the physical properties of the soil, the second for the study of the physiography and physionomy of the whole profile. The methods of taking bigger monoliths have been, and still are, different in different institutes. In Russia for a long time Rispoloženski's aparatus was used. A tin box (60 × 20 × 4—5 cm) with sharp edges was thrust into the ground and so a natural monolith was cut out. The use of Rispoloženski's method was limited, because it could be only applied on soils without stones. Therefore the method of taking monoliths in wooden boxes has been later more often applied. On the soil profile a monolith of the size of the box is cut out, the frame of the box is then drawn over the monolith. The dimensions of the boxes for the monoliths are not everywhere the same. Glinka uses cases of the size of 75—100 × 18 × 5

to 10 cm, Miklaszewski 120 × 20 × 10 cm etc. The deficiencies of the monolith method were very soon perceived. The monoliths are very heavy what considerably complicates the transport on the terrain and also in the laboratory when they are used for didactic and other purposes. Therefore the pedologists endeavoured to find a convenient method of taking thinner monoliths which could be more easily transported and the soil structure at the same time would be sufficiently preserved. New difficulties arose again, because the thin monoliths broke easily and therefore cannot be cut out in the usual way especially in the case of light soils.

Some authors recommended the taking of thick monoliths on the terrain out of which should be elaborated thin monoliths in the laboratory. So Vilenski in 1927 announced his laboratory method of making thin monoliths. A thin layer of the primary monolith is strengthened with cement for instance, and then a second monolith 1.2—1.5 cm thick is cut out. Such a monolith weighs about 2 kg, whereas the primary monolith sometimes attains a weight of more than 25 kg.

In the Geological Institute in Budapest a similar procedure according to Spirhanzl is used, with the exception that the primary monolith is consolidated by gelatine and then cut into thin layers, which are fastened to a firm backing material. There is no doubt that through the cutting of the monolith the structure of the soil is damaged very much and so the monoliths made by this method do not look natural, much in the same way as the monoliths made by the old monolith method. This is very well seen in the collection of soil monoliths which are exhibited in the Agricultural Museum in Budapest. By Pinkert's Budapest-method which is not as yet published — as far as we know — secondary monoliths scarecely 6 mm thick are obtained, but their facies are not quite natural.

The "Klebeplatten-monolith"-method according to Schlacht

In the year 1929 Schlacht tried to replace the monolith method with the method of taking soil profile samples. On an ideally smoothed profile — wall Schlacht presses a cardboard or board coated with a special glue ("Monolith Leim" of the I. G. Farbenindustrie). When the glue is dried a thin profile sample sticks to the board.

The insufficiencies of Schlacht's method are manyfold: it cannot be used for heavy soils with strong coherency but mainly for light soils. A special instrument for pressing the board or card-board on the profile is required, which renders the transport on the terrain more difficult,

and then it cannot be used for open profiles on the roadside or the like without a background, but only in pits.

In spite of these insufficiencies this method has its value in the solution of the problem of taking profile samples, because it showed the way to further investigations and progress.

On the same principle Bushnell has worked out his method of taking soil profile samples, with the difference that he uses "pad-glue", and instead of card-board or a board he uses cloth coated with "pad-glue". It is presumed that the glue hardens quickly, but the binding of the soil is evidently not strong enough, as the profile sample must be cut and not merely taken by lifting the cloth.

Voigt's method of obtaining "Lackfilmprofils"

Dr. E. Voigt's method of the Geological Institute in Halle on the Saal is based on an entirely new principle. It was originally elaborated for the needs of Paleontology and used for the first time for excavations in the eocene brown coal in Geiseltal. Later the method was recommended to be used in Pedology.

The principle, advantage and defficiencies of Voigt's method

Voigt makes the surface of the profile stronger with a diluted kolodion varnish, then coats it with the so-called "Geiseltal-Sprimoloid" — lacquer which is elastic when dry like a film. When the lacquer gets dry, Voigt takes it off the profile and together with it a thin layer of a few mm of the soil sticking to the lacquer. Voigt calls such a profile sample "Lackfilmprofil".

By Voigt's method we can very easily obtain true profile samples of every soil, both on the terrain as well as in the laboratory.

According to the statement of the author the drying of the lacquer takes several hours if the weather is fine. The slow drying was not a handicap to the work for which this method was planned, because the investigations were carried on for a long time at the same place. But in the pedological investigations, the time spent in one place being much shorter, the slow drying is a great hindrance to the method.

The practical value of Voigt's method is further much lessened because of the fact that the lacquer which is needed is very expensive and can be obtained only from the factory of Springer and Moeller in Leipzig.

According to Dr. Voigt's statements, for one profile sample of the dimensions of 1 × 0.25 m, about one kilogram of lacquer is needed; the price of one kilogram of this lacquer (without the tin can which

is charged seperately) is RM. 3.75 apart from cost of delivery. Furthermore kolodion varnish is needed for the impregnation which is also quite expensive.

The Zagreb film — Lacquer method of taking pedological soil profile samples

In our Institute an attempt was made to find a method of taking profile samples on Voigt's principle but with a cheaper glue. After attempts with different substances such as strong glue with glycerine, gelatine etc., it was stated that for the purpose a lacquer would be good produced by a kino-film be cleansed of its gelatine and dissolved in acetone. The lacquer obtained by the solution of the kino-film in acetone is not only cheaper than the lacquer which Voigt uses, but from 1 kg of it two or three profile samples of the size 1 × 0.25 m can usually be taken.

During the researches made in our Institute with the acetone-film-lacquer and with one sample of Sprimoloid lacquer that the Institute received from the factory was stated that there is no difference in the quality of the profile samples between our lacquer and the Sprimoloid lacquer, and further that our lacquer dries much sooner than the Sprimoloid lacquer.

To date in our Institute a long series of profile samples with acetone film lacquer has been made from soils very different in mechanical structure. These have been made both from Institute monoliths and fröm natural profiles on the terrain. According to the data gathered in two years work we are able to assert that the method absolutely answers the purpose.

It must be emphasized that the preliminary condition for a successful use of this method is the dryness of the profile. But this is also the condition in the case of the Sprimoloid-lacquer method, and which even Voigt himself especially emphasizes.

As the pedological investigations are more often made in summer in fine weather the earth is usually so dry that profile samples can easily be taken. In the case of the soil being wet it is necessary to take a monolith on the terrain and later, in the laboratory when it is dry, to take the profile sample with the film-lacquer.

The principle of the method

The dry and smoothed down profile is made coherent by thin film-lacquer and after the impregnation is dry, it is coated with thick film-lacquer. After drying a tough crust of the dried lacquer is left behind

on the profile. By taking away this crust we also take away from the profile a thin layer of soil (of a few mm thickness) which sticks to the crust.

A right impregnation of the profile is very important. At the impregnation diluted lacquer penetrates through the capillary and non-capillary pores among the aggregates of the soil and binds them firmly one to another. So in this way a soil layer is obtained on the surface of the profile in which the mechanical and structural elements are more firmly bound together than in the rest of the soil. The thick lacquer which firmly sticks to the surface of this layer hardened through the impregnation, and which also itself penetrates partly into the soil, makes after drying a very firm and flexible backing material. By taking off this crust of the soil profile the mechanical elements of the soil will part from each other at the points of least resistance, i. e. on the boundary between the lacquer impregnated and un-impregnated soil layer. The impregnated soil layer sticks to the elastic backing material and has on its surface the absolutely true natural colour and preserved structure that is unattainable when using other methods with the exception of Schlacht's.

The thickness of the profile sample depends on the depth to which the diluted lacquer penetrates.

With light (sands) and well structured soils (e. g. rendzina) the lacquer will at the impregnation penetrate very easily into the soil and the sample will be very thick (up to 2 cm), whereas with heavy soils the lacquer penetrates into the soil very slowly: the sample will be thin, sometimes a tenth of a millimetre only.

With light soils any possible moisture of the profile will not hinder, as the lacquer will penetrate through the non-capillaries into the surface-layer of the soil inspite of the presence of water in the capillaries; whereas the penetrating of the lacquer through very heavy soils will be impossible even if the ground is only a little moist because of the back of the non-capillaries and the presence of capillary water which the lacquer cannot press out.

Preparation of the film-lacquer

The film-lacquer can be obtained by dissolving the cinema-film (cleansed of its gelatine) in pure acetone (aceton purum). (Film companies sell old films at 17. — Dinars a kilogram.)

The film must be cut into small pieces, a few centimetres long, and thrown into a pot of hot water to which some potassium or sodium hydroxide (NaOH, KOH) has been added. The contents of the pot must

be well mixed. After one or two minutes the gelatine is already completely dissolved. The hot, quite black water, blackened by the dissolved gelatine, must be thrown out of the pot and the film washed several times with cold water. The absolutely clean film-strip must be spread out on a thin sheet of paper and dried in the air. The dried film must be kept in a place where there is no danger of it catching fire through carelessness.

Preparation of the dilute lacquer for the impregnation of the profile

40 gms of the clean film-strip is dissolved in one litre of pure acetone.

Preparation of the thick lacquer

140 gms of the clean film-strip is dissolved in one litre of pure acetone.

We dissolve the film by putting it slowly into the acetone and mixing. We leave the mixture for a time, mixing it only from time to time. The lacquer will be ready for use the next day. It is not good to throw the whole of the film into the acetone at once, as it sticks together and dissolves more slowly.

Equipment for the work on the terrain

For the work on the terrain we need:

For dilute lacquer: a flat tin of about 2 litre volume with a screw lid which closes hermetically.

For the thick lacquer: a square tin of the same size with a large opening and a lid which fits well.

A broad, soft painter's brush for painting the thick lacquer.

A small washing bottle with a volume of about 250 ccm and several small reserve glass tubes at hand. These reserve glass tubes are necessary because the small glass tube of the washing bottle often gets stopped up with some dirt from the lacquer. The opening of the tube should be about 1 mm in diametre. The washing bottle must have a small rubber baloon for pressing the air into it, because the lacquer cannot be sprayed over the profile by blowing.

Besides this we need: a pointed knife 20 cm long, a rag and some pure acetone which may be necessary for diluting the lacquer and washing the hands. We will take more or less lacquer according to the number of profile samples we wish to take. If a larger quantity of the lacquer is needed, it is better to take the thick lacquer in several small tins of 2 litre size each rather than a big one, because the thick lacquer dries very quickly and after opening and painting again and again the rest

of the lacquer would stiffen and also get dirty with the soil brought into the tin by the painting brush.

On an average for the work on the terrain we must reckon to use for two profile samples of 1 × 0.25 m size each 1 kg of the thick lacquer at the most. The same quantity of dilute lacquer is needed for the impregnation of the profile.

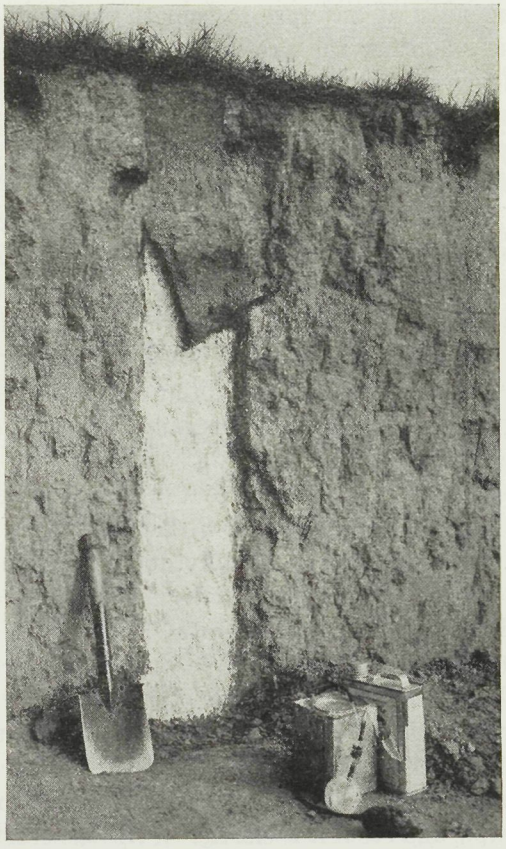
The process

It is recommended at any rate to smooth the profile before taking the sample. The smoother the profile the less lacquer we spend. To paint a quite uneven profile would mean to waste the expensive lacquer. Then we measure and mark the dimensions of the sample on the profile. If we wish the profile sample to be, say 1 × 0.20 m big when mounted on a board, we shall take a somewhat bigger profile sample on the terrain say 105 × 25 cm. First we soak the marked part of the profile from top to bottom with dilute lacquer. For light soils we use the dilute lacquer (which is prepared in the way mentioned above) whereas for heavy soils we dilute the lacquer in the washing bottle with acetone. The heavier the soil the more we must dilute the lacquer. A certain experience is necessary for this which one obtains quickly. As soon as the soil soaks is sufficiently soaked by the impregnation liquid and a little dried what happens in a quarter of an hour, we coat the profile again from top to bottom with the thick lacquer. The coat of thick lacquer dries quickly. After about twenty minutes the layer of lacquer which is already half dry gets milky white. This happens only on the terrain where the soil is always a little moist. At this stage of drying the surface of the lacquer moistens a little: the acetone evaporates and on the surface water remains the acetone has drawn out. We may wipe the surface with a rag to quicken the drying. We can further on hasten the drying by fanning with a rag or card board over the surface of the lacquer, but even without these helps the lacquer will dry in one hour at least if the weather is fine. To see whether the lacquer is dry we lift one corner of the crust of the profile sample and see if it is elastic. If the the crust is dry enough, it is absolutely resistent on stretching.

It is sufficient to paint the profile face with lacquer only once. The crust formed after the drying of the lacquer is so tough and firm that there is no need for it to be very thick. The places painted too thinnly with lacquer are easily visible because of their transparency and we re-paint them once more with a little lacquer.

If the soil is stony it is necessary to coat the profile face twice in order to prevent fracture of the profile sample when taking it off, for the weight of the soil or stones sticking to the lacquer.

The profile sample must be taken off from top to bottom. First we lift the edges of the dried lacquer a little. With the knife we must cut off every little root which is caught by the lacquer, otherwise these small roots would break the profile sample. (See plate which shows the taking off of a lacqeur profile sample from a podsolized soil.)



The taking of a profile sample of a Zagreb podsolic soil
by the Zagreb film-Lacquer method

The removed profile sample can be rolled up and thus transported. It must be rolled up with the side with the lacquer on the outside and the soil on the inside.

The mounting of the profile sample

We glue the profile sample to a board and then put it in a frame under glass.

The board which is somewhat smaller than the profile sample (we take the size 1 × 0.20 m as normal) must be coated with a corresponding glue quite thinly. The already mentioned "Monolith-Leim" of the "I. G. Farbenindustrie" is very good for this purpose, but also a mixture of yellow shellac and our lacquer for taking the profile samples, pure shellac, etc. can be used. The pure acetone-film lacquer is not good for this purpose, because it dries before the whole board is painted. The thinner and more delicate the profile sample is, the thinner we must paint the board with the glue. This fact is of considerable importance. The consumption of lacquer for glueing the profile sample to its backing material is slight. We spread the profile sample on the glue coated board putting the upper end of the profile sample that represents the surface of the soil exactly on the upper edge of the board. Below and on the sides the profile sample is wider than the board. The profile sample must be smoothed well, some sawdust, absolutely free of dust and fine sawdust (we may sift it through) is strewn over it and now another board is put on top of it in order to make absolutely equal pressure. The pressure can be pretty high, but not so high as to change the structure of the soil. When the glue has dried, we cut the edges of the profile sample that hang over the edges of the board with a sharp knife. At this point, if needed, improvements are made on the profile sample. First of all the profile sample must be cleaned of sawdust, what can be done only by blowing. We take away from the surface layer, in which part the profile sample is usually thicker, the superfluous soil in order to make the soil profile sample equally thick. We remove the structural aggregates of the soil by sticking a sharp and strong needle between the clefts and roll them off until the profile sample is equally thick in all its parts. It is by no means possible to do it with a knife, because we should damage the structure of the soil. If some stones stand out very much, we might shorten them by cutting them cautiously with tongs (if the stones are not too hard).

If there happen to be any holes in the profile sample, we glue these visible parts of the board with the glue used for glueing the profile sample and strew fine soil over it. We take the soil for such mending from the cut-off edges or from the soil aggregates broken off the profile sample. We must, of course, mend with soil from the same horizon.

After the soil sample profile is thus completed, we leave it in order to let the mended places dry and then we remove the soil which is loose and which would fall off after a time by blowing or shaking. It is not recommended to clean the profile sample with a painting brush, because thus the natural surface changes and often some parts of the profile sample after such a cleaning appear lighter.

The impregnation of the finished soil profile sample

In order to bind the possible loose aggregates of the soil in the profile sample and also to make the profile sample more resistant to influences from outside (such as moisture for instance) we impregnate it with diluted kolodion varnish. For this purpose we use a fine dissipator (sprayer) for lacquer. We dilute the lacquer with acetone in a ratio of about 1 : 5. We can impregnate only thicker profile samples of structural soils. Very thin profile samples, especially light non-structural soils or horizons, must be impregnated only a little and very carefully. It is best not to impregnate them at all. When impregnated there is always a danger for such profile samples to lose their delicate natural and dull surface and become somewhat darker in colour.

The completely finished and dry soil profile sample is framed and put under glass. As a rule such a profile sample is not much heavier than a framed painting of the profile sample in its natural size where a skilled hand has endeavoured to illustrate in the truest possible way the colour and structure of the profile in nature. It is now, however, an ideal copy of the picture that nature herself has made.

References

1. Bushnell, T. M.: The Purdue technique for taking and mounting monolithic soil profile samples. Soil Science, vol. XXIX, 1930, No. 5, p. 395.
2. Glinka, K.: Typen der Bodenbildung. Berlin 1914.
3. Schlacht, K.: Eine neue Methode zur Konservierung von Bodenprofilen. Zeitschr. f. Pflanzenernährung, Düngung u. Bodenkunde, A Bd. 13, 1929, p. 426.
4. Spirhanzl, J.: Die Bodenmonolithen. Stoklasa-Festschrift, Berlin 1928, p. 381.
5. Voigt, E.: Ein neues Verfahren zur Konservierung von Bodenprofilen. Zeitschr. f. Pflanzenernährung, Düngung u. Bodenkunde, Bd. 45, 1936, p. 111.

A contribution to the classification of skeletal soils

by

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Introduction

In the soil science the need is felt more and more of thoroughly elaborating in detail the different systems of classification of soils with the purpose to ascertain the proper place of each soil in the pedosphere. In Croatian soil science practice, however, the need is felt even more of elaborating a system of classification of the so called skeletal soils, as they occupy large areas of land in our country. Unfortunately in the soil science literature there is even no attempt of a detailed classification of skeletal soils.

On examining many of the soil science maps of different countries, we shall soon be convinced that for the greater part all the soils which contain a larger quantity of bound or free stones are considered to be skeletal soils. There is usually no detailed differentiation of skeletal soils although even every lay person will known that they can be very different. In Stremme's pedological map of Europe 1927 there a difference is made between skeletal soils and soils rich with skeleton, and they are further classified into skeletal-podzolic soils, skeletal-humous soils of the high lands, skeletal rendzinas etc. Such a classification hardly satisfies the needs of soil science cartography even in the case of maps on the small scale. For more detailed cartography it is not at all satisfactory. The insufficiency of the classification of skeletal soils practised up to date is also clearly seen from the fact that absolutely stony soils of the pastures on our northeast Croatian littoral islands as well as the stony diluvial sediments of some "karst" fields, and even very shallow soils of hilly terrains covered with forest or grass vegetation are qualified as skeletal soils. These differences which become striking even by merely observing the outer physiography of soils, must be made all the more conspicuous in soil science cartography. The work in connection with the pedological taking of maps of our "karst" areas induced me to try to elaborate a system of classification that would include all the skeletal soils. The results of our investigations of this problem are presented in this work.

The Problems and their Solution

The fundamental question is about the principle to be applied in the classification of skeletal soils: the dispersologic, morphologic, pedogenetic or any other. On examining the soil studies about skeletal soils, we shall see that different principles are often mixed up even in one and the same work, which confuses even the soil scientist and far more still the natural scientist to whom soil science is only an auxiliary subject.

Especially often are skeletal and litogenic soils identified, although wrongly as one and the same thing, for litogenic soils are not bound to be skeletal, and skeletal soils are not bound to be litogenic as we shall show later by giving an example. Just because of such different conceptions it is absolutely necessary that in this part of soil science also notions should get stabilised and a logical system of classification of skeletal soils elaborated.

I decided on the dispersologic principle, especially as the designation "skeletal" was primarily used in the soil science dispersology. According to the terminology of the known pedologist and kolloid-chemist G. Wiegner, soil is a poli-dispersic system in which all dispersions are represented from the coarse to the finest (molecular and ionic). From the pedo-dispersologic point of view all parts of the soil can be divided into two large groups: the "skeleton" and "fine earth", fine earth being a mass of soil built of particles smaller than 2 mm (equivalent radius), whereas the part of the soil that is built of particles bigger than 2 mm is referred to as skeleton.

According to the conclusion of the Commission for soil physic of the International Association of soil science (1913) the particles of the skeleton are divided into two groups:

1. particles of gravel, of the size of 0.2—2 cm (equivalent radius) and
2. paticles of stone, over 2 cm.

Although this classification does not agree with the petrographic or the geological conception, it is customary in soil science practice and also corresponds in general to the conception of the laymen.

A further classification of the skeletal particles has not yet been made, although it is highly necessary for the group of the pronounced skeletal soils. Therefore I have introduced the following classification of stone and gravel-particles.

1. Stone particles	coarse	> 20 cm
	middle-sized	5—20 cm
	fine	2—5 cm
2. Gravel particles	coarse	1—2 cm
	middle-sized	0,5—1 cm
	fine	0,2—0,5 cm.

Just in the same way as we classify the fine soils according to the degree of dispersion of their particles and also according to the quantitative ratio of these particles, into clays, loams and sands, we should also classify the skeletal soils into several groups on the basis of the quantitative relation of the skeletal particles. Let us first of all make sure of the most important notions.

As skeletal soils we shall consider all soils which contain more than 50% skeletal particles. All soils which contain less than 50% skeletal particles, we shall call skeletoidic in order to make clear the difference.

The skeleton built only of stone particles we call stony, and the one that is built of gravel particles, gravelly.

The stony part of the skeleton is further divided into the coarse-stony, middlesized-stony, and fine-stony skeleton according to the quantity of the particles.

Just in the same way the gravelly part of the skeleton is divided into coarse, middle-sized, and fine-gravelly.

The skeleton built of stone particles and gravel particles is called stony-gravelly or gravelly-stony according to whether it consists for the greater part of stone or gravel-particles.

The chief dispersive characteristic of the soil is indicated by putting the principal component first of all and the secondary less important component in the second and third places according to their significance.

Although it is not necessary to elaborate the classification of the skeletal soils in such details as is necessary with the classification of the fine soils, the need to define approximately the quantity of the soil in the skeleton is still felt. I introduce therefore these definitions:

a) Skeletal soils:

1. Absolutely skeletal soils, i. e. soils with more than 90% skeletal particles.
2. Intensely skeletal soils with 70—90% skeletal particles.
3. Skeletal soils with 50—70% skeletal particles.

b) Skeletoidic soils:

1. Intensely skeletoidic with 30—50 % of skeletal particles.
2. Skeletoidic with 10—30 % of skeletal particles.
3. Slightly skeletoidic with less than 10 % skeletal particles.

In accordance with the already emphasized principle in the classification of soils according to texture, the definitions of skeletal soils always come first of all, while the definitions of skeletoidic soils only in the second place.

Here an example.

The analysis has shown that the soil contains 78 % skeletal particles and 22 % fine soil, and that the skeleton is in its main part fine stony, whereas the fine earth consists of loamy sand. Such an intensely skeletal soil has following textural characteristic: intensely skeletal, fine stony soil with loamy sand.

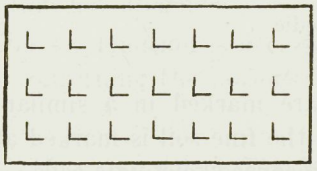
In the case when the relation between the skeleton and the fine soil is reversed we should define the soil as: a loamy sand, skeletoidic, fine stony.

The system of classification of soils presented here can be applied both when investigating the soil as a mass as well as when studying it as a natural evolutionised body, i. e. when investigating the whole of its profile. In the first case the classification is simple for it concerns only a certain quantity of the investigated soil. In the second case it is somewhat more difficult at the first glance, as it concerns the whole soil profile, the individual horizons of which are mostly not of the same mechanical composition. If, however, a whole profile is concerned, then the only right thing to do is to define the dispersive construction of each individual horizon and to elaborate the textural classification of the profile by making the textural classification of the individual horizons. Here an example: A typical humous-carbonatic soil with A_1, A_2, AC and C horizons is concerned. The A_1 horizon is only very slightly skeletoidic, while the A_2 is skeletoidic and the A_2C very intensely skeletoidic, and so is also the C horizon. We shall say that this rendzina is skeletoidic in its whole profile, but the skeletoidicity increases with the increasing depth of the profile. If the surface layer of this soil (A_1) would not be skeletoidic at all, we should say that the rendzina is skeletoidic only in the A_2-C part of the profile.

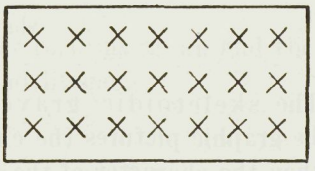
If we want to express the universal textural character of the whole active profile, we must consider the quantitative relation of the skeleton and the fine earth of the whole profile without respect to the horizons and with exception of the parent substrat.

The different skeletons and skeletoidic profiles can of course be very differently constructed and therefore we distinguish different varieties of these sorts of soils. It is apparently the most difficult case of classification if the dispersoidic composition of large areas of soils or whole geographical districts must be shown. However, here also as in other cases the dominancy of the principal kinds of soils in the different districts must be kept in sight. It is of course clear that the textural composition of the pedosphere as well as of its individual parts cannot be represented only by the textural composition of the surface layer, but by examining the composition of the whole of its active profile. Many skeletal and skeletoidic soils having a very similar outer physiognomy and morphology may at the same time have a fairly different mechanical composition of the profile. Undertaking soil cartography it is necessary to make numerous soundings or investigations of whole profiles.

For designation of the stone or gravel particles we use these signs:

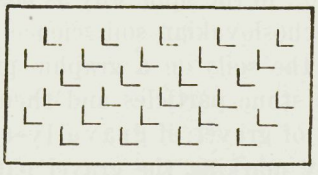


a) particles of stone

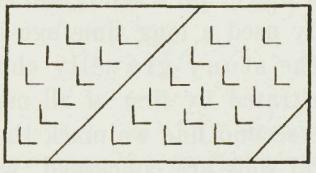


b) particles of gravel

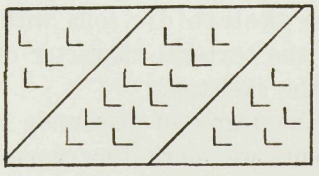
Skeletal soils-stony-are represented in this way for cartographing purposes:



apsolutely skeletal



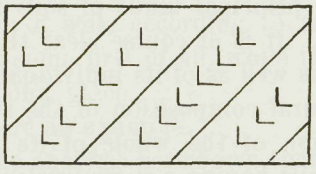
intensely skeletal



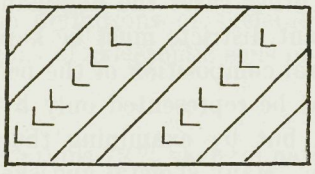
skeletal

Skeletal gravelly soils are represented in a similar way with the exception that instead of the signs for particles of stone, the signs for particles of gravel are marked.

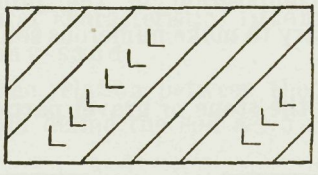
The skeletoidic stony soils are designated in the following way:



intensely skeletoidic



skeletoidic



slightly skeletoidic

The skeletoidic gravelly soils are marked in a similar way. On the graphic pictures the character of the fine soil is marked at first and then the character of the skeleton, because skeletoidic soils contain less than 50% skeletal particles.

In our graphic pictures the straight single lines (/) which we chose to represent the loam as explained in another of my studies. There will be two parallel lines (//) istead of one if the soil is clayey, and a dotted line (/) if a sandy soil is concerned, in the same way as has been already used a long time ago in the Czechoslovakian soil science.

The stony-gravelly character of the soils on a graphic picture is illustrated by first of all marking the stone particles and then only in the second line we mark the particles of gravel; if gravelly-stony skeletal soils are concerned, we begin by marking the gravel particles (the lines going from left to right).

In a similar way we mark the stony-gravelly or gravelly-stony character of the skeletoidic soils with the difference that in these we always mark the textural character of the fine soil first and then the character of the skeleton.

In order to make the degree of dispersion of the particles of stone and gravel more evident, we mark the coarse particles with thicker signs (LX), the middle-sized particles with signs of the thickness of

normal letters (|_X), and the fine particles of the skeleton with thin lines.

Finally let us turn our attention to the difference between the litogenic and skeletal as well as the skeletoidic soils. I have already emphasized that these soils are very often but wrongly identified: neither must all skeletal soils be litogenic, nor are all litogenic soils skeletal. The term "litogenic" is a pedo-genetic notion, that shows that the parental substrat has a dominating influence on the development of the type of soil. For instance rendzinas, mineralcarbonatic soils and others belong to the litogenic types, because the parent material is the chief pedogenetic factor, but again neither the rendzinas nor the mineral-carbonatic soils are bound to be skeletal. On the other hand we know of skeletal hydrogenic soils or podzolic soils on hard chalks, which are not litogenic, because the principal factor of their genesis and evolution is not the parent substrat. Such soils very often have qualities which are quite diverse to the qualities of the parent substrat from which they originated. — Many of the colluvial skeletal soils are very often not litogenic.

This explanation is necessary in order to bring to an end the confusion concerning the notions: skeletal and litogenic.

References

1. Schucht, F.: Bericht über die Sitzung der Internationalen Kommission für die mechanische und physikalische Bodenuntersuchung usw. Internat. Mitteilungen für Bodenkunde, 1914, H. 1, S. 30.
2. Gračanin, M.: Die Bodenklassifikation nach der Textur. Annales pro experimentis foresticis, 6, Zagreb 1938.

The cultivated moraine soils in Scania

(Die kultivierten Moränenböden Schonens)

by

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In Scania, the southern most province in Sweden, the most common cultivated soil types are moraine soils. But other geological soil types also occur. Here and there we have glacio-fluvial deposits and peats. In north-western Scania there appear fairly large districts with sea-clays. Moreover, rather extensive sea-sand deposits are to be found in several places. In this paper, however, I shall only give a short description of the various moraine soils with special reference to their geology, mechanical composition, most important physical and chemical properties, etc. Other factors affecting the growth of plants will also be discussed. All these factors result in rather great differences between the various moraines, as far as the fertility of the soils is concerned.

I. Geology

During the last Glacial Period of the Quaternary, we had four different continental glaciers in Scania, which more or less transgressed the province: the Old-Baltic glacier, the great North-East inland ice, the Middle-Baltic and the Low-Baltic glaciers. The supposition that these various ice-streams existed is based on observations of glacial striae and on studies of rock fragments, stones, gravel, etc., included in the deposits of the glaciers or the moraines. In both cases we thus obtain information of the direction of the glacial flow.

The directions of the various glacial striae and the rock fragments in the moraines have shown that in southern Scania the Baltic ice-streams advanced from the east to the west, from the Baltic Sea depression. The North-East ice, however, moved across Scania from the north-east to the south-west, fig. 1.

The stones or rock-fragments in the North-East moraine consist above all of rocks that make up the bedrock in north-eastern and central Scania, such as various kinds of gneiss, Cretaceous limestone with white-spotted flint from north-eastern Scania, Cambrian sandstone, Silurian shales, etc. In the Baltic moraines, on the other hand, there

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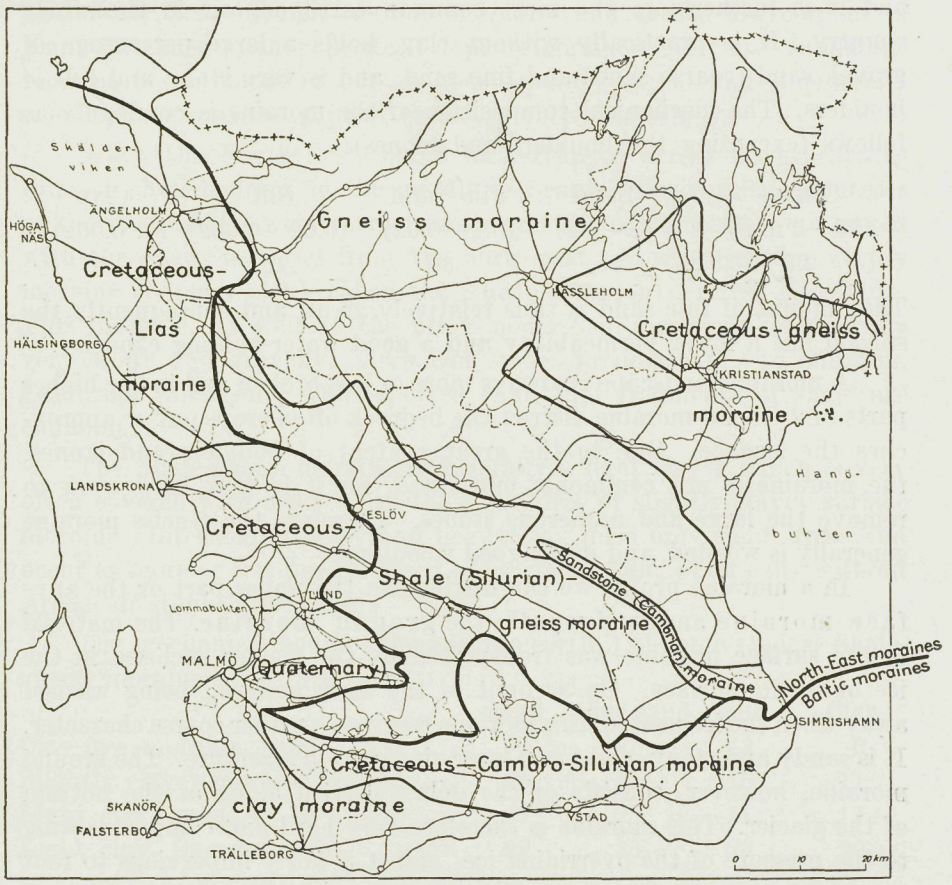

Fig. 1. The moraine regions of Scania.

are stones from the Baltic district. These Baltic stones consist of Cretaceous rocks with one-coloured flint, grey Baltic limestone, red Öland limestone, Archaean rocks from Åland, Baltic quartzporphyries, etc.

The deposits of the North-East glacier occupy north-eastern and central Scania. They may be divided into the following regions, all of which are generally well demarcated and characteristic, viz., the Gneiss moraine, the Cretaceous-gneiss moraine, the Sandstone (Cambrian) moraine and the Shale-(Silurian)-gneiss moraine. The names indicate what rocks make up the various moraines.

The Gneiss moraine, which is the largest of the Scanian moraines, consists exclusively of Archaean rocks, principally of gneiss. This moraine is indeed the most common moraine in the whole of Sweden,

and it is furthermore the most common earth deposit in the whole country. It is practically without clay, holds a large percentage of gravel, sand (coarse sand) and fine sand, and is very stony and full of boulders. The mechanical composition of the moraine is commonly as follows (excepting the boulders and stones):

Gravel	Sand	Fine sand	Silt	Clay
(20—2 mm)	(2—0.2)	(0.2—0.02)	(0.02—0.002)	(< 0.002)
25	25	30	15	5

The amount of fine sand is thus relatively great, and consequently the subsoil has a lower permeability and a good water-holding capacity.

A moraine landscape is always more or less broken and in the higher parts of a Gneiss-moraine district the bedrock often crops out or approaches the surface. Due to the great content of boulders and stones, the moraine is not commonly cultivated, for it is very hard work to remove the large and numerous stones. Therefore the Gneiss moraine generally is wooded, and it is a good woodland.

In a moraine profile we can distinguish the upper part or the surface moraine and, underneath, the ground moraine. The material in the surface moraine was transported by the glacier enclosed in the ice or on its surface. On account of the finer material being washed away when the ice melted, this moraine received a rather coarse character. It is sandy and stony, and has a loose single-grain structure. The ground moraine, however, consists of the débris carried along at the bottom of the glacier. This moraine is therefore very hard and compact, owing to the pressure of the overriding ice, and it is fairly impervious to root growth.

The thickness of the surface moraine varies considerably, from a few to seven decimetres. The value of the moraine from the point of view of cultivation is highly dependent on its thickness, for if the mellow surface-layer is shallow, the soil fertility will be lower. Here I must add that the loose structure also depends on the weathering, the work of frost, the roots of plants, etc. These latter factors seem, however, to be of a more subordinate importance.

In the district of the Cretaceous-gneiss moraine, the bedrock consists of cretaceous limestone. The moraine is here made up of gneiss and limestone. In solitary places a pure Limestone moraine may be found.

The Sandstone (Cambrian) moraine, as well as the Gneiss moraine, is poor in clay or it is almost entirely wanting. It is made up of the hard, quartzitic Cambrian sandstone. The moraine is extremely rich in boulders and stones. As, moreover, the hard sandstones weather

but slowly, have a high content of quartz and thus a low content of plant nutriments, they produce a poor moraine-type. The Sandstone moraine is cultivated to but an inconsiderable extent and is generally woodland or consists of poor, little vegetative moorfields.

When the North-East inland ice advanced across the calcareous Silurian shale-bedrock in the middle of Scania, considerable quantities of the loose shales were carried along and these fragments were mixed with the gneiss-material from the north-east. Now arose that clayey moraine (boulder clay), called the Shale (Silurian)-gneiss moraine. This moraine, as well as the other north-east moraines, is generally very stony and gravelly. Archaean stones predominate. In addition, Cambrian sandstone, white-spotted flint, and fragments of shale are common.

The Shale-gneiss moraine is generally a light clay[1]), which is very often covered with a 0.5—1 m thick clay-free or slightly clayey surface moraine. Intermediate clay and heavy clay form only small areas and occur as more or less pure crushed products of shale, practically without Archaean stone intermixture.

The mechanical compositions ("fine earth") of some typical Shale-gneiss moraine types are:

	Sand	Fine sand	Silt	Clay
Clay-free moraine, sandy	70	21	3	6
Slightly clayey moraine, sandy . .	36	35	18	11
Light clay, sandy	49	23	11	17
Light clay, fine sandy	22	35	23	20

The light clay moraine is of two different types: the sandy (coarse sandy) and the fine sandy moraine. The latter type with a high content of fine sand and silt arose out of fine sandy shales and only little clayey shales. It has a poor structure. When wet it is in the single grain state. After drying it is hard and compact and very little permeable to air

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[1]) According to the content of clay substance, we use, in Sweden, the following division of the humus-free mineral soils. The hygroscopicity according to Rodewald-Mitscherlich (W_h) is used as standard method (2, p. 97—99).

	W_h
Clay-free soils	< 2
Slightly clayey soils	2—3
Light clay	3—4
Intermediate clay	4—7
Heavy clay	7—10
Very heavy clay	> 10

and the roots of plants. These unfavourable circumstances are especially disadvantageous for the cultivation of sugar-beets.

When the North-East inland ice was melting and retreating from the middle of Scania, a Baltic glacier, the Middle-Baltic glacier, transgressed the southern part of the province. Now the Cretaceous-Cambro-Silurian moraine was formed. This moraine is a composition of various kinds of rock: Archaean rocks, Cambro-Silurian shales, limestones and sandstones, together with Cretaceous rocks. The amount of stones is small as compared with the north-east moraines. The ground moraine is a sandy and gravelly moraine-clay (light clay or intermediate clay). The surface moraine is lighter, a slightly clayey soil or light clay.

The moraines of western Scania, the Cretaceous-(Quaternary) clay moraine and the Cretaceous-Lias moraine, were formed by the Low-Baltic glacier, the last ice-stream of Scania. The Cretaceous-(Quaternary) clay moraine consists mainly of Cretaceous bedrock: chalk with flint and Cretaceous limestone. Embedded in the moraine there are often found even great boulders or floats of chalk. The stones are also mainly flint, the flint being one-coloured, black, grey, or yellow. The whitespotted flint is lacking.

The content of stone in the Cretaceous-clay moraine is low and far lower than in the Cretaceous-Cambro-Silurian moraine. Therefore the whole moraine area is cultivated, woods and moorfields are lacking, and, because of the want of large stones, no stone fences are to be found. The clay content in the moraine is almost always high and the moraine is generally an intermediate clay or heavy clay, this depending on the glacier having advanced across districts with heavy stone-free sea-clays, which thus were carried away by the ice and mixed with the other moraine material. The mechanical composition of the moraine is usually about as follows:

Boulder	Stone	Gravel	Sand	Fine sand	Silt	Clay
0.5	4	6	23	20	16	31

Upon the Baltic ice melting, a large part of the Cretaceous-clay moraine or its western districts on the coast lay below the surface of the ice-sea. The upper part of the moraine was now influenced by the waves and bottom-currents of the ice-sea. Here we therefore often find, above the heavy moraine-clay, a sediment that is a sandy and gravelly light clay with a thickness of about half a metre, a re-stratification of the moraine. This bed of light clay is certainly not found everywhere. It is at times lacking even within rather large districts. Fur-

thermore, the thickness of the layer varies and is frequently less than half a metre. As a general rule, however, this layer is typical of the districts under the uppermost limit of the ice-sea.

This light clay is generally a little more stony and gravelly than the moraine-clay. In certain spots the clay has, furthermore, been washed away by the waves of the sea. On these spots we therefore find a stony and gravelly sand, forming small ridges or very low hills, which were thrown up on shore by the waves.

Thanks to the occurrence of these sea-deposits the moraine below the level of the former ice-sea is more easily tilled and cultivated than above that limit. Because of the lighter nature of the deposit, the humus-containing surface soil has generally a greater thickness, 40—50 cm.

The Cretaceous-Lias moraine. When the Low-Baltic glacier advanced northwards across the north-western part of Scania, it crossed a country that was higher than the south-western part. The heavy sea-clays were probably lacking. The ground seems to have consisted of stony north-east moraines with, here and there, hills of Lias sandstone, etc. The Baltic moraine material transported by the ice was thus to a rather large extent diluted with north-east moraine and sandstone fragments. As a result, the northern part of the deposits of the Low-Baltic ice may be distinguished from the southern part. The Cretaceous-Lias moraine thus differs from the Cretaceous-clay moraine by its somewhat higher content of stone and a considerably lower percentage of clay. Among the stones, the Archaean are more common than the flints, besides which the moraine is more gravelly and sandy.

II. Climate

The predominant climatic factors are temperature, precipitation, and evaporation. The annual temperature is highest in the south-western part of Scania with about + 8° C, and lowest in the central and northern parts of the province, about + 7°. The greatest difference of temperature is only 1 or 2°.

The atmospheric precipitation, however, displays greater differences. The annual precipitation is lowest in the south-western part of the province (Falsterbo), about 400 mm, and highest in north-western Scania (Båstad), or 800 mm.

The relation between precipitation and temperature or the climatic humidity is of very great importance. The weathering and the effect of soil conditions are greatly dependent of this relation. A higher rainfall co-operating with a lower temperature, the latter retarding the evaporation, lead to considerable water movements downwards in the

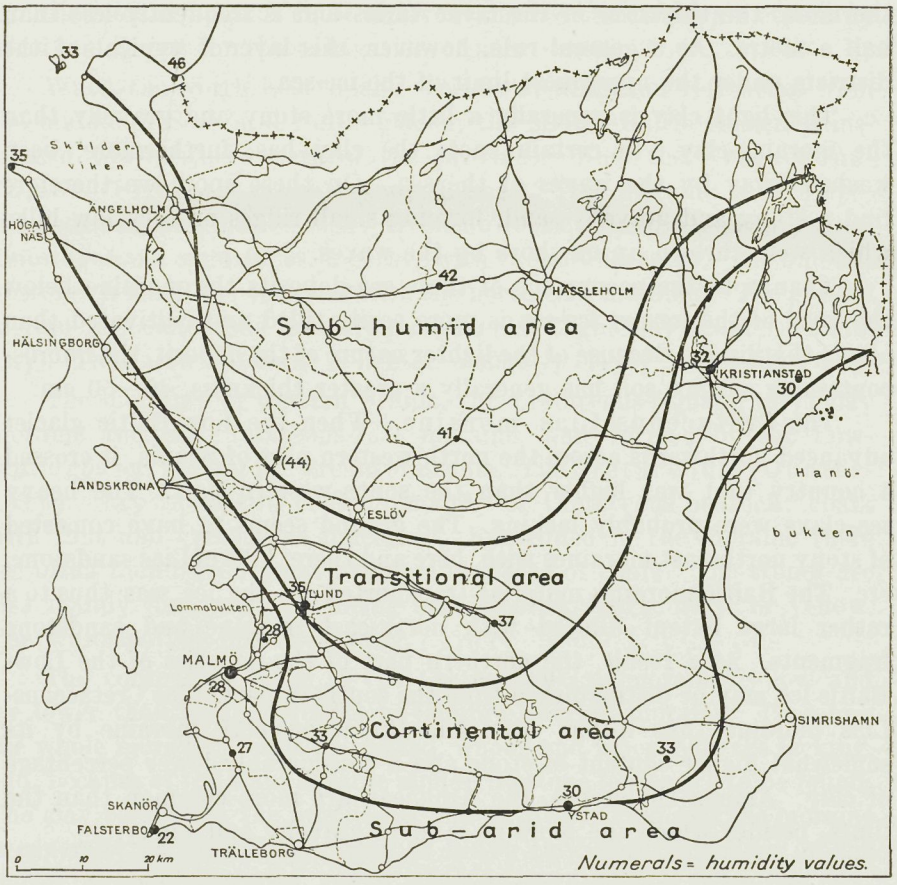

Fig. 2. Map of humidity, according to H. Hesselman 1932.

soil. In this way a more active impoverishment or eluviation originates in the upper soil levels.

A good method of assigning the climatic humidity is, according to the investigations of Hesselman (6), afforded by the so-called humidity value, which is $N : (T + 10)$, N being the annual precipitation and T the annual temperature. The humidity values, which appear from the humidity map of Sweden by Hesselman, show the lowest figures in the southern and the highest figures in the northern parts of Scania, fig. 2. The map also shows the different climatic areas into which Hesselman considers that the province may be divided with regard to temperature and humidity values, namely the sub-arid (the south-coast districts), the continental, the transitional, and the sub-humid (in northern Scania) areas.

Now what is the influence of temperature, precipitation, and humidity on the agriculture of the province? The south-western part, the Southern Plain (Söderslätt) enjoys the most favourable temperature conditions, better than some other parts of our country, and a precipitation that is lower than in other parts of the province. This results in a sunnier climate and a warmer, more forcing soil. The Plain of Lund has a somewhat lower temperature and a higher precipitation (about 600 mm), which means a cooler soil. The difference in climate between the Southern Plain and the Plain of Lund is illustrated by the humidity values, which are 25 and 35, resp. The Southern Plain belongs to the sub-arid area, whereas the Plain of Lund is part of the continental and transitional areas.

East of the Southern Plain, towards Ystad, climatic conditions are somewhat different. The climate becomes more humid, which leads to the cultivated area of pastures increasing while that of barley is reduced. This, however, must also be attributed partly to a change in soil conditions and topography.

The northern part of the province belongs to the sub-humid area. The higher humidity produces a larger area of peats, and in the mineral soils increased impoverishment in the upper soil layers. This latter, however, is also promoted by the lighter character of the soils and the poverty of lime. The content of humus in the surface soil is also rather high.

III. Soils

The soils are podsols and brown earths. According to the investigations of Hesselman and Tamm, the sub-arid area is distinguished by the occurrence of brown earth without or with only a low degree of podsolisation. Within the continental area brown earths are still characteristic, although indistinct podsolisation is not unknown. Within the transitional area podsols as well as brown earths occur, and the sub-humid area is distinguished by more strongly podsolised profiles but also by brown earth appearing locally. Certainly, geological factors, parent material, and topography are of local importance in addition to the climatic factors.

There are some local soil variations as regards the podsols that are of great importance from an agricultural point of view. These are the formation of pans ("ortstein"), iron pan and humus pan. In these podsol types the accumulation of sesquioxides (mainly hydrated ferric oxide) or humus is so great that coherent layers of stones have arisen in the B horizon of the pedosphere.

The iron pan is found in hillocks where the earth deposit is a clay-free moraine. It is fairly common in the central part of Scania. The pan reduces considerably the value of the cultivated soil, for it is impervious to root growth. It is furthermore proof of the fact that the upper soil levels have been exposed to fairly great impoverishment.

The humus pan is encountered in low sand areas where the surface soil has a high humus content. Owing to the presence of the dense and hard pan, the earth is here impervious to the movements of water and thus a cold soil, and as a rule it has a strongly acid reaction.

IV. Topography

Topography has great influence on the value of the cultivated soil. Level fields are better than hilly ones. In the hilly districts the soil is less uniform, the humus-containing surface layer is shallower on the hills than in the valleys, drainage conditions vary, the earth dries more or less quickly, the difference between a southern slope and a northern slope is considerable, water conditions vary, etc.

With regard to the topography of the country, great differences are displayed in the different parts of the province. The most level and flattest districts are found in those parts of Scania where the moraine is covered with sea-deposits, sediments of clay and sand, e. g. the Plain of Ängelholm. In the true moraine districts, however, the ground is more or less broken, undulating and rugged, on account of the inland ice not having unloaded its material uniformly. The Cretaceous-clay moraine, however, presents the flattest topographical conditions. This is particularly true of the Southern Plain, which is a level moraine-landscape with flat clay-fields. But also other parts of the Cretaceous-clay moraine and likewise of other Baltic moraines show level plains, as the Plain of Lund and the Plain of Landskrona.

The hilliest area in Southern Scania is the moraine district between Malmö and Ystad, which partly belongs to the Cretaceous-Cambro-Silurian moraine, partly to the Shale-gneiss moraine. It is a hilly and strongly undulating landscape of terminal moraines, sags and swells. The north-east moraines show throughout a broken surface but the landscape is not so hilly as in the terminal moraine district. The undulations are softer and greater, in other words the normal topography of a moraine landscape.

V. Calcium content and soil reaction

The Baltic moraines as well as the Shale-gneiss moraine and the Cretaceous-gneiss moraine no doubt had a high content of calcium

carbonate up to the surface, due to these moraines being composed of calcareous rocks. In the layers of the moraine that have not been exposed to weathering and leaching, the Cretaceous-clay moraine has, for instance, a content of calcium carbonate that is generally between 20—25 %, and the Shale-gneiss moraine 4—6 %. Ever since the end of the Glacial period or during the last about 17,000 years a continuous leaching of calcium has taken place, however, and now we find the calcareous moraine (the moraine marl) only at a certain depth below the surface. In the Cretaceous-clay moraine, the so-called lime-limit is generally found at a depth of 0.5—1.5 m, and in the Cretaceous-Cambro-Silurian moraine and the Shale-gneiss moraine 1 or 2 m below the surface. As a result of the leaching of calcium carbonate, we often find calcareous concretions at a depth of 1 to 1.5 m below the surface (established mainly in sea-clays).

In the Cretaceous-clay moraine area the soil reaction is neutral or alkaline with pH values generally between 6.5 and 7. 5. In the south-western part of the area the reaction is somewhat higher or pH 7—8. Other Baltic moraines also have a neutral or alkaline reaction, now and then faintly acid.

As regards the north-east moraines, the soils of Cretaceous-gneiss moraine are generally alkaline. The Shale-gneiss moraine is faintly acid to neutral. The Gneiss moraine and the Sandstone moraine, however, are made up of calcareous-poor rocks. The content of exchangeable bases is therefore rather low and the soil reaction is generally acid.

Upon comparing the soil reaction of the humus-containing surface soil and that of the underlying soil, we very often find that the former layer has a higher pH value than the latter. This is even found in the more calcareous districts as in the Southern Plain. The higher reaction in the surface layer depends on earlier marling or liming. In the latter part of the last century marling was extensively carried out. This is evident from the marl-pits frequently found in the calcareous earth deposits.

VI. Content of available plant nutrients

The results of field experiments carried out in the Baltic moraines with different kinds of fertilizer show that only a little or no fertilizing effect is obtained by using phosphate and potash fertilizers. Nitrogen fertilizers, on the other hand, give a very good effect. In the area of the north-east moraines the phosphate and potash requirements are generally higher than in the Baltic moraines. Here I shall only make

a comparison between two moraines with reference to their phosphate content.

According to a large number of phosphate investigations, carried out in the field as well as in laboratories, by various scientists, the Baltic moraines, above all the Cretaceous-clay moraine, have a comparatively high content of easily soluble phosphoric acid. This phosphate content is thus considerably higher in the Cretaceous-clay moraine (with generally 30—60 or more so-called phosphate degrees) than e. g. in the Shale-gneiss moraine (20—30 phosphate degrees), depending on the fact that the Cretaceous-clay moraine contains the more easily weathered, phosphorus-rich mineral phosphorite. This moraine is to a great extent made up of Cretaceous rocks and also of Cambrian and Ordovician rocks, which all have a high percentage of phosphorite. The Shale-gneiss moraine, however, is composed of Archaean rocks and Silurian shales, in which phosphorite never or rarely occurs.

VII. Soil fertility

The following data may be used as indicators of the fertility of the various soil types: the hectare yield of various cultivated plants; what plants may be thought of for cultivation; the area of arable land; the density of population of the countryside, and the values of assessment.

Ågren (8) has divided Scania into a number of different agricultural areas. The division was made on the basis of agricultural statistics and with reference to the distribution of the soil types according to the geological maps. Most of the figures (though rounded) in the following table have been taken from Ågren's paper.

The moraine regions are here, generally speaking, shown in the order of their fertility. When reading the table downwards, we thus find that as a rule the density of population, area of arable land, drained arable land, winter wheat, barley, and sugar-beets show decreasing values, whereas the figures for less pretentious plants, winter rye, oats, potatoes, and pastures, together with the figure for fallow, increase. The values of assessment, taken from the valuation list of the year 1932 and referring to properties of more than 100 hectares, give a good indicator of the fertility.

As a rule the Scanian farmers rate the Baltic moraines as first-class soil and the Shale-gneiss moraine as second-class soil. If we complete the classification, we may refer the Gneiss moraine and the Sandstone moraine to the third and the fourth classes, respectively. The Baltic moraines, i. e. the Cretaceous-clay moraine, the Cretaceous-

Moraine region	Density of population, square kms	Arable land in % of the total area	Drained arable land	Winter wheat	Winter rye	Barley	Oats	Potatoes	Sugar-beets	Pastures	Fallow	Value of assessment, Sw. Kronor
			% of the area of arable land									
Cretaceous-clay moraine												
The Southern Plain	58	90	86	13	4	18	4	2	14	12	1	2150
The Plains of Lund and Landskrona .	51	90	91	16	5	11	4	2	11	18	1	1900
Cretaceous-Cambro-Silurian moraine . . .	55	86	65	8	8	7	7	6	6	22	3	
Cretaceous-Lias moraine (including sea-clay deposits)	51	86	84	10	9	5	8	2	6	24	4	
Shale-gneiss moraine	40	72	67	4	11	5	7	6	2	27	5	1100
Gneiss moraine	20	26	34	—	11	2	23	7	—	29	3	700

Cambro-Silurian moraine, and the Cretaceous-Lias moraine, may be referred to the sub-classes 1 A, 1 B, and 1 C, respectively.

Summary

It may be said that the greatest differences in the natural fertility of the soils in Scania depend on geological factors: the parent rock, the process of the geological formation of the deposits, and the mechanical composition of these deposits. Thus it is the content of clay, stone, etc., together with the chemical nature of the rock material that determine the result. Climatic factors and topographical conditions also play an important part.

References.

1. Arrhenius, O.: Fosfathalten i skånska jordar. (Summary). — Sveriges geologiska undersökning, Ser. C, Nr. 383, 1934.
2. Ekström, G.: Agrogeologiska undersökningar vid Svalöv. (Zusammenfassung.) — Sveriges geologiska undersökning, Ser. C, Nr. 380, 1934.
3. Ekström, G.: Skånes moränområden. (Zusammenfassung.) — Svensk geografisk årsbok, Lund 1936.
4. Ekström, G.: Jordarterna i Malmöhus län. — Medd. från Malmöhus läns skogs- och betesvårdsförening, Nr. 8, Malmö 1936.
5. Ekström, G.: Klimat och jordmån i Malmöhus län. — Ibid., Nr. 1, 1937.
6. Hesselman, H.: Om klimatets humiditet i vårt land och dess inverkan på mark, vegetation och skog. (Zusammenfassung.) — Medd. fr. Statens skogsförsöksanstalt, H. 26, Nr. 4, Stockholm 1932.
7. Tamm, O.: Om brunjorden i Sverige. (Zusammenfassung.) — Svenska skogsvårdsfören. tidskrift, Stockholm 1930.
8. Ågren, G.: Skånes jordbruksområden. — Sydsvenska geografiska sällskapets årsbok, Lund 1926.
9. Ågren, G.: De naturliga förutsättningarna för Skånes jordbruk. — En bok om Skåne, Del II, Malmö 1937.

Prinzip einer neuen Temperaturmessung für ökologische oder bodenkundliche Untersuchungen

von

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A. Einleitung

Die Temperatur spielt für das Reaktionsgeschehen in der belebten und unbelebten Natur die Rolle eines Hauptfaktors. Sie bestimmt unter vergleichbaren Verhältnissen die Geschwindigkeit chemischer Reaktionsabläufe. Bei vorwiegend einseitig verlaufenden biologischen oder anorganischen Reaktionen bedingt sie weitgehend das quantitative Reaktionsausmaß.

Die Temperatur ist einer der wichtigsten Wachstumsfaktoren[1—6]). Die Assimilations- und Atmungsintensität grüner Pflanzen ist temperaturabhängig. Der Ernteertrag wird bei sonst gleichbleibenden Bedingungen vom Temperaturverlauf während der Vegetationszeit beeinflußt. Die mikrobielle Tätigkeit folgt bestimmten systembedingten Temperaturgesetzen. Die verschiedenen Pflanzengesellschaften stellen ihre eigenen Ansprüche an den Wärmehaushalt des Standortes.

Die Intensität J der Verwitterung anorganischer Bodenbildner oder der Humifizierungsvorgänge befolgt — genügend Wasser vorausgesetzt — das Gesetz $J = k \cdot T^n$. Die regionale Verteilung der Bodentypen hängt eng mit den Temperaturverhältnissen an der Erdoberfläche zusammen.

Mit der Feststellung der Temperatur und des Temperaturverlaufes über bestimmte Zeitperioden befassen sich neben den Klimatologen auch die Biologen und Bodenkundler. Es stehen ihnen hierfür eine große Zahl erprobter Methoden zur Verfügung.

a) Zur Bestimmung von Temperatur-Einzelwerten dienen beispielsweise Quecksilberthermometer, Thermoelemente oder elektrische Widerstandsthermometer in verschiedenen, den besonderen Meßzwecken angepaßten Ausführungen.

b) Die kontinuierliche Messung des Temperaturverlaufes über eine bestimmte Meßperiode wird mit automatisch aufzeichnenden

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[1—6]) Siehe Literaturverzeichnis.

Registrierinstrumenten ausgeführt. Dazu bewährten sich: Thermographen, Thermoelemente[4]) und Widerstandsthermometer mit galvanometrischer Punktaufzeichnung. Aus den selbsttätig aufgezeichneten Temperaturkurven können die arithmetischen Mitteltemperaturen über bestimmte Zeiten planimetrisch bestimmt werden.

c) Für die direkte Temperatur-Mittelwertmessung hat in neuerer Zeit E. Tamm[1,6]) (Berlin) die sog. Elektrolytzähler eingeführt. Neben dem Elektrolytzähler liegt im Stromkreis ein elektrisches Pt-Widerstandsthermometer, dessen Widerstand sich bei einer Temperaturerhöhung vergrößert. Die bei der Elektrolyse unter der konstanten Spannung von 4,00 Volt entwickelte Gasmenge (Volumen) steht über den erwähnten Widerstand des Pt-Widerstandthermometers mit der Temperatur des Meßortes im Zusammenhang. Aus der Höhe der im Elektrolytzähler zwischen zwei Ableseterminen abgeschiedenen Gassäule kann die Mitteltemperatur aus Eichtabellen direkt abgelesen werden.

Für Biologen und Bodenkundler haben Temperatur-Einzelwert-Messungen nach a) nur bedingten und orientierenden Wert. Sie sollten durch die kontinuierliche Feststellung des Temperaturverlaufes oder durch die Bestimmung der Mitteltemperaturen über gewisse Meßperioden vervollständigt werden. Die Temperatur-Einzelwert-Messung nimmt trotz einfacher Methodik relativ viel Zeit in Anspruch, sobald weit auseinander liegende und zahlreiche Meßorte kontrolliert werden müssen.

Die Temperaturmessung mit automatischen Registrierinstrumenten nach b) und c) besitzt große Vorteile. Die Temperaturen werden selbsttätig an den verschiedenen Meßorten über gleiche Zeitspannen bestimmt, so daß ein späterer Vergleich der Resultate vorgenommen werden kann. Diesen Vorteilen stehen aber eine Reihe schwerer Nachteile gegenüber: die Anschaffung der erforderlichen Apparaturen erheischt große finanzielle Aufwendungen. Die kostspieligen Apparate sind relativ empfindlich und erfordern ständige Überwachung.

Für den im Gelände — im Flachland oder im Gebirge — arbeitenden Biologen oder Bodenkundler kommen daher diese erwähnten Verfahren b) und c) nur ausnahmsweise in Frage.

Die neue, im nachstehenden entwickelte Methode der Temperaturmessung liefert ebenfalls Mitteltemperaturen über bestimmte Zeitperioden. Die im Gelände ausgelegten „Temperatur-Registratoren" bestehen aus kleinen, mit Zucker-Pufferlösungen gefüllten Glasampullen, die frei oder in Metallhülsen verwendet werden. Die Gestehungskosten

einer solchen betriebsfertigen Meßampulle liegen unter 1 Franken. Sie können im Bodenprofil vergraben, auf der Bodenoberfläche verlegt oder im Luftraum plaziert werden. Die Mitteltemperatur über ein bestimmtes Zeitintervall wird aus der Inversionsgeschwindigkeit des in einer Pufferlösung gelösten Rohrzuckers polarimetrisch bestimmt.

Die im Gelände ausgelegten Meßampullen erfordern keine Wartung, sie sind weitgehend frost- und hitzeresistent. Ihr tiefer Gestehungspreis ermöglicht es, die Temperatur an zahlreichen Meßorten zu bestimmen. Das Prinzip und die Eichung der Methode, die Bedeutung der gemessenen Mitteltemperatur, die Genauigkeit und Anwendbarkeit des neuen Verfahrens werden in den folgenden Abschnitten kurz beschrieben.

B. Das Prinzip der neuen Temperaturmessung

Der Rohrzucker (Saccharose, Sucrose) wird in wässeriger Lösung durch Wasserstoffionen in Traubenzucker und Fruchtzucker zerlegt. Der Rohrzucker wird invertiert.

Bei konstanter Wasserstoffionen-Konzentration der Zuckerlösung wird die Inversionsgeschwindigkeit durch steigende Temperaturen stark erhöht.

Die Inversionsgeschwindigkeit des Rohrzuckers befolgt bei konstanter Temperatur und innerhalb nicht zu weiter pH-Spannen die Gleichung:

$$1.\ \frac{dx}{dt} = K \cdot H\,(A - x),$$

wobei bedeuten: A = Rohrzuckerkonzentration zur Zeit $t = 0$
x = Invertzucker zur Zeit t
$A - x$ = Verbliebener Rohrzucker zur Zeit t
t = Zeit (bei unseren Versuchen in Tagen)
K = Inversionskonstante für die Temperatur T
H = Wasserstoffionen-Konzentration der Lösung.

Die Inversionskonstante K_T läßt sich für eine bestimmte Temperatur T aus der integrierten Gleichung 1 berechnen:

$$2.\ K_T = \frac{1}{H \cdot t} \log \frac{A}{A - x}.$$

Die Bedeutung der in Gleichung 2 auftretenden Größen ist sub 1 angegeben. An Stelle des natürlichen Logarithmus wird der dekadische verwendet.

Zur Bestimmung der Inversionskonstanten K_T für die verschiedenen Temperaturen werden sterile, in Glasampullen eingeschmolzene Zucker-Zitratpufferlösungen von pH 2,90 in Thermostaten während einiger Monate aufgestellt. Nach verschiedenen Zeiten t werden die Inversionsbeträge mit Na-Licht polarisations-optisch ermittelt. Für die polarimetrische Messung des Inversionsbetrages läßt sich Gleichung 2 umformen:

$$3.\ K_T = \frac{1}{H \cdot t} \log \frac{\alpha_o - \beta_o}{\alpha - \beta_o}$$

worin nun bedeuten:

α_o = opt. Drehwinkel des Rohrzuckers zur Zeit t = O (positiv)
β_o = opt. Drehwinkel des Invertzuckers zur Zeit t = ∞ (negativ)
α = opt. Drehwinkel der partiell invertierten Zuckerlösung zur Zeit t.

C. Die Herstellung der Zucker-Pufferlösungen für die Inversions- bzw. Temperaturmessungen

Zur Konstanthaltung einer definierten Wasserstoffionenkonzentration H wird der Rohrzucker in einer Zitrat/HCl-Pufferlösung von pH 3,0 aufgelöst. Die keimfreie Zucker-Pufferlösung wird in sterile Glasampullen von 20—50 ccm Fassungsvermögen eingeschmolzen. Die im nachstehenden verwendete Zucker-Pufferlösung besitzt bei 18° C ein pH = 2,90.

Zur Herstellung der Zucker-Pufferlösungen dienen drei Lösungen:

1. Zitratlösung,
2. n/5 Salzsäurelösung,
3. Rohrzuckerlösung.

I. Herstellung der verschiedenen Lösungen

1. Zitratlösung (erste Pufferkomponente): 42,016 g Zitronensäure nach S. P. L. Sörensen werden in 200 ccm 2-normaler NaOH gelöst und hierauf mit destilliertem Wasser auf 1000 ccm Lösung aufgefüllt.

2. Salzsäurelösung (zweite Pufferkomponente) Chemisch reine Salzsäure wird zu einer genau n/5 Salzsäurelösung verdünnt. Der eigentliche Zitrat/HCl-Puffer wird durch Mischung der beiden Komponenten 1 und 2 hergestellt. Man fügt zu 404 ccm Zitratlösung 596 ccm n/5 Salzsäure. Die Mischung umfaßt 1000 ccm und weist ein pH von 3,00 (18° C) auf.

3. Rohrzuckerlösung: 1500 g reinste Saccharose (Sucrose oder Rohrzucker) werden in 1000 ccm destilliertem Wasser gelöst. Durch

das Eigenvolumen des gelösten Zuckers steigt das Lösungsvolumen auf etwa 1900 ccm an. Der erhaltene Zuckersirup wird durch ein gewöhnliches Faltenfilter filtriert.

II. Herstellung der Inversionsmischung (Zucker-Pufferlösung) von pH = 2,90

Die zur Aufnahme der sterilen Zucker-Pufferlösung bestimmten, mit Wattepfröpfchen verschlossenen Glasampullen (20—50 ccm Inhalt) werden im elektrischen Trockenschrank während drei Stunden auf 140° C erhitzt.

In einem speziellen Doppelkolben-Apparat wird die Sterilisation der Zitrat/HCl-Pufferlösung und der Zuckerlösung getrennt, aber gleichzeitig vorgenommen. (Fig. 1 u. 2).

In die beiden Glasrundkolben des Sterilisators werden mit Hilfe langstieliger Trichter vorsichtig gleiche Volumina Rohrzuckerlösung bzw. Zitrat/HCl-Pufferlösung eingefüllt. Eine Vermischung der beiden Lösungen ist unbedingt zu vermeiden. Der gefüllte, mit Watte verschlossene, zweiteilige Glassterilisator wird im Dampfautoklaven während 60 Minuten auf 120° C erhitzt. Die sterilisierten Lösungen werden unter ständiger Vermeidung einer Vermischung der beiden Komponenten möglichst rasch abgekühlt.

Sobald alle Vorbereitungen für das Abfüllen beendigt sind, gießt man durch Drehen des Glassterilisators den kalten Zitrat/HCl-Puffer zur kalten Zuckerlösung und mischt durch kräftige Drehbewegung durch. Diese Mischung muß gründlich ausgeführt werden. Die Zucker-Pufferlösung kann hierauf durch ein seitlich am Glasapparat mittels Schliffen aufsteckbares und mit Glashahn verschließbares Glasröhrchen (vgl. Figur 2) in die Ampullen eingefüllt werden. Das zur Ampullenfüllung dienende Glasröhrchen lag in 96% Alkohol aufbewahrt und ist auf diese Weise steril. Den ersten, durch die alkoholbenetzte Glasröhre durchgehenden Lösungsanteil verwirft man. Die Ampullen werden bis auf $^2/_3$ ihres Volumens aufgefüllt.

Nach dem Abfüllen der Ampullen werden diese sofort zugeschmolzen.

Die verschlossenen Ampullen werden bis zu ihrer Verwendung in einem Kühlschrank bei — 2 bis — 3° C aufbewahrt. Die Aufbewahrungszeit bis zur Verwendung soll 10 Tage nicht überschreiten.

Der experimentell ermittelte Gefrierpunkt des Ampulleninhalts liegt bei — 4,7° C. Die gefrorene Füllung hat griesig-breiige Konsistenz. Ein Zersprengen der Ampullen konnte selbst bei — 15° C nicht beobachtet werden. Die zugeschmolzenen Ampullen sind auch gegen Drucksteigerungen bei höheren Temperaturen ziemlich widerstandsfest.

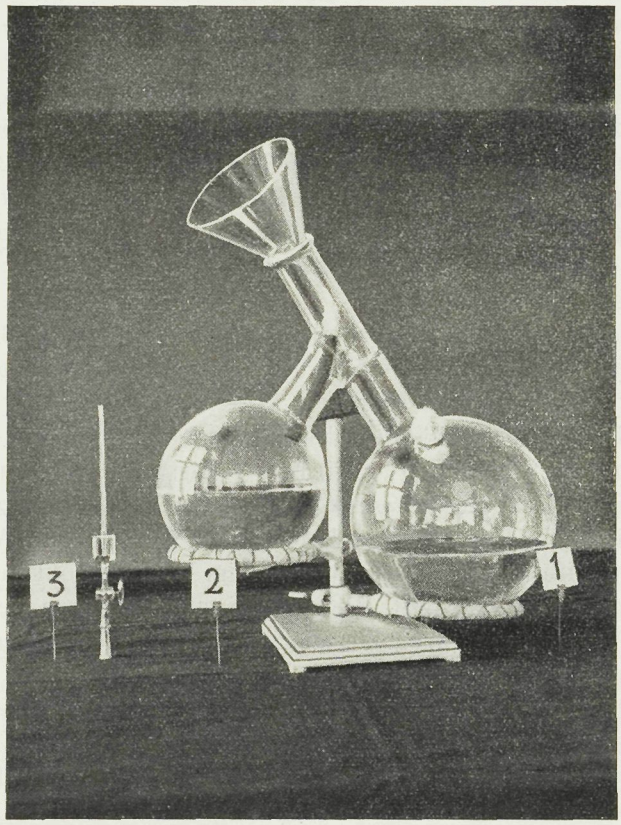

Fig. 1. Doppelkolben-Sterilisator für die getrennte Sterilisation von Rohrzucker (1) — und Pufferlösung (2) Ampullenabfüll-Röhre (3)

D. Die experimentelle Bestimmung der Inversionskonstanten K_T im langfristigen Thermostatenversuch

I. Mitteltemperaturen der Thermostaten und zugehörige Inversionskonstanten K_T

In die verschiedenen Thermostaten[1]) wurden je sechs Ampullen mit Zucker-Pufferlösung gebracht. Je nach der Temperatur verblieben

[1]) Herrn Prof. Dr. E. Gäumann danken wir für die freundliche Überlassung der Thermostaten.

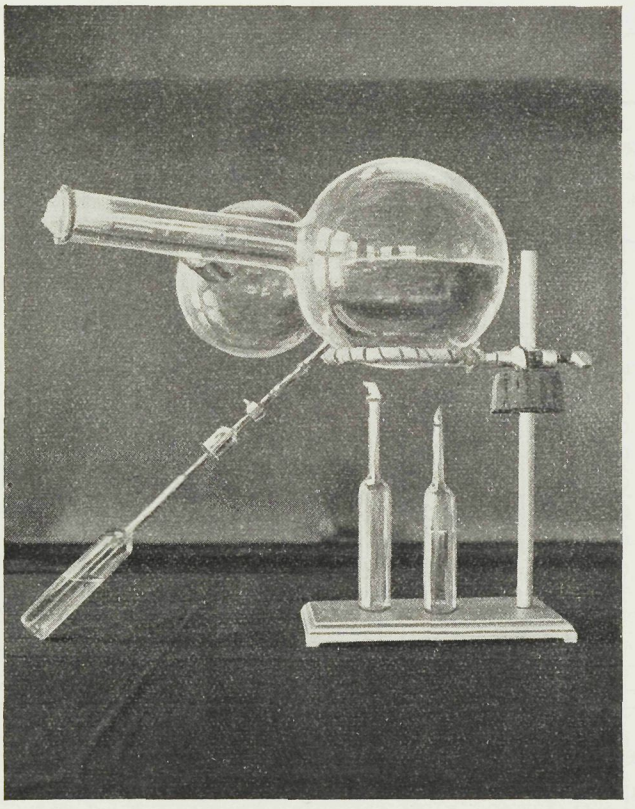

Fig. 2. *Doppelkolben-Sterilisator in Abfüllstellung* Zucker- und Pufferlösung vereinigt. Abgefüllt durch Glassöhre

sie darin 67 bis 140 Tage. In kurzen Zeitabschnitten wurden die Thermostaten-Temperaturen kontrolliert und aus den Einzeltemperaturen die entsprechenden Mittelwerte berechnet. Die Temperaturschwankungen erwiesen sich als relativ klein. Nach bestimmten Zeiten t wurden den verschiedenen Thermostaten je eine Ampulle entnommen und deren Inhalt im thermokonstanten Meßraum bei 20° C mit dem Schmidt-Haensch-Apparat im Na-Licht polarimetriert. Jedem Mittelwert der Inversionskonstanten K_T liegen mehrere (4—6) Einzelwerte zugrunde.

Der starke Einfluß der Temperatur auf die Aufspaltungsgeschwindigkeit des Rohrzuckers geht aus den oben mitgeteilten Inversionskon-

Tabelle 1
Temperaturmittel der verschiedenen Thermostaten und Mittelwerte der entsprechenden Inversionskonstanten K_T
(Zucker-Zitratpufferlösungen von pH 2,90)

Thermostaten-Temperatur-Mittel	Mittlerer Fehler *) ±	Inversions-Konstanten Mittelwerte	Mittlerer Fehler *) ±
— 0,3° C	0,05° C	0,0548	0,0021
+ 5,4° C	0,05° C	0,1461	0,0027
9,0° C	0,08° C	0,2682	0,0020
12,5° C	0,09° C	0,5195	0,0051
15,2° C	0,14° C	0,7485	0,0064
18,3° C	0,05° C	1,2876	0,0117
21,3° C	0,08° C	2,0930	0,0082
24,4° C	0,06° C	3,3338	0,0081
27,3° C	0,11° C	5,3021	0,0265
32,9° C	0,05° C	11,3370	0,0542
37,7° C	0,19° C	22,2370	0,4244

*) Der mittlere Fehler des Mittelwertes berechnet sich nach Gleichung:

$$\sqrt{\frac{\Sigma \triangle^2}{n(n-1)}}$$

stanten hervor. Die Konstanz der Werte innerhalb eines bestimmten Temperaturversuches ist gut. Einzig bei 37,7° C schwanken die Einzel-K_T-Werte etwas stärker.

II. Zusammenhang zwischen den Inversionskonstanten und der Temperatur

Zwischen der Mitteltemperatur der Thermostaten und den experimentell bestimmten Inversionskonstanten besteht ein einfacher Zusammenhang, der durch nachstehende Gleichung 4 und Fig. 3 ersichtlich ist.

4. $\log \overline{K_T} = B + m \cdot T$.

Hierin sind:

$\overline{K_T}$ = Mittelwert der jeweiligen Inversionskonstanten K_T
B und m = Konstanten der Gleichung 4
T = Temperaturmittel der entsprechenden Thermostaten.

Die Konstanten B und m der Geraden wurden nach der Methode der kleinsten Fehlerquadrate berechnet. Aus den berechneten B- und m-Werten werden die sog. ausgeglichenen oder „berechneten" Inversionskonstanten bestimmt.

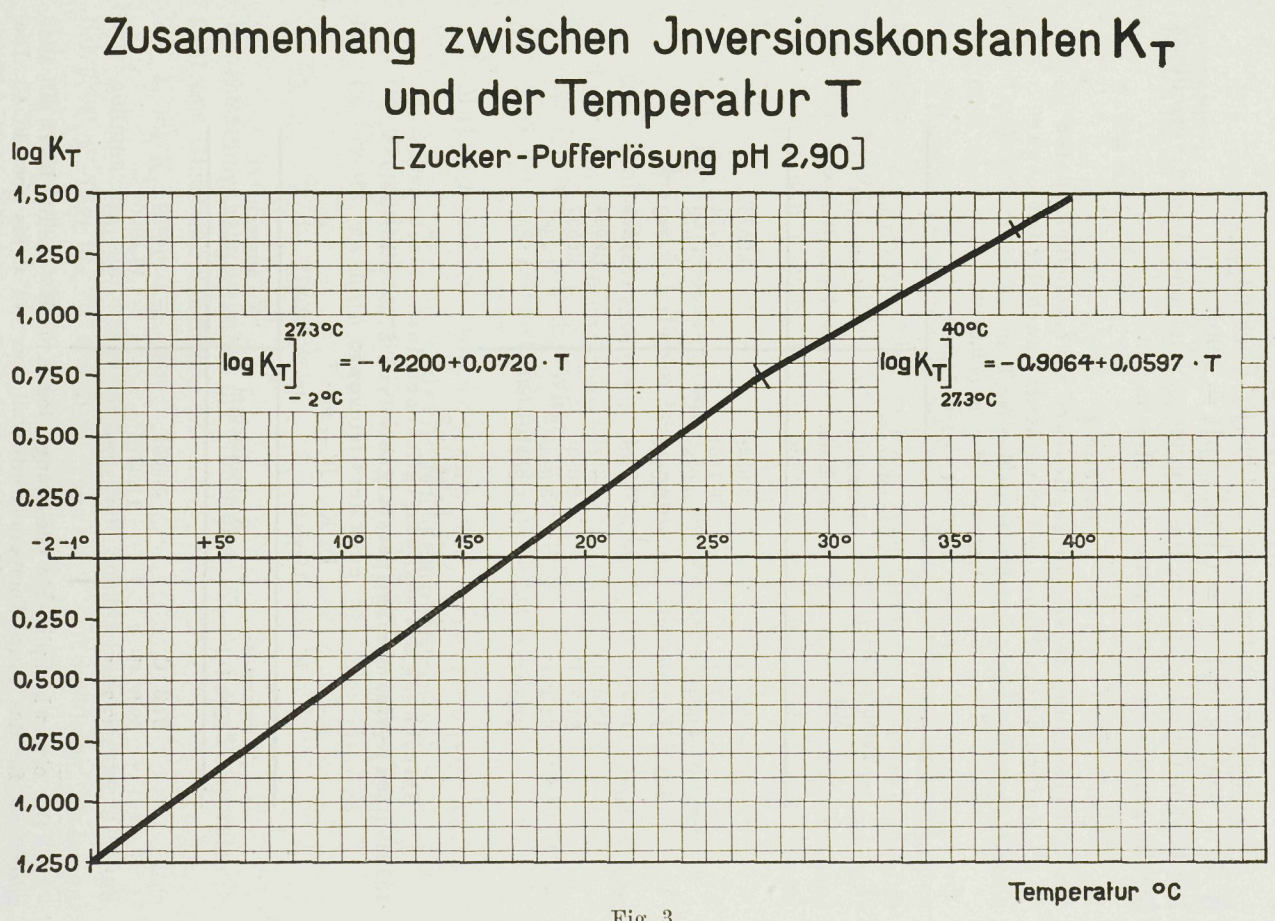
Zusammenhang zwischen Jnversionskonstanten K_T
und der Temperatur T
[Zucker-Pufferlösung pH 2,90]
log K_T
1,500
1,250
1,000
0,750
0,500
0,250
-2 -1°
+5°
10°
15°
20°
25°
30°
35°
40°
0,250
0,500
0,750
1,000
1,250
$\log K_T \Big]_{-2°C}^{27,3°C} = -1,2200 + 0,0720 \cdot T$
$\log K_T \Big]_{27,3°C}^{40°C} = -0,9064 + 0,0597 \cdot T$
Temperatur °C

Fig. 3

Für das Temperaturgebiet[1]): — 2° C bis 30° C gelten
B = — 1,22000 und m = 0,07197 (pH 2,90).

Für das Temperaturgebiet: 28° bis 40° C gelten
B′ = — 0,90644 und m′ = 0,05971 (pH = 2,90).

Die beiden Geraden sind in Fig. 3 eingezeichnet und dienen vorteilhaft für die graphische Auswertung der Messungen.

Tabelle 2

Berechnung der sog. ausgeglichenen Inversionskonstanten K_T für die verschiedenen Temperaturen nach der Gleichung:

$$\log K_T = B + m \cdot T$$

$B = -1{,}22000$ $m = 0{,}07197$

(Temperaturgebiet — 2,0° C bis 28° C)

Temperatur-Mittel	Inversions-konstanten K_T beob.	Inversions-konstanten K_T berechnet
— 0,3° C	0,0548	0,0573
+ 5,4° C	0,1461	0,1474
+ 9,0° C	0,2682	0,2678
12,5° C	0,5195	0,4782
15,2° C	0,7485	0,7481
18,3° C	1,2876	1,2504
21,3° C	2,0930	2,0557
24,4° C	3,3338	3,4361
27,3° C	5,3021	5,5562

Tabelle 3

Berechnung der sog. ausgeglichenen Inversionskonstanten K_T für das Temperaturgebiet von 27,3° C bis 37,7° C nach der Gleichung:

$$\log K = B' + m' \cdot T$$

$B' = -0{,}90644$ $m' = 0{,}05971$

Temperatur-Mittel	K_T beobachtet	K_T ausgeglichen (berechnet)
27,3° C	5,3021	5,2925
32,9° C	11,3370	11,4300
37,7° C	22,2370	22,1105

[1]) Die etwas komplizierte Gleichung: $\log K_T = B + a \cdot T + b \cdot T^2$ gilt ausgezeichnet für das ganze Temperaturintervall von —2° C bis über 40° C. Die Konstantenwerte (gültig für pH 2,5 und 2,9) sind: B = — 1,24552, a = + 0,07853, b = — 0,0002585. Zur graphischen Bestimmung der eT-Zahl können vervielfältigte $\log K_T$-eT-Kurven von uns geliefert werden.

III. Berechnung der Konstanttemperaturen aus den zugehörigen Inversionskonstanten K_T

Die vorstehenden Versuche wurden bei Konstanttemperaturen ausgeführt. Die Berechnung dieser Konstanttemperaturen kann mit Gleichung 4 bzw. 5 vorgenommen werden:

$$4.\ \log K_T = B + m \cdot T$$

$$5.\ T = \frac{(\log K_T - B)}{m}.$$

Die Temperaturen können aber auch mit Vorteil aus Figur 3 graphisch ermittelt werden.

Kleine Abweichungen in der Bestimmung der Inversionskonstanten machen sich besonders bei tieferen Temperaturen bemerkbar. Die experimentell beobachteten Abweichungen zwischen der Soll-Temperatur und der aus dem Experiment ermittelten belaufen sich auf maximal 0,5° C. In den meisten Fällen bleiben die Fehler zwischen 0,1° und 0,3° C.

E. Die Inversionskonstanten $K_T^{\cdot\cdot}$ der Zucker-Pufferlösungen bei veränderlichen Temperaturen. Die sog. eT-Zahl.

Bei Temperaturmessungen im Gelände ist die Voraussetzung einer ständig konstanten Temperatur nicht erfüllt.

Im folgenden soll die Wirkung veränderlicher Temperaturen auf den Wert der „Inversionskonstanten" abgeklärt werden.

I. Mathematische Behandlung des Inversionsverlaufes bei veränderlichen Temperaturen[1])

Die Grundgleichung der Zuckerinversion bei konstanter Temperatur hat die bereits erwähnte Form:

$$2.\ K_T = \frac{1}{H \cdot t} \log \frac{A}{A - x}.$$

Der Zusammenhang zwischen der Konstanten K_T und der Temperatur T geht aus Gleichung 4 hervor:

$$4.\ \log K_T = B + m \cdot T.$$

Wir nehmen an, daß beispielsweise eine Zucker-Pufferlösung t′ Tage bei T′° C, t″ Tage bei T″° C und t‴ Tage bei T‴° C verbleibe. Es lassen sich im gegebenen Beispiel drei verschiedene Temperatur-Zeit-

[1]) Herrn Prof. Dr. Polya (E.T.H.) danken wir bestens für die freundliche Beratung.

Etappen unterscheiden. Die Frage lautet: Welchen Wert nimmt die beobachtete „Konstante“ K_T''' an, die nach $t' + t'' + t'''$-Tagen aus dem Drehwert α (bzw. aus dem noch vorhandenen Rohrzuckergehalt $A_o - x'''$) berechnet wird?

Zur Abklärung dieser Frage formt man Gleichung 4 um:

6. $K_T = 10^B \cdot 10^{m \cdot T}$ oder falls $10^B = P$ gesetzt wird:

6a. $K_T = P \cdot 10^{m \cdot T}$.

In der ersten Inversionsetappe berechnet sich die Etappenkonstante K_T' zu:

$$7.\ K_T' = P \cdot 10^{m \cdot T'} = \frac{1}{H \cdot t'} \log \frac{Ao}{Ao - x'}.$$

In der zweiten Etappe liegt noch eine Rohrzucker-Anfangskonzentration $Ao - x' = A'$ vor. Die Etappenkonstante K_T'' berechnet sich zu:

$$7a.\ K_T'' = P \cdot 10^{m \cdot T''} = \frac{1}{H \cdot t''} \log \frac{A'}{A' - x''}.$$

In der dritten Etappe wird der entsprechende Etappenwert von K_T durch die noch vorhandene Etappen-Anfangskonzentration an Rohrzucker $A'' = A' - x''$ bestimmt:

$$7b.\ K_T''' = P \cdot 10^{m \cdot T'''} = \frac{1}{H \cdot t'''} \log \frac{A''}{A'' - x'''}.$$

Der Wert der am Ende der gesamten Meßperiode des Dreietappenversuches berechneten „Mittelkonstante“ K_T''' liegt zwischen dem höchsten und dem kleinsten Etappenwert. K_T''' stellt einen Mittelwert aller Etappenkonstanten dar.

$$8.\ K_T''' = \frac{1}{H \Sigma t} \left[\log \frac{Ao}{A'} + \log \frac{A'}{A''} + \log \frac{A''}{A'''} \right] = P \cdot 10^{m \cdot \bar{T}}$$

oder zusammengefaßt zu Gleichung 9, wobei $\Sigma t = t' + t'' + t'''$

$$9.\ K_T''' = \frac{1}{H \cdot \Sigma t} \log \frac{Ao}{A'''} = P \cdot 10^{m \cdot \bar{T}}.$$

Aus der am Schluß des Versuches bestimmten Rohrzuckerkonzentration A''' (polarimetrisch als entsprechenden Drehwinkel α zu bestimmen) und der Summe der Versuchstage läßt sich die Mittelkonstante K_T''' berechnen und aus dieser nach Gleichung 5 die wirksame Mitteltemperatur über die ganze Versuchszeit bestimmen.

II. Was bedeutet der Begriff wirksame Mitteltemperatur? Die sog. exponentielle Mitteltemperatur oder die eT-Zahl

Der Begriff „Mittel“ ist zunächst unbestimmt. Unter diesem „Mittel“ kann ein arithmetischer oder ein geometrischer Mittelwert

verstanden werden. Das „Mittel“ kann aber auch noch eine andere mathematische Bedeutung besitzen. Aus Gleichung 8 ist abzuleiten:

$$10.\ P \cdot 10^{m \cdot \dddot{T}} = \frac{P\,[\cdot t' \cdot 10^{m \cdot T'} + t'' \cdot 10^{m \cdot T''} + t''' \cdot 10^{m \cdot T'''}]}{t' + t'' + t'''} = K_{\dddot{T}}$$

Die im linken Glied der Gleichung auftretende Mitteltemperatur $\dddot{T}$ besitzt den Charakter eines sog. „exponentiellen Mittels“, das wir eT-Zahl nennen wollen. Diese eT-Zahl liegt zwischen der Höchst- und der Tiefsttemperatur und ist funktionell über Gleichung 10 mit diesen Extremtemperaturen verknüpft.

Die höheren Temperaturen gehen in die eT-Zahl mit höherem Gewicht ein als die tieferen Temperaturen. Die eT-Zahl ist daher stets größer als das arithmetische Mittel aus sämtlichen Etappen-Temperaturen, sie ist aber mathematisch streng definiert und ohne jeden zufälligen Charakter.

Die eT-Zahl basiert auf der Abhängigkeit der Reaktionsgeschwindigkeits-Konstanten von der Temperatur. Sie bringt daher die Eigentümlichkeit aller Reaktionen in der belebten und unbelebten Natur mit, die „bessere Erinnerung an höhere Temperaturen“ zu besitzen. Van't Hoff formulierte 1884 die bekannte RGT.-Regel (Reaktionsgeschwindigkeit-Temperatur-Regel): „Einer Temperaturzunahme von 10° C entspricht erfahrungsgemäß eine Zunahme der Reaktionsgeschwindigkeit um das Doppelte oder das Dreifache.“

Die Reaktionen in der belebten und unbelebten Natur befolgen diese angegebene Regel innerhalb gewisser systembedingter Grenzen (so werden z. B. die meisten physiologisch-chemischen Reaktionen in der lebenden Zelle bei Temperaturen über 45° C durch Veränderungen der Reaktionsträger gehemmt oder sistiert). Handelt es sich um weitgehend einseitig verlaufende Reaktionen, wie z. B. die hydrolytische Verwitterung mit gleichzeitigem Abtransport der Verwitterungslösungen im Bodenprofil oder um Assimilationsreaktionen mit erfolgendem Wegtransport der Assimilate usw., so werden sich über eine gewisse Reaktionsperiode die bei höheren Temperaturen verlaufenden Etappenreaktionen für den Gesamteffekt innerhalb der ganzen Periode stärker auswirken müssen als die bei tieferen Temperaturen abgelaufenen. Im Gesamteffekt der Reaktion gehen die höheren Etappentemperaturen mit höherem Gewicht ein als die tieferen.

Die eT-Zahl stellt einen Sonderfall dar, indem sie sich auf die Reaktion der Rohrzuckerinversion bezieht. Sie liefert aber eine „Mitteltemperatur“, die wohl für die meisten Systeme der belebten und unbelebten Natur besser mit der „wirksamen Mitteltemperatur“ übereinstimmt als die arithmetische Mitteltemperatur.

Die eT-Zahl entspricht jener Temperatur, die als Konstanttemperatur über die ganze Meßperiode herrschen müßte, um den gleichen Endeffekt zu erreichen.

F. Messung der eT-Zahlen in den verschiedenen Gesellschaften des subalpinen Bergföhrenwaldes[1])

Im Rahmen der bodenkundlich-pflanzensoziologischen Untersuchung in der subalpinen Waldstufe, die der eine von uns (H. P.) in Gemeinschaftsarbeit mit J. Braun-Blanquet und P. J. Haffter seit 1926 ausführt, wurde im Sommer 1939 zum erstenmal mit der hier beschriebenen Methode versucht, einen Einblick in die Temperaturverhältnisse der verschiedenen Waldgesellschaften zu erhalten. Als Versuchsort wurde ein bei Fuorn (Ofengebiet, Unterengadin) liegender Hügel gewählt, der zahlreiche bodenkundlich und soziologisch eingehend studierte Waldgesellschaften auf gleicher Meereshöhe (1880 bis 1910 m) und gleichem Muttergestein (Wettersteindolomit) aufweist. Die Temperaturmessungen sollten gleichzeitig als Prüfstein für die praktische Verwendung der neuen Methode dienen.

I. Auslegen der Zucker-Pufferampullen im Gelände

Die Z-P-Ampullen (30 ccm Lösung) wurden im Agrikulturchemischen Institut der E. T. H. vorbereitet, sofort im Kühlschrank gekühlt, hierauf in Seidenpapier gewickelt und in einer mit kaltem Sägemehl gefüllten Blechschachtel „per Expreß" nach Fuorn spediert. Das pH der Zucker-Pufferlösung betrug 2,90. ($\alpha_o = 25{,}70°$ und $\beta_o = -9{,}53°$.) Die Zuckerkonzentration war 38,6%. Je Bestand wurden 3—5 Ampullen — mit Fettstift markiert — in die bodennahe Kraut- oder Moosschicht bzw. auf den Rohboden gelegt. Kleine Ungleichheiten in der Lagerung (etwas tiefer oder höher in der Moosschicht, etwas stärker oder weniger stark beschattet usw.) machten sich in Abweichungen der später bestimmten Drehwerte der zusammengehörigen Ampullen bemerkbar.

II. Einsammeln, Verpacken und Rücksenden der Ampullen am Ende der Meßperiode

Die ausgelegten Z-P-Ampullen wurden am 10. September 1939, nach 45 Versuchstagen eingesammelt. Alle Ampullen konnten in unversehrtem Zustand aufgefunden werden. Die Fettstiftmarkierungen wurden ausgebessert, die Ampullen in Papier eingeschlagen, in Sägemehl gebettet und in einer Blechkiste mit kürzester Post nach Zürich zurückspediert. Nach dem Eintreffen der Sendung wurden die Messungen der Drehwinkel sofort polarimetrisch ausgeführt[2]).

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[1]) Siehe Literaturverzeichnis 7.

[2]) Herrn Kollegen J. Braun-Blanquet danken wir für die soziologische Beratung und die Mithilfe bei den Versuchen im Gelände.

Tabelle 4

eT-Werte in den verschiedenen Waldgesellschaften des Plan-Possa-Hügels bei Fuorn. Meereshöhe: 1880—1910 m. eT-Werte für die Zeit: 28. Juli bis 10. September 1939

Amp.-No.	Waldgesellschaft	Optischer Drehwert	eT-Zahl ber.	Mittelwert der eT-Zahlen
1	A Mugeto-Rhodoretum hirsuti. Übergang zum Rhod. Vaccinietum	+ 23,99°	11,1° C	**11,2° C**
2		+ 23,97°	11,2° C	
3		+ 23,97°	11,2° C	
6	B Mugeto-Rhodoretum hirsuti	+ 23,84°	11,6° C	**11,7° C**
7		+ 23,86°	11,6° C	
8		+ 23,74°	12,0° C	
11	C Mugeto-Ericetum hylocomietosum Übergang zu B	+ 23,76°	11,9° C	**12,1° C**
12		+ 23,59°	12,4° C	
13		+ 23,74°	12,0° C	
16	D Mugeto-Ericetum hylocomietosum	+ 21,75°	16,4° C	**15,9° C**
17		+ 22,13°	15,8° C	
18		+ 22,29°	15,5° C	
21	E Mugeto-Ericetum flache S-Exposition	+ 19,71°	19,1° C	**18,3° C**
22		+ 21,92°	16,1° C	
23		+ 19,23°	19,7° C	
26	F Mugeto-Ericetum E-Exposition	+ 16,99°	21,7° C	**22,0° C**
27		+ 16,86°	21,8° C	
28		+ 16,09°	22,4° C	
31	G Pineto-Caricetum humilis Steile S-Exposition	+ 8,12°	27,1° C	**27,7° C**
32		+ 5,68°	28,3° C	
33		+ 6,35°	28,0° C	
34		+ 7,49°	27,4° C	

Anmerkung:

A = Nord-Exposition am Hangfuß
B = Nord-Exposition 30° geneigt
C = WNW-Exposition 25° geneigt
D = NW-Exposition 20° geneigt
E = Süd-Exposition 10° geneigt
F = Ost-Exposition 15° geneigt, offener
G = Süd-Exposition 35° geneigt, offen

III. Resultate der Messungen

In umstehender Tabelle 4 sind die Untersuchungsergebnisse zusammengestellt. Die eT-Zahlen wurden aus den Drehwinkeln (α) und aus den Konstanten B und m über 45 Tage berechnet.

Die gemessenen eT-Zahlen erscheinen sowohl dem Bodenkundler wie auch dem Pflanzensoziologen durchaus vernünftig. Die bodenkundliche und soziologische Kennzeichnung und Unterscheidung der verschiedenen Waldtypen erfährt dadurch auch von der standortklimatischen Seite her eine Bereicherung. Feinheiten in der soziologischen Unterscheidung bestimmter Übergangstypen finden sich in den entsprechenden eT-Zahlen ausgeprägt.

G. Zusammenfassung

1. Die neue Temperaturmessung liefert Mitteltemperaturen (eT-Zahl) über eine gewisse Meßperiode von Σ t Tagen.
2. Die eT-Zahl entspricht dem exponentiellen Temperaturmittel einer Meßperiode; es liegt stets höher als das arithmetische Temperaturmittel aus den verschiedenen Versuchsetappen. Die höheren Etappentemperaturen gehen in die eT-Zahl mit höherem Gewicht ein als die tieferen (vgl. Abschnitt E II).
3. Die experimentelle Bestimmung der eT-Zahl ist einfach, mit relativ wenig Kosten verbunden, rasch und hinreichend genau auszuführen. Sie basiert auf der Feststellung der temperaturabhängigen Inversionsgeschwindigkeit einer in Glasampullen von 20—50 ccm Inhalt eingeschmolzenen sterilen Rohrzucker-Pufferlösung.
   a) In der verwendeten Zucker-Pufferlösung müssen das pH und die optische Anfangsdrehung α_o genau bekannt sein. Die experimentelle Bestimmung der Enddrehung β_o wird durch Inversion des Ampulleninhaltes im Wasserbad oder im elektrischen Heizschrank bei etwa 100° C vorgenommen. Die Konstanz der Enddrehung muß experimentell gesichert sein. Die Kenntnis obiger Größen (vgl. Gleichung 3) ist für die Berechnung der $K_T^{\cdots}$-Werte bzw. der eT-Zahl notwendig.
   b) Zwischen der Inversionskonstanten K_T und der Konstant-Temperatur T gilt im Temperaturbereich von — 2° C bis gegen 30° C die lineare Beziehung[1]):

$$\log K_T = B + m \cdot T.$$

   (Bei pH 2,90 wurden ermittelt: B = 1,22000 und m =0,07197). Für Temperaturen von 28° C bis gegen 40° C werden diese Konstanten: B = — 0,90644 und m = 0,05971.

[1]) Vgl. Fußnote: Abschnitt D. II (Seite 62).

Die eT-Zahlen werden für das Temperaturgebiet von — 2,0° C bis 40° C mit Vorteil graphisch aus Figur 3 interpoliert. Besonders bei höheren Temperaturen wird die graphische Auswertung zu guten Werten führen.

4. Die maximale Dauer einer Meßperiode, deren eT-Zahl bestimmt werden soll, richtet sich nach dem pH der Zucker-Pufferlösung und nach der zu erwartenden Temperatur. Bei der Verwendung von Zucker-Pufferlösungen von pH 2,50 werden die Inversionsgeschwindigkeiten 2,5 mal so hoch als bei der Messung mit Zucker-Pufferlösungen von pH 2,90. Für die Messung relativ tieferer Temperaturen wird man vorteilhaft mit Zucker-Pufferlösungen höherer Wasserstoffionen-Konzentration arbeiten (also z. B. mit pH 2,50).

   Beträgt beispielsweise die Anfangsdrehung einer Ampullenfüllung $\alpha_0 = +24{,}13°$ und beträgt die zugehörige Enddrehung $\beta_0 = -8{,}95°$, so soll die Messung nicht über $-7{,}00° = \alpha$ hinaus erstreckt werden. Die Bestimmungsfehler werden in diesen tiefen Endstadien der Inversion größer. In der nachstehenden Tabelle 5 sind für die verschiedenen Temperaturen die Zeiten notiert, in denen im gewählten Inversionssystem (pH = 2,90) die Anfangsdrehwinkel ($\alpha_0 = +24{,}13°$) auf $\pm 0{,}00°$ zurückgehen ($= \alpha$). Von diesem Drehwinkel $\alpha = \pm 0{,}00°$ vermag die Lösung noch weiter bis zum Enddrehwinkel $\beta_0 = -8{,}95°$ zu invertieren. Der 0,00°-Winkel ist also noch relativ weit von der Enddrehung β_0 entfernt.

   Die maximale Länge einer Meßperiode, über die das exponentielle Temperaturmittel eT gilt, hat sich nach den Zahlen in Tabelle 5 zu richten.

5. Die kürzeste Dauer einer Meßperiode ist ebenfalls von den herrschenden Temperaturen abhängig.

   Für eT-Messungen[1]) während der Vegetationsperiode dürften wohl bei Bedarf die minimalen Meßperioden kürzer als 14 Tage sein. Während des Sommers können selbst in der subalpinen Stufe der Alpen Zeitperioden von sieben Tagen gemessen werden. Bei Verwendung von Zucker-Puffersystemen mit pH 2,50 könnte die minimale Meßperiode noch kürzer als sieben Tage gewählt werden.

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[1]) Mit Zucker-Pufferlösungen von pH 2,90.

Tabelle 5

Der Drehwinkel $\alpha = \pm 0{,}00°$ ist bei den verschiedenen Temperaturen nach folgenden Zeiten erreicht:

(Inversionssystem = Rohrzucker-Zitratpuffer-Lösung
Rohrzuckerkonzentration A_o = 36,24 g/100 ccm Lösung
Anfangsdrehung α_o = + 24,13°, Enddrehung $\beta_o = -8{,}95°$
Wasserstoffionen-Konzentration der Lösung = $H = 1{,}259 \cdot 10^{-3}$)

Temperatur	Zeit bis zum Erreichen von $\alpha = 0{,}00°$
— 0,3° C	7777 Tage
+ 5,4° C	3038 Tage
9,0° C	1679 Tage
12,5° C	943 Tage
15,2° C	604 Tage
18,3° C	363 Tage
21,3° C	221 Tage
24,4° C	133 Tage
27,3° C	82 Tage
32,9° C	39 Tage
37,7° C	20 Tage

Tabelle 6

Bei den verschiedenen Temperaturen sinkt der Anfangsdrehwinkel ($\alpha_o = 24{,}13°$) in folgenden Zeiten um 0,20° auf $\alpha = + 23{,}93°$ ab (pH 2,90)

Temperatur	Zeit zum Absinken der Anfangsdrehung um 0,20°
— 0,3° C	36,1 Tage
+ 5,4° C	14,1 Tage
9,0° C	7,8 Tage
12,5° C	4,4 Tage
15,2° C	2,8 Tage
18,3° C	1,68 Tage
21,3° C	1,03 Tage
24,3° C	0,62 Tage
über 24,3° C	wenig. als 0,62 Tage

6. Weitere Studien für den Ausbau der Methode sind noch im Gange. Folgende Probleme stellen sich:
   a) In welcher Form werden die Meßampullen am besten im Gelände — auf dem Boden, im Boden, im Luftraum — verlegt? Es sind Schutzhüllen, welche die besonders im Boden eingegrabenen Ampullen mechanisch schützen, auszuprobieren.
   b) Die Sofortmessung der Ampullen im Gelände ist anzustreben. Eine kleine Apparatur für die Polarisation im Felde muß noch konstruiert und erprobt werden.

Literatur

1. R. Geiger: Das Klima der bodennahen Luftschicht. Verlag Friedr. Vieweg & Sohn, Braunschweig 1927.
2. H. Lundegårdh: Klima und Boden in ihrer Wirkung auf das Pflanzenleben. 2. Aufl. Verlag Gustav Fischer, Jena 1930.
3. E. Tamm: Gedanken und Vorschläge zur Errichtung einer „Pflanzenwetter- und Klimastation". Fortschr. d. Landw., Jahrg. 8, 1933 (S. 24—29) und gl. Bd. (S. 59—61).
4. E. Tamm: Vergleichende Temperaturmessungen in der Zone des Pflanzenklimas. Landwirtsch. Jahrbücher, Bd. 83, 1936 (S. 457—554).
5. E. Tamm: Vergleichende Temperaturmessungen in der Zone des Pflanzenklimas. Landwirtsch. Jahrbücher, Bd. 88, 1939 (S. 479—548) mit ausführlicher Literaturangabe.
6. E. Tamm: Die Pflanzenklimastation des Instituts für Acker- und Pflanzenbau. Zeitschrift. Die Ernährung der Pflanze, Bd. 35, 1939 (S. 257—265).
7. J. Braun-Blanquet, G. Sissingh und J. Vlieger: Prodromus der Pflanzengesellschaften. Fasc. 6. Klasse der Vaccinio-Piceetea, 1939.

Schwedische bodenkundliche Arbeiten während der 10-Jahresperiode 1929—1938

von

Sigurd Eriksson und **Yngve Gustafsson**[1])

Einleitung

Vorliegende Zusammenfassung der schwedischen bodenkundlichen Literatur umfaßt die wichtigsten bodenkundlichen Arbeiten aus der 10-Jahresperiode 1929 bis 1938. Die Verfasser haben versucht, sie möglichst vollständig zu machen, aber natürlich sind die Grenzen zwischen Bodenkunde und den naheliegenden Wissenschaften, z. B. Geologie nicht immer leicht zu unterscheiden, weshalb einige Arbeiten vielleicht nicht mitgenommen sind, die manche in dieser Zusammenfassung erwarten könnten usw.

Obwohl die Verfasser der Meinung sind, daß der Objektivität wegen keine Arbeiten auf dem Gebiete ausgelassen werden dürften, sind doch der Raumersparnis wegen nach einer näheren Prüfung der gesammelten Arbeiten sehr viele aus der Zusammenstellung gestrichen worden.

Die Literatur ist in Gruppen zerlegt, die den Kommissionen der Internationalen Bodenkundlichen Gesellschaft entsprechen. Natürlich sind in dieser Zusammenstellung auch manche Arbeiten aufgeführt, die in internationaler Hinsicht geringe Bedeutung haben und es dürfte deshalb am Platze sein, auf die wertvollsten Arbeiten hinzuweisen. Die meisten wichtigsten Originalarbeiten sind nicht in schwedischer, sondern in einer der großen Sprachen oder wenigstens mit einer derartigen Zusammenfassung geschrieben. Viele Arbeiten der schwedischen Bodenkundler sind auch in den größeren internationalen Publikationen veröffentlicht.

Die schwedischen Publikationen, in denen man die wertvollsten Arbeiten auf dem Gebiete der Bodenkunde findet, sind:

1. Lantbrukshögskolans annaler (Annalen der Landw. Hochschule Schwedens).
2. Meddelande från Jordbruksförsöksanstalten, Lantbrukshögskolan, bis 1938 Meddelande från Centralanstalten för försöksväsendet på jordbruksområdet. (Mitteilungen der Versuchsanstalt der Landw. Hochschule.)
3. Kungl. Lantbruksakademiens tidskrift (Zeitschrift der Kgl. Schwed. Akademie der Landwirtschaft).
4. Meddelande från Statens skogsförsöksanstalt. (Mitteilungen aus der Forstlichen Versuchsanstalt Schwedens.)
5. Sveriges geologiska undersökning. Årsbok. (Jahrbuch der Geologischen Landesanstalt Schwedens.)
6. Nordisk Jordbrugsforskning. (Publikation des Vereins Nordischer Landwirtschaftlicher Forscher.)
7. Svenska Mosskulturföreningens tidskrift. (Zeitschrift des Schwedischen Moorkulturvereins.)

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[1]) Die Verfasser sind beide gleich verantwortlich.

I. Bodenphysik

Unter den Arbeiten der Bodenphysik verdienen besonders die von Beskow, Torstensson und Åslander erwähnt zu werden. Beskow hat sich hauptsächlich mit den Problemen der Frostbildung im Boden und ihrer Bedeutung für den Wassertransport in den Bodenschichten beschäftigt. Seine Arbeiten auf diesem Gebiete dürften von grundlegender Bedeutung sein. Torstensson und Åslander haben mehrere Bodenbearbeitungsfragen behandelt. Der erstgenannte hat außerdem mit Eriksson zusammen eine neue Methode zur Bestimmung der Porosität des Bodens ausgearbeitet.

II. Bodenchemie

Auf dem Gebiete der Bodenchemie wollen die Verfasser vor allem die Arbeiten von Egnér, Lundegårdh, Mattson, Odén und Tamm erwähnen. Egnér und Lundegårdh haben sich damit beschäftigt, Methoden auszuarbeiten, um den Düngungsbedarf des Bodens zu bestimmen, was u. a. in die allbekannte sog. Egnérsche Laktatmethode zur Bestimmung des Phosphatbedarfs resp. die spektralanalytische sog. „Trippelanalysemethode" von Lundegårdh resultierte. Mattson und Mitarbeiter haben grundlegende Arbeiten durchgeführt, um die chemischen und physikalisch-chemischen Eigenschaften der Bodenkolloide zu erklären. Vor allem muß sein Nachweis des amphoteren Charakters derselben und seine Theorie der isoelektrischen Verwitterung erwähnt werden. Odén und Tamm haben u. a. die Chemie der Verwitterung und Bodenbildung studiert und der letzte hat eine Methode — Tamms Oxalatmethode — zur Auslaugung der ausgeflockten Bodenkolloide ausgearbeitet. Weiter hat sich Nydahl mit einigen Methoden zur Bestimmung des Kalibedürfnisses der Böden beschäftigt.

III. Bodenmikrobiologie

Auf diesem Gebiete sind mehrere Arbeiten von Barthel und seinen Mitarbeitern Bengtsson, Bjälfve und Nilsson am Institut für Mikrobiologie der Landw. Hochschule ausgeführt worden. Besonderes Interesse hat man der Frage der Nitrifikation des Stalldüngerstickstoffes gewidmet und außerdem hat man die Zuwachsbedingungen und die praktische Bedeutung der Knöllchenbakterien der Leguminosen studiert.

IV. Bodenfruchtbarkeit

Hier liegt eine sehr reichhaltige Literatur vor, aber die meisten Arbeiten sind nur von aufklärender Natur für die praktische Landwirtschaft und deshalb hier nicht mitgenommen. Arbeiten von besonderem wissenschaftlichen Interesse sind folgende: Lundegårdh und Burström haben eine Reihe von Arbeiten über verschiedene Probleme bei der Nährstoffaufnahme der Pflanzen veröffentlicht und Osvald hat u. a. über den Bormangel einiger Kulturpflanzen gearbeitet. Torstensson und Mitarbeiter sowie auch Franck haben sich eingehend mit der Frage der Festlegung von Phosphorsäure im Boden beschäftigt.

V. Bodengenetik, -morphologie und -kartographie
und
Vb. Waldböden

Arrhenius und Ekström haben mehrere Arbeiten über Bodenkartierungsprobleme veröffentlicht und Kartierungsarbeiten durchgeführt. Hesselman

hat die Relation zwischen die Humidität des Klimas und die Bodenbildung studiert und weiter hat er die Einwirkung verschiedener Faktoren auf die Entwicklung der Humusdecke eingehend behandelt. Besondere Aufmerksamkeit verdienen die Arbeiten von Tamm. Er hat in einer Reihe von Abhandlungen die Waldböden Schwedens eingehend beschrieben und weiter hat er bedeutungsvolle Studien über die Einwirkung von geologischen, hydrologischen und klimatologischen Faktoren auf die Entwicklung der Böden durchgeführt.

Arbeiten über die hydrologischen Verhältnisse in Wäldern sind von Malmström publiziert.

VI. Bodenmelioration

Auf diesem Gebiete hat Flodkvist verschiedene Probleme zu näherem Studium aufgenommen. Seine Forschungen über die Wasserströmung in dräniertem Boden hat zu einer neuen Theorie der Strömungen geführt. Weiter müssen seine Studien über den Zusammenhang zwischen die meteorologischen Faktoren und den Dränwasserabfluß erwähnt werden, was eine Umarbeitung der Abflußkoeffizienten veranlaßt hat.

VIa. Moorböden

Booberg und Granlund haben entwicklungshistorische und torfgeologische Studien schwedischer Moore getrieben und Lundquist und Thunmark haben Seesedimente aus Süd- und Mittelschweden untersucht. Osvald hat u. a. ein Handbuch in Moorkultur herausgegeben und Lundblad hat die Bodenbildung organischer Böden studiert. Außer diesen wissenschaftlichen Arbeiten muß auch die für die praktische Landwirtschaft bedeutende Wirksamkeit des schwedischen Moorkulturvereins erwähnt werden.

Literatur

Bodenphysik

Beskow, Gunnar: Om jordarternas kapillaritet. En ny metod för bestämning av kapillärkraften (eller kapillära stighöjden). (English summary.) Sveriges geologiska undersökning. Ser. C, No. 356, Årsbok 1929. Über die Kapillarität der Erdarten. — **Beskow, Gunnar:** Tjälbildningen och tjällyftningen med särskild hänsyn till vägar och järnvägar. (English summary.) Sveriges geologiska undersökning. Ser. C, No. 375, Årsbok 1932. Statens väginstitut. Meddelande 48. Frostbildung und Frostbehebung im Boden mit besonderer Rücksicht auf Straßen und Eisenbahnen. — **Franck, O.:** Undersökningar rörande sambandet mellan tjälbildning och grundvattendjup samt tjälningsdjupet i odlade marker inom olika delar av landet. (English summary.) Stockholm 1936, Kungl. Landtbr.-Akad.Handl. och Tidskr., 1936, No. 1, S. 38—72. Untersuchungen über den Zusammenhang zwischen Frostbildung im Boden und Grundwassertiefe sowie die Tiefe der gefrorenen Schicht in kultivierten Böden verschiedener Teile Schwedens. — **Gustafsson, Yngve:** Om teorierna för vattnets bindning och rörelse i jord med särskild hänsyn till nyare forskningsresultat. Nord. Jordbrugsforsk. 1937, Nr. 7—8, A, S. 225—239. Über die Theorien der Bindung und Bewegung des Wassers im Boden mit besonderer Rücksicht auf neuere Forschungsresultate. — **Halden, Bertil E.:** Marktorkan å sand- och grusmarker. (Mit deutscher Zusammenfassung.) Sv. Skogsvårdsför. Tidskr., 1932, H. 1—2, S. 39—131. Die Bodentrockenheit auf Sand- und Kiesböden mit besonderer Rücksicht auf Regenwinde, Bodenbeschaffenheit und mechanische Zusammensetzung des Bodens.

— **Tamm, Olof:** Om mekanisk analys av svenska skogsjordar. En metodgranskning. (Deutsche Zusammenfassung.) Medd. fr. Statens Skogsförsöksanst., 1932—1934, H. 27, S. 290—312. Über die mechanische Analyse von schwedischen Waldböden. — **Tamm, Olof:** En snabbmetod för mineralogisk jordartsgranskning. Stockholm, Sv. Skogsvårdsfören:s Tidskr., 1934, S. 231—251. (Deutsche Zusammenfassung.) Eine Schnellmethode zur mineralogischen Untersuchung des Bodens. — **Torstensson, G.:** Ein Beitrag zur Frage der Verteilung der Düngerphosphorsäure im Ackerboden bei verschiedener Art der Aufbringung. (Med svensk sammanfattning.) Lantbrukshögskolans Annaler 1937, vol. 4, S. 191—219. — **Torstensson, G.:** Zur Methodik des Bodenbearbeitungsversuches. Die Technik in der Landwirtschaft, 1937, 18. Jahrg., H. 10, S. 187 bis 188. — **Torstensson, G.:** Jordbearbetningens inverkan på förhållandet vatten: luft i marken. Beret. om N. J. F.:s 6. Kongres. Nord. Jordbrugsforsk. 1938, Nr. 4—7, S. 587—590. — Über die Einwirkung der Bodenbearbeitung auf das Verhältnis Wasser : Luft im Boden. — **Torstensson, G.** und **Sigurd Eriksson:** Eine neue Methode zur Bestimmung der Porosität des Bodens. (Med svensk resumé.) Lantbrukshögskolans Annaler, 1935, S. 159—179. — **Torstensson, G.** and **Sigurd Eriksson:** A new method for determining the porosity of the soil. Soil Science, 1936, No. 6, S. 405—416. — **Åslander, Alfr.:** Helträdan, dess betydelse och brukande. (English summary.) Kungl. Landtbr.-Akad. Handl. och Tidskr., 1934, No. 5, S. 492—538, Landtm. 1934, S. 898—899. Die Schwarzbrache, ihre Bedeutung und Bestellung.

Bodenchemie

Arrhenius, O.: Markanalysen i arkeologiens tjänst. Stockholm, Geol. fören. förhandl., Bd. 53, 1931, S. 47—59. Die Bodenanalyse im Dienste der Archäologie. — **Bengtsson, N.:** Sönderdelning av cellulosa, pentosaner och lignin i jord. Försök med stubb och rötter av korn i sand. (English summary.) Lantbrukshögskolans Annaler, 1936, S. 1—48. Die Zerteilung von Zellulose, Pentosanen und Lignin im Boden. — **Egnér, H.:** Bestämning av åkerjordens reaktion. (English summary.) Medd. No. 359 fr. Centralanst. för försöksväsendet på jordbruksomr. Stockholm 1929. Bestimmung der Reaktion des Ackerbodens. — **Egnér, H.:** Om saltfel vid kolorimetriska reaktionsbestämningar i jord. N. J. F.s kongressberet., 1929, S. 347—353. Salzfehler bei kolorimetrischen Reaktionsbestimmungen der Böden. — **Egnér, H.:** Fosfatens löslighet i jord och gödselmedel. Kungl. Landtbr.-Akad. Handl. och Tidskr., 1931, No. 8, S. 1227—1234. Die Löslichkeit des Phosphats in Böden und Düngemitteln. — **Egnér, H.:** Metod att bestämma lättlöslig fosforsyra i åkerjord. (English summary.) Kungl. Landtbr.-Akad. Handl. och Tidskr., 1933, No. 1, S. 30—63. Eine Methode zur Bestimmung leichtlöslicher Phosphorsäure im Ackerboden. — **Egnér, H., G. Köhler** und **F. Nydahl:** Die Laktatmethode zur Bestimmung leichtlöslicher Phosphorsäure in Ackerböden. (Med svensk sammanfattning.) Lantbrukshögskolans Annaler, Vol. 6, S. 253—298, Uppsala 1938. — **Ekman, Per:** Anionenumtausch bei Bodenkolloiden. Bodenkunde und Pflanzenernährung, 1938, Bd. 9/10, S. 134—141. — **Franck, O.:** Fosfatgödslingsbehovet enligt citronsyremetoden. Nord. Jordbrugsforsk., 1931, Nr. 2—3, S. 127—134. Das Phosphatbedürfnis nach der Zitronensäuremethode. — **Franck, O.:** Undersökningar rörande kalkbleket i Mästermyr. Stockholm 1933, Kungl. Landtbr.-Akad. Handl. och Tidskr., 1933, No. 2, S. 254—266. Untersuchungen über die Kalkbleiche in „Mästermyr". — **Lundblad, K.:** Studies on

podzols and brown forest soils. — Soil Science, 41, S. 35—45, 1936. — **Lundegårdh, H.:** The triple analysis method of testing soil fertility and probably crop reaction to fertilization. Soil Science, 1938, Vol. 45, S. 447—454. — **Mattson, Sante:** Isoelektrische Niederschläge und ihre Eigenschaften. Kolloid-Zeitschr., 1932, S. 305 bis 314. — **Mattson, Sante:** The laws of soil colloidal behavior. VIII. Forms and functions of water. Soil Science, Vol. XXXIII, S. 301—322, New Jersey 1932. — **Mattson, Sante:** The laws of soil colloidal behavior. IX. Amphoteric reaction and isoelectric weathering. Soil Science, Vol. XXXIV, S. 209—240, New Jersey 1932. — **Mattson, Sante:** Isoelektrisk förvittring. Nord. Jordbrugsforsk., 1933, No. 5 bis 6A, S. 300—318. Isoelektrische Verwitterung. — **Mattson, S.:** The pH and base saturation of the podzol profile. Transact. of the 3. rd. Internat. Congress of Soil Science, Vol. 1, 1935, S. 67—70. — **Mattson, S.:** The constitution of the pedosphere. (Med svensk sammanfattning.) Lantbrukshögskolans Annaler, Vol. 5, S. 261—276, Uppsala 1938. — **Mattson, Sante** and **J. S. Csicky:** The laws of soil colloidal behavior. XVI. The cation exchange-maximum in alumino-silicates. Soil Science, Vol. 39, S. 161—165 (1935). — **Mattson, S.** and **Per Ekman:** The reaction and the buffer capacity of soil organic matter. Transact. of the 3. rd International Congress of Soil Science, Vol. 1, 1935, S. 374—377. — **Mattson, Sante** and **Yngve Gustafsson:** The chemical characteristics of soil profiles. I. The podzol. Lantbrukshögskolans Annaler, Vol. 1, 1933—1934, S. 33—68. — **Mattson, Sante** and **Yngve Gustafsson:** The chemical characteristics of soil profiles. II. The mutual interactions of podzolic materials. (Med svensk resumé.) Lantbrukshögskolans Annaler, 1935, S. 1—30. — **Mattson, Sante** and **Yngve Gustafsson:** The neutral salt reaction in relation to the point of exchange neutrality, the saturation and the combining capacity of a soil. Lantbrukshögskolans Annaler, 1935, S. 135 bis 157. — **Mattson, Sante** and **Yngve Gustafsson:** The Electro-Chemistry of Soil Formation. I. The Gel and the Sol Complex. (Med svensk resumé.) Lantbrukshögskolans Annaler, 1937, Vol. 4, S. 1—54. — **Mattson, Sante** and **Yngve Gustafsson:** The laws of soil colloidal behavior. XVIII. Colloidal electrolytes. Soil Science, 1937, Vol. 43, S. 421—452. — **Mattson, Sante** and **Yngve Gustafsson:** The laws of soil colloidal behavior. XIX. The gel and the sol complex in soil formation. Soil Science, 1937, Vol. 43, S. 453—473. — **Mattson, Sante** and **B. Jackson Hester:** The laws of soil colloidal behavior. XV. The degradation and the regeneration of the soil complex. Soil Science, Vol. 39, S. 75—84 (1935). — **Mattson, Sante** and **Nils Karlsson:** The electro-chemistry of soil formation. II. The phosphate complex. (Med svensk resumé.) Lantbrukshögskolans Annaler, Vol. 6, S. 109—157, Uppsala 1938. — **Mattson, Sante** and **Kwang-Chiung Hou:** The laws of soil colloidal behavior. XX. The neutral salt effect and the amphoteric points of soils. Soil Science, 1937, Vol. 43, S. 151—166. — **Mattson, Sante** and **Ingvar Nilsson:** The chemical characteristics of soil profiles. III. The podzol complex. (Med svensk resumé.) Lantbrukshögskolans Annaler, 1935, S. 115 bis 134. — **Mattson, Sante** and **A. Pugh:** The laws of soil colloidal behavior. XIV. The electrokinetics of hydrous oxides and their ionic exchange. Soil Science, Vol. 38, S. 299—313 (1934). — **Mattson, Sante** and **Lambert Wiklander:** The equiionic point and the point of exchange neutrality of soils. (Med svensk resumé.) Lantbrukshögskolans Annaler, 1937, Vol. 4, S. 169—189. — **Nydahl, Folke:** Jämförelse mellan några metoder att bestämma åkerjordens kaligödslingsbehov. (English summary.) Kungl. Landtbr.-Akad. Handl. och Tidskr., 1932, No. 6, S. 845—868. Ein Vergleich zwischen einige Methoden, um den Kalidüngungs-

bedarf des Ackerbodens zu bestimmen. — **Nydahl, Folke:** Jämförelse mellan några metoder att bestämma åkerjordens kaligödslingsbehov. II. (English summary.) Kungl. Landtbr.-Akad. Handl. och Tidskr., 1935, No. 3, S. 435 bis 442, Stockholm 1935. Ein Vergleich zwischen einigen Methoden, um den Kalidüngungsbedarf des Ackerbodens zu bestimmen. — **Odén, Sven:** Sedimentationsanalysen och dess tillämpning på kemiska, agrikulturkemiska och tekniska problem. Svensk kemisk tidskrift. Årg. XLIV. Stockholm 1932, No. 1, S. 2—15; No. 2, S. 35—43; No. 4, S. 64—79. Die Sedimentationsanalyse und ihre Anwendung auf chemische, agrikulturchemische und technische Probleme. — **Odén, Sven** och **Gösta Köhler:** Nyare undersökningar över jordkolloiderna. Nord. Jordbrugsforsk., 1933, Nr. 5—6 A, S. 275—299. Neuere Untersuchungen über Bodenkolloide. — **Odén, Sven** und **A. Löddesøl:** Undersökningar över sambandet mellan basmättningsgrad och reaktion hos några jordarter. (English summary.) Kungl. Landtbr.-Akad. Handl. och Tidskr., 1930, No. 2, S. 271—303. Untersuchungen über den Zusammenhang zwischen Basensättigungsgrad und Reaktion einiger Böden. — **Odén, Sven** och **Torgil Wijkström:** Elektrodialysen, dess metodik och tillämpning på jordartsundersökningar. (English summary.) Stockholm 1931, Kungl. Landtbr.-Akad. Handl. och Tidskr., 1931, No. 3, S. 428—490. Die Elektrodialyse, ihre Methodik und Anwendung für Bodenuntersuchungen. — **Sundelin, Gustav:** Metoder för bestämning av jordens näringsbehov. Kungl. Landtbr.-Akad. Handl. och Tidskr., No. 7, S. 953 bis 971. Methoden zur Bestimmung des Nährstoffgehalts des Bodens. — **Sundelin, Gustav, O. Franck** och **C. Larson:** Metoder för bestämning av jordens gödslingsbehov. I. (With an english summary.) Kungl. Landtbr.-Akad. Handl. och Tidskr., 1932, No. 7, S. 974—1004. Methoden zur Bestimmung des Düngungsbedarfs der Böden. — **Tamm, Olof:** An Experimental Study on Clay Formation and Weathering of Felspars. (En experimentell studie över lerbildning och vittring av fältspater.) Medd. fr. St. Skogsförsöksanst., 1929, H. 25, No. 1—2, S. 1—28. — **Tamm, Olof:** Über die Oxalatmethode in der chemischen Bodenanalyse. Medd. fr. Statens Skogsförsöksanst., 1932, Häft. 27, No. 1—3, S. 1—20. — **Tamm, Olof:** Markförvittring och jordmånsbildning under olika klimat med särskild hänsyn till förhållandena i vårt land. Kung. Landtbr.-Akad. Handl. och Tidskr., 1932, No. 2, S. 150—161. Verwitterung und Bodenbildung in verschiedenen Klimaten mit besonderer Rücksicht auf die Verhältnisse in unserem Lande. — **Tamm, Olof:** Experimentelle Studien über die Verwitterung von Silikatmineralien. Stockholm Ark. f. kemi, min. o. geol., Bd. 11 A, No. 14, Upsala 1934.

Bodenmikrobiologie

Barthel, Chr.: Några nyare jordbakteriologiska forskningsresultat. Landtbr.-Akad. Handl. och Tidskr., 1932, No. 2, S. 113—124. Einige neuere bodenbakteriologische Forschungsresultate. — **Barthel, Chr.** och **N. Bengtsson:** Bidrag till frågan om stallgödselkvävets nitrifikation i åkerjorden. VI. (English summary.) Kungl. Landtbr.-Akad. Handl. och Tidskr., 1930, No. 7, S. 1014—1031. Beitrag zur Frage der Nitrifikation des Stalldüngers im Boden. VI. — **Barthel, Chr.:** och **N. Bengtsson:** Bidrag till frågan om stallgödselkvävets nitrifikation i åkerjorden. VII. (Mit deutscher Zusammenfassung.) Kungl. Landtbr.-Akad. Handl. och Tidskr., 1931, No. 4, S. 669—679. Beitrag zur Frage der Nitrifikation des Stalldüngers im Boden. VII. — **Barthel, Chr.** och **N. Bengtsson:** Bidrag till frågan om stallgödselkvävets nitrifikation i åkerjorden. VIII. (English sum-

mary.) Kungl. Landtbr.-Akad. Handl. och Tidskr., 1931, No. 5, S. 818—830. Beitrag zur Frage der Nitrifikation des Stalldüngers im Boden. VIII, Nr. IX. Siehe Bengtsson, N. — **Barthel, Chr.** och **N. Bengtsson:** Bidrag till frågan om stallgödselkvävets nitrifikation i åkerjorden. X. (English summary.) Kungl. Landtbr.-Akad. Handl. och Tidskr., 1934, No. 1, S. 25—40. Beitrag zur Frage der Nitrifikation des Stalldüngers im Boden. X. Nr. XI siehe Bengtsson, N. och Chr. Barthel. — **Bengtsson, N.:** Bidrag till frågan om stallgödselkvävets nitrifikation i åkerjorden IX. Bestämning av salpeter i jord och gödsel. (English summary.) Kungl. Landtbr.-Akad. Handl. och Tidskr., 1932, No. 5, S. 620—659. Beitrag zur Frage der Nitrifikation des Stalldüngers im Boden. IX. — **Bengtsson, N.** och **Chr. Barthel:** Bidrag till frågan om stallgödselkvävets nitrifikation i åkerjorden. XI (English summary.) Kungl. Landtbr.-Akad. Handl. och Tidskr., 1935, No. 5, S. 719—747. Beitrag zur Frage der Nitrifikation des Stalldüngers im Boden. XI. — **Bjälfve, G.:** Baljväxternas kväveupptagande och dess samband med jordens näringsinnehåll och reaktion. I. Försök i klöver och vicker på en starkt sur mullrik mellanlera. (English summary.) Kungl. Landtbr.-Akad. Handl. och Tidskr. 1934, No. 2, S. 184—204. Die Stickstoffaufnahme der Leguminosen und ihr Zusammenhang mit dem Nährstoffinhalt und der Reaktion des Bodens. — **Forslund, Karl-Herman:** Bidrag till kännedomen om djurlivets i marken inverkan på markomvandlingen. 1. Om några kornkvalsters (oribatiders) näring. (Mit deutscher Zusammenfassung.) Stockholm 1938. Meddelande från Statens Skogsförsöksanstalt, H. 31, S. 87—104. Beitrag zur Kenntnis über die Einwirkung des Tierlebens im Boden auf die Bodenbildung. — **Koffman, M.:** De egentliga jordprotozoerna. Deras ställning till andra jordmikroorganismer och deras roll vid de mikrobiologiska processerna i jorden. (English summary.) Kungl. Landtbr.-Akad. Handl. och Tidskr., 1931, No. 4, S. 556—620. Die eigentlichen Bodenprotozoen. — **Torstensson, G.:** Undersökningar angående marktäckning. Kungl. Landtbr.-Akad. Handl. och Tidskr., 1931, No. 5, S. 685—727. Untersuchungen über Bodenbedeckung.

Bodenfruchtbarkeit

Arrhenius, O.: Besondere Anwendungen der Bodenanalyse. Bodenkunde u. Pflanzenernähr., 1938, Bd. 9/10, S. 82—87. — **Burström, H.:** Kemisk fysiologisk analys av kalknings- och gödslingsförsök på sur lerjord. (Deutsche Zusammenfassung.) Kungl. Landtbr.-Akad. Handl. och Tidskr., Stockholm 1937, No. 3, S. 304—353. Chemisch-physiologische Analyse einiger Kalkungs- und Düngungsversuche auf saurem Lehmboden. — **Burström, Hans** und **Kazimierz Boratynski:** Über die Kupfer- und Manganaufnahme des Weizens bei verschiedener pH. (Med svensk resumé.) Lantbrukshögskolans Annaler, 1936, S. 147—168. — **Eriksson, Sigurd:** Bidrag till frågan om fosforsyrans fastläggning i betesmarker Beret. om N. J. F.s 6. Kongres. Nord. Jordbrugsforsk., 1938, No. 4—7, S. 388 bis 395. Beitrag zur Frage nach der Festlegung der Phosphorsäure in Weiden. — **Franck, O.:** Gallstranden vid Tåkern. Ett anmärkningsvärt fall av fullständig brist på växtlöslig fosforsyra. Kungl. Landtbr.-Akad. Handl. och Tidskr., 1931, No. 5, S. 805—817. „Gallstranden" bei Tåkernsee. Ein bemerkenswerter Fall von vollständigem Mangel an pflanzenlöslicher Phosphorsäure. — **Franck, O.:** Metoder för bestämning av jordens gödslingsbehov. II. Egnérs laktatmetod och Arrhenius' citronsyremetod för bestämning av fosfatgödslingsbehovet jäm-

förda med gödslingsförsök i fält. (With a summary in English.) Kungl. Landtbr. Akad. Handl. och Tidskr., 1933, No. 1, S. 117—146. Methoden zur Bestimmung des Düngungsbedarfs des Bodens. II. Egnérs Laktatmethode und Arrhenius' Zitronensäuremethode verglichen mit Düngungsversuchen im Felde. — **Franck, O.:** Undersökningar rörande den lättlösliga fosforsyran i våra odlingsmarker. (English summary.) Kungl. Lantbr.-Akad. Handl. och Tidskr., 1935, No. 6, S. 753—819. Untersuchungen über die leichtlösliche Phosphorsäure in unseren Kulturböden. — **Franck, O.:** Undersökningar rörande fosforsyrans fastläggning i marken samt därmed sammanhörande gödslings- och kalkningsspörsmål. (English summary.) Kungl. Landtbr.-Akad. Handl. och Tidskr. 1937, No. 7, S. 822—856. Untersuchungen über die Festlegung der Phosphorsäure im Boden und damit zusammenhängende Düngungs- und Kalkungsfragen. — **Franck, O.:** Kan exempelvis fosforsyrans fastläggande i översta jordlagret betinga betesvallens omläggning? Beret. om N. J. Fs. 6. Kongres. Nord. Jordbrugsforsk., 1938, No. 4—7, S. 381—387. Kann z. B. die Festlegung der Phosphorsäure in der obersten Bodenschicht eine Umlegung der Weiden motivieren? — **Franck, O.:** Markanalysens betydelse för bestämning av jordens gödslings- och kalkbehov. Beret. om N. J. Fs. 6. Kongres. Nord. Jordbrugsforsk., 1938, No. 4—7, S. 546 bis 552. Die Bedeutung der Bodenanalyse bei der Bestimmung des Düngungs- und Kalkbedarfs des Bodens. — **Franck, O.:** Bedeutung der Bodenanalyse für die Bestimmung des Düngungs- und Kalkbedarfes des Bodens auf Grundlage schwedischer Verhältnisse. Bodenkunde u. Pflanzenernähr., 1938, Bd. 9/10, S. 24—30. — **Franck, O.** och **N. G. Bengtsson:** Metoder för bestämning av jordens gödslingsbehov. III. Bondorffs natriumkloridmetod och Kirssanoffs saltsyremetod för bestämning av kalibehovet jämfört med Mitscherlich's kärlförsöksmetod. (English summary.) Kungl. Landtbr.-Akad. Handl. och Tidskr., 1938, Nr. 4—5, S. 458—463. Methoden zur Bestimmung des Düngungsbedarfs der Böden. III. Die NaCl-Methode von Bondorff und die HCl-Methode von Kirssanoff verglichen mit Gefäßversuchen nach Mitscherlich. — **Hjertstedt, H.:** Torvjordarnas kalk- och kvävehalt i olika delar av Sverige. (Deutsche Zusammenfassung.) Sv. Mosskulturför. Tidskr., 1932, No. 6, S. 337—348. Der Gehalt an Kalk und Stickstoff der Moorböden in verschiedenen Bezirken Schwedens. — **Larsson, Carl:** Orienterande översikt över fosfat- och kalibehovet på fastmarksjordarna inom Sveriges olika jordbruksområden enligt de lokala fältförsöken. Beret. om N. J. Fs. 5. Kongres. Nord. Jordbrugsforsk., 1935, No. 4—7, S. 174—184. Orientierende Übersicht über den Phosphat- und Kalibedarf in den Mineralböden der verschiedenen Ackerbaugebiete Schwedens laut den lokalen Feldversuchen. — **Lundegårdh, H.:** Studier över stråsädens näringsupptagande samt dettas betydelse för tillväxten och för uppkomsten av icke-parasitära sjukdomar. (English summary.) Kungl. Landtbr.-Akad. Handl. och Tidskr., 1931, No. 7, S. 1021 bis 1164. Studien über die Nährstoffaufnahme des Getreides sowie die Bedeutung derselben für den Zuwachs und für die Entstehung nicht-parasitärer Krankheiten. — **Lundegårdh, H.:** Markbeskaffenhet och gödslingsbehov. (English summary.) Kungl. Landtbr.-Akad. Handl. och Tidskr., 1934, No. 3, S. 225 bis 289. Bodenbeschaffenheit und Düngungsbedarf. — **Lundegårdh, H., H. Burström** och **E. Rennerfelt:** Untersuchungen über die Salzaufnahme der Pflanzen. II. Die Aufnahme von Alkali- und Erdalkalichloriden. Svensk botanisk tidskrift, 1932, H. 1/2, S. 271—283. — **Osvald, Hugo** och **Gunnar Pettersson:** Experiments with boron against Heart Rot. Medd. No. 4 från Inst. för växtodlingslära. —

Lantbrukshögskolans Annaler 4, Upsala 1937. — **Sundelin, G.** och **O. Franck:** Reaktionstillståndet och kalkbehovet i de svenska odlingsjordarna. (English summary.) Kungl. Lantbr.-Akad. Handl. och Tidskr., 1930, No. 5, S. 706—794. Bodenreaktion und Kalkbedarf der schwedischen Ackerböden. — **Sundelin, G.** och **O. Franck:** Markreaktion och kalkbehov. (English summary.) Kungl. Landtbr.-Akad. Handl. och Tidskr., 1931, No. 4, S. 656—668. Bodenreaktion und Kalkbedarf. — **Sundelin, Gust., C. Larsson** och **E. Manell:** Den lokala gödslingsförsöksverksamheten år 1928. Årsberättelse. (With a summary in english.) Medd. No. 366 fr. Centralanst. f. försöksväsendet på jordbruksområdet. (Jordbruksavd. No. 71.) Stockholm 1929. Die lokale Düngungsversuchswirksamkeit im Jahre 1928. — **Sundelin, Gustav, C. Larsson** och **S. Eliasson:** Den lokala gödslingsförsöksverksamheten år 1929, 1930, 1931, 1932, 1933, 1934, 1935 (del I, II, III), 1936 (del I, II, III). Årsberättelse. (English summary.) Medd. No. 389, 405, 416, 439, 447, 460, 463, 468, 470, 477, 480 fr. Centralanst. f. försöksväsendet på jordbruksområdet. Die lokale Düngungsversuchswirksamkeit im Jahre 1929, 1930, 1931, 1932, 1933, 1934, 1935, 1936. — **Svanberg, Olof:** Om de lantbrukskemiska förutsättningarna för uppkomsten av lokalbundna anämisjukdomar i Norrland. Lantbrukshögskolans Annaler, Vol. 1, 1934. Über die agrikulturchemischen Voraussetzungen der Entstehung von örtlichen Anämiekrankheiten. — **Svanberg, Olof, E. Hannerz** och **Torgil Wijkström:** Analyser av stråfodervegetationen från sura jordar i Norrbotten. Lantbrukshögskolans Annaler, Vol. 2, 1935. Analysen der Strohfuttervegetation von sauren Böden in Norrbotten. — **Torstensson, G.:** Jordens gödsling ock kalkning. Särtryck ur Svenska jordbrukets bok, S. 111—162, Stockholm 1935. Düngung und Kalkung des Bodens. — **Torstensson, G.** und **Sigurd Eriksson:** Studien über die Festlegung der Phosphorsäure in Gyttjaböden. (Med svensk sammanfattning.) Lantbrukshögskolans Annaler, Vol. 5, S. 377—403; Vol. 6, S. 89—107, Uppsala 1938. — **Åslander, Alfr.:** Äro humussyror växtskadliga? (With an English summary) Nord Jordbrugsforsk., 1930, Nr. 4, S. 297—312. Sind die Humussäuren pflanzenschädlich? — **Åslander, A.:** Studies on Antagonism in acid Nutrient Solutions. Sv. Bot. Tidskr., 1931, H. 1, S. 77—107. — **Åslander, Alfr.:** Förefinnes korrelation mellan markreaktion och skördeavkastning? (With a sumin English.) Nord. Jordbrugsforsk., 1932, Nr. 4, S. 141—154. Liegt eine Korrelation zwischen Bodenreaktionen und Ernteertrag vor? — **Åslander, Alfr.:** Nyare undersökningar över sambandet mellan markreaktion, jordens näringsinnehåll och skördeutbytet. (English summary.) Kungl. Landtbr.-Akad. Handl. och Tidskr., 1932, No. 7, S. 898—955. Neuere Untersuchungen über den Zusammenhang zwischen Bodenreaktion, Nahrungszustand des Bodens und Ernteertrag. — **Åslander, Alfr.:** The neutralizing action of plants on acid nutrient solutions. Sv. Bot. Tidskr., 1933, Bd. 27, H. 2, S. 257—272. — **Åslander, Alfr.:** Bodenextrakt als Nährlösung für höhere Pflanzen. Zeitschr. f. Pflanzenernähr., Düngung u. Bodenk., 1936, Bd. 44, S. 282—306.

Bodengenetik, -morphologie und -kartographie

Arrhenius, O.: Fosfathalten i skånska jordar. (English summary.) Sveriges geologiska undersökning. Ser. C. Avhandlingar och uppsatser, No. 383, Årsbok 28 (1934), No. 3, Stockholm 1934. Der Phosphatgehalt der schonischen Böden. — **Arrhenius, O.:** Upplysningar till en karta över den gotländska åkerjordens fosfathalt. (English summary.) Sveriges geologiska undersökning

Ser. C, Avhandlingar och uppsatser, No. 412, Årsbok 32 (1938), No. 2, Stockholm 1938. Erklärungen zu einer Phosphatkarte über Gotland. — **Booberg, Gunnar:** Klassificering och kartering av lösa jordlager i tropikerna. Stockholm, Geol. fören. förhandl., Bd. 53, S. 521—531. Klassifizierung und Kartierung der lockeren Bodenarten in den Tropen. — **Ekström, Gunnar:** Allmänna termer och petrografisk jordartsindelning. N. J. F.s Kongresberet., 1929, S. 290—297. Allgemeine Ausdrücke und petrographische Einteilung der Erdarten. — **Ekström, Gunnar:** Agrogeologiska undersökningar vid Svalöv. (Deutsche Zusammenfassung.) Sveriges geologiska undersökning. Ser. C. Avhandlingar och uppsatser, No. 380, Årsbok 27 (1933), No. 5, Stockholm 1934. Agrogeologische Untersuchungen bei Svalöv. — **Ekström, G.:** De agrogeologiska kartläggningarna i Sverige, Beretom N. J. F.s 5. Kongres, Nord. Jordbrugsforsk., 1935, Nr. 4—7, S. 361—372. Die agrogeologischen Aufnahmen in Schweden. — **Ekström, Gunnar:** En överblick av Värmlands åkerjordar. Sv. gods och gårdar. II—III, S. 29—34, Uddevalla 1936. Ein Überblick über die Ackerbodenarten Värmlands. — **Ekström, Gunnar:** Åkerjordarna i Skåne, speciellt i dess sydvästligaste del. Sv. gods och gårdar. IV, S. 1—17, Uddevalla 1936. Die Ackerböden in Schonen, besonders in dem südwestlichen Teil. — **Ekström, Gunnar:** Jordarterna i Malmöhus län. Medd. fr. Malmöhus läns skogs- och betesvårdsfören, No. 8, S. 3—8, Malmö 1936. Die Ackerbodenarten im Bezirk Malmöhus. — **Ekström, Gunnar:** Åkerjordarna i Skåne, Speciellt i Torna, Frosta och Färs härader. Sv. gods och gårdar, VI, S. 9—20, Göteborg 1937. Die Ackerböden in Schonen, besonders in den Bezirken Torna, Frosta und Färs. — **Ekström, Gunnar:** Södermanlands jordarter. Sv. gods och gårdar., XII, S. 17—23, Uddevalla 1938. Die Böden Södermanlands. — — **Halden, Bertil E.:** Genetisk jordartsindelning. N. J. F.s Kongresberet., 1929, S. 298—305. Genetische Einteilung der Erdarten. — **Hesselman, Henrik:** Om klimatets humiditet i vårt land och dess inverkan på mark, vegetation och skog. (Deutsche Zusammenfassung.) Medd. fr. Statens skogsförsöksanst., 1932, Häft. 26, S. 515—559. Über die Humidität des Klimas und ihre Einwirkung auf Boden, Vegetation und Wald. — **Hofman-Bang, O.:** Ultunatraktens geologi. En kort översikt. Lantbrukshögskolan. En vägledning, Uppsala 1938, S. 7—17. Die Geologie der Gegend von Ultuna. — **Johansson, Simon:** Principerna för agrogeologisk kartläggning i Sverige. N. J. F.s Kongresberet., 1929, S. 309—313. Die Prinzipien der agrogeologischen Aufnahmen in Schweden. — **Lundqvist, G.:** Sjösediment från mellersta Norrland. Indalsälvens, Ångermanälvens och Umeälvens vattenområden. Sveriges geologiska undersökning. Ser. C. Avhandlingar och uppsatser, Stockholm 1936, 8 : o. Seesediment aus mittlerem Norrland. — **Tamm, Olof:** Om brunjorden i Sverige. (Mit deutscher Zusammenfassung.) Sv. Skogsvårdsför. Tidskr., 1930, H. 1, S. 1—30. Der braune Waldboden in Schweden. — **Tamm, Olof:** Die Böden Schwedens. Die Ernährung der Pflanze, Jahrg. XXVIII, H. 17, S. 297—308, Berlin 1932. — **Thomé, Karl Erik:** En vittringsjord av översilurisk kalksten. En svensk parallell till Sydeuropas Terrarossa. Stockholm, Geol. fören. förhandl., Bd. 54, 1932, S. 505—514. Ein Verwitterungsboden von obersilurischem Kalkgestein. Ein schwedischer Parallelismus zur Terra rossa in Südeuropa. — **Torstensson, G.:** Redogörelse över försök och undersökningar rörande den s. k. rödjordens förekomst och egenskaper. Tidning för Stockholms läns och stads hushållningssällskap 1931, No. 3, S. 129 bis 141. Bericht über Versuche und Untersuchungen betreffs des Vorkommens und der Eigenschaften von Gyttjalehmböden. — **Torstensson, G.:** Jorden och

jordbruket i Upland. Sv. gods och gårdar, X, S. 9—16, Uddevalla 1938. — Boden und Landwirtschaft in Upland. — **Torstensson, G.** och **Sigurd Eriksson:** Lilla Sunnersta, egendomsbeskrivning. Svenska Betes- och Vallföreningens årsskrift 1937. La. Sunnersta, Bodenverhältnisse usw.

Waldböden

Granlund, Erik och **Sten Wennerholm:** Sambandet mellan moräntyper samt bestånds- och skogstyper i Västerbottens lappmarker. Sveriges geologiska undersökning. Ser. C. Avhandlingar och uppsatser, No. 384, Årsbok 28 (1934), No. 4, Stockholm 1935. Der Zusammenhang zwischen Moräntypen und Bestands- und Waldtypen in den Lappmarken Västerbottens. — **Halden, Bertil E.:** Övre Dalarnas geologi och jordmånsförhållanden ur skoglig synpunkt. Norrlands Skogsvårdsförbunds Tidskr., III, 1934. Die Geologie und Bodenverhältnisse des nördlichsten Dalecarlien aus forstlichen Gesichtspunkten. — **Hesselman, Henrik:** Om humustäckets beroende av beståndets ålder och sammansättning i den nordiska granskogen av blåbärsrik Vacciniumtyp och dess inverkan på skogens föryngring och tillväxt. (Deutsche Zusammenfassung.) Medd. fr. Statens Skogsförsöksanst., 1937, H. 30, S. 529—716. Über die Abhängigkeit der Humusdecke von Alter und Zusammensetzung der Bestände im nordischen Fichtenwald von blaubeerreichem Vaccinium-Typ und über die Einwirkung der Humusdecke auf die Verjüngung und das Wachstum des Waldes. — **Malmström, Carl:** Om faran för skogsmarkens försumpning i Norrland. En studie från Kulbäckslidens och Roklidens försöksfält. (Deutsche Zusammenfassung.) Medd. fr. Statens skogsförsöksanst., 1932, Häft. 26, S. 127—162. Über die Gefahr der Versumpfung des Waldbodens in Norrland (Nordschweden). Eine Studie an den Versuchsfeldern Kulbäcksliden und Rokliden. — **Tamm, Olof:** Studier över jordmånstyper och deras förhållande till markens hydrologi i nordsvenska skogsterränger. (Mit deutscher Zusammenfassung.) Medd. fr. Statens Skogsförsöksanstalt, H. 24, 1930—1931. Studien über Bodentypen und ihre Beziehungen zu den hydrologischen Verhältnissen in nordschwedischen Waldterrains. — **Tamm, Olof:** Ett försök till klassifikation av skogsmarken i Sverige. Medd. fr. Statens skogsförsöksanst., H. 28, No. 2, S. 269—298, Stockholm 1935. (Deutsche Zusammenfassung.) Versuch einer Klassifikation des Waldbodens in Schweden. — **Tamm, Olof:** Om de lågproduktiva sandmarkerna å Hökensås och i övre Lagadalen. (Deutsche Zusammenfassung.) Medd. från Statens Skogsförsöksanst., 1937, H. 30, S. 1—66. Über die schwachproduktiven Sandböden auf dem Hökensås und im oberen Lagatal, Südschweden. — **Wretlind, J. E.:** Naturbetingelserna för de nordsvenska järnpodsolerade moränmarkernas tallhedar och mossrika skogssamhällen. Stockholm, Sv. Skogsvårdsförens Tidskr., 1934, S. 329—396. (Deutsche Zusammenfassung.) Die Naturbedingungen für die Entstehung der Kieferheiden und Hylocomium-reichen Waldgesellschaft der nordschwedischen eisenpodsolierten Moränenböden.

Bodenmelioration

Ekström, Aug.: Jordarternas hydrologi ur kulturteknisk synpunkt. Nord. Jordbrugsforsk., 1931, No. 4—5, S. 147—162. Die Hydrologie der Erdarten aus kulturtechnischem Gesichtspunkt. — **Ekström, Gunnar:** Slagruta och vattenådror. (Mit deutscher Zusammenfassung.) Kungl. Landtbr.-Akad. Handl. och

Tidskr., 1932, No. 6, S. 763—800. Wünschelrute und Wasseradern. — **Ekström, Gunnar:** Preliminärt nordiskt förslag till jordvattnets terminologi. Beret. om N. J. F.s 6. Kongres. Nord. Jordbrugsforsk., 1938, No. 4—7, S. 299—317. Ein präliminarer nordischer Entwurf zur Terminologie des Bodenwassers. — **Flodkvist, Herman:** Kulturtechnische Grundwasserforschungen. Stockholm 1931. Sveriges geologiska undersökning. Ser. C. Avhandlingar och uppsatser, No. 371, Årsbok 25 (1931), 4. — **Flodkvist, Herman:** Die Bewegung des Grundwassers in dräniertem Boden. Transactions of the Third Int. Congr. of Soil Sci., 1935, Vol. III. — **Flodkvist, Herman:** Ultuna invallningsföretag. Lantbrukshögskolan. En vägledning, Upsala 1938, S. 77—79. Die Eindeichung bei Ultuna. — **Flodkvist, Herman:** Grundförbättringsverksamhetens organisation och den kulturtekniska undervisningen i olika länder. Nord. Jordbrugsforsk. 1931, No. 4—5, S. 188—199. — **Flodkvist, Herman:** Neue, binnen gewisser Grenzen geltende Theorie der Querdränung auf Tonboden. Transactions of the Third Int. Congr. of Soil Sci., 1935, Vol. III. — **Flodkvist, Herman** und **Yngve Gustafsson:** Hydrologische Forschungen I. Studien über Grundwassereinströmung durch die Fugen der Dränleitungen. (Med svensk sammanfattning.) Lantbrukshögskolans Annaler, Vol. 5, S. 131—164, Uppsala 1938. — **Franck, O.:** Grundvattenståndsförsöken vid Experimentalfältet åren 1920—1928. (With a summary in English.) Stockholm 1929, Kungl. Landtbr.-Akad. Handl. och Tidskr., 1929, No. 4, S. 431 bis 473. Die Grundwasserstandversuche bei Experimentalfältet 1920—1928. — **Gustafsson, Yngve:** Om materialtransporten i dräneringsledningar. Beret. om N. J. F.s 6. Kongres. Nord. Jordbrugsforsk. 1938, No. 4—7, S. 723—732. Über den Materialtransport in Dränröhren. — **Johansson, Simon:** Lerornas permeabilitet. Några synpunkter på deras dränering. Beret. om N. J. F.s 6. Kongres. Nord. Jordbrugsforsk. 1938, No. 4—7, S. 326—335. Die Permeabilität der Lehm- und Tonböden. — **Malmström, Carl:** Om resultaten av en 70-årig myrdikning i Västerbotten. (Mit deutscher Zusammenfassung.) Medd. fr. St. skogsförsöksanstalt, 1932, H. 27, No. 4, S. 123—144. Über die Resultate einer 70jährigen Moorentwässerung in Västerbotten (Nordschweden). — **Malmström, Carl:** Om skogsdikning och försumpningsfrågan i Norge. (Mit deutscher Zusammenfassung.) Sv. Skogsvårdsför. Tidskr., 1933, No. 1, S. 11—52. Über Forstentwässerung und die Versumpfungsfrage in Norwegen. — **Perman, Olof:** Erfarenheter från täckdikningsförsöken vid Lanna försöksgård. Beret. om N. J. F.s 5. Kongres. Nord. Jordbrugsforsk. 1935, No. 4—7, S. 242—250. Erfahrungen von den Dränversuchen auf dem Versuchsgut Lanna. — **Ullberg, P. E.:** Jordens torrläggning och bevattning. Uddevalla 1936. Studiebibliotek i jordbrukslära. 5. Särtr. ur: Lärobok i jordbrukslära, 2a uppl., S. 75—118. Die Melioration und Bewässerung des Bodens.

Moorböden

Booberg, Gunnar: Gisselåsmyren. En växtsociologisk och utvecklingshistorisk monografi över en jämtländsk kalkmyr. 4:0 (2), Uppsala 1929. Das Gisselås-Moor. Eine pflanzensoziologische und entwicklungshistorische Monographie eines jämtländischen Kalkmoores. — **Dahlstedt, F.:** Trapagyttjor och Cladiummossar i Södertäljetrakten. Geol. fören. förhandl., Bd. 59, 1937, S. 293—299. Trapagyttjaböden und Claudiummooren in der Gegend von Södertälje. — **Dorff, Paul:** Järn- och manganutfällningarna i Svartökärr. (Mit deutscher Zusammenfassung.) Sv. Mosskulturför. Tidskr., 1932, No. 2, S. 97—108. Die

Eisen- und Manganausscheidungen im Niedermoor Svartökärr. — **Flodkvist, Herman:** Undersökningar rörande sättning av myrmarker vid Hjälmaren. Beret. om N. J. F.s 6. Kongres. Nord. Jordbrugsforsk. 1938, No. 4—7, S. 678—679. Untersuchungen über die Sackung der Moorböden bei Hjälmaren. — **Franck, O.:** Några försöksresultat rörande gyttjelerors brukning, kalkning och gödsling. Beret. om N. J F.s 6. Kongres. Nord. Jordbrugsforsk. 1938, No. 4—7, S. 346 bis 354. Einige Versuchsresultate betreffs der Bearbeitung, Kalkung und Düngung der Gyttjalehmböden. — **Granlund, Erik:** Kungshamnsmossens utvecklingshistoria jämte pollenanalytiska åldersbestämningar i Uppland. Stockholm 1931. Sveriges geologiska undersökning. Ser. C. Avhandlingar och uppsatser, 368, Årsbok 25 (1931), 1. Die Entwicklungsgeschichte des Kungshamnsmoors samt pollenanalytische Altersbestimmungen in Uppland. — **Granlund, Erik:** De svenska högmossarnas geologi, deras bildningsbetingelser, utvecklingshistoria och utbredning jämte sambandet mellan högmossbildning och försumpning. (Mit deutscher Zusammenfassung.) Sveriges geologiska undersökning. Ser. C. Avhandlingar och uppsatser, No. 373, Årsbok 26 (1932), 1, Stockholm 1932. Die Geologie der schwedischen Hochmoore. Ihre Bildungsbedingungen, Entwicklungsgeschichte und Verbreitung sowie der Zusammenhang von Hochmoorbildung und Versumpfung. — **Hjertstedt, H.:** Torvjordarnas beskaffenhet i olika län med avseende på torvslag och förmultningsgrad samt kalk- och kvävehalt. (Resumé en Francais.) Sv. Mosskulturför. Tidskr. 1936, No. 4, S. 448—484. Die Beschaffenheit der Torfböden in verschiedenen Bezirken in Hinsicht auf Torfart und Humifizierungsgrad nebst Kalk- und Stickstoffgehalt. — **Lundblad, Karl:** Jordmånsundersökningar på Svartökärr. (Deutsche Zusammenfassung.) Sv. Mosskulturför. Tidskr., 1935, No. 4, S. 142—166. Bodenuntersuchungen auf Svartökärr. — **Lundblad, Karl:** Svartökärr. En torvgeologisk och utvecklingshistorisk studie. (Deutsche Zusammenfassung.) Sv. Mosskulturför. Tidskr., 1936, No. 1, S. 47—74; No. 2, S. 108—149. Svartökärr. Eine torfgeologische und entwicklungsgeschichtliche Studie. — **Lundqvist, Gösta:** Studier i Ölands myrmarker. (Mit deutscher Zusammenfassung.) Sveriges geologiska undersökning. Årsbok 1928, Ser. C, No. 353. Studien der Moorböden Ölands. — **Lundqvist, G.:** Klotentjärnarnas sediment. (Deutsche Zusammenfassung.) Sveriges geologiska undersökning. Ser. C. Avhandlingar och uppsatser, No. 414, Årsbok 32 (1938); No. 4, Stockholm 1938. Sedimente der Klotenseen. — **Lundqvist, G.:** Sjösediment från Bergslagen (Kolbäcksåns vattenområde). (Deutsche Zusammenfassung.) Sveriges geologiska undersökning. Ser. C. Avhandlingar och uppsatser, No. 420, Årsbok 32 (1938); No. 10, Stockholm 1938. Seesedimente aus Bergslagen. — **Osvald, Hugo:** Myrar och myrodling. Stockholm 1937. Moore und Moorbau. — **von Post, Lennart:** Om Gotlands myrar. Sv. Mosskulturför. Tidskr., 1929, No. 4, S. 229—247. Über die Moorböden Gotlands. — **Stenberg, M.:** Gisselåsmyrens sättning under tioårsperioden 1922—1932. Handlingar till Lantbruksveckan år 1935, S. 172—191. Die Sackung des Gisselåsmoors während der 10-Jahresperiode 1922—1932. — **Thunmark, Sven:** Über die regionale Limnologie von Südschweden. Sveriges Geologiska Undersökning. Ser. C, No. 410, Årsbok 31 (1937), No. 6.

Notices of books and periodicals — Revue des livres et des périodiques — Bücher- und Zeitschriftenschau

(Papers received — Travaux communiqués — Eingesandte Schriften)

Annales Agronomiques, Organe des Stations de Recherche Agronomique. Redacteur en chef: A. Demolon, 9. année, No. 4 et 5, Juillet—Octobre 1939, p. 539 à 758.

Sommaire: Sir E. John Russell, L'érosion du sol. — Gabriel Bertrand, Sur la maladie du coeur de la betterave et son traitement par le bore. — G. Aubert, Lejeaille et Driss Bouazza, Observations sur les méthodes d'analyse mécanique des terres calcaires. — E. Radet, Observations sur la séparation de la fraction „argile" dans les terres calcaires de Champagne. — S. Miklaszewski, Détermination de la profondeur du labour. — J. Apsits, Quelques observations générales sur les façons culturales et les recherches d'agrophysique. — R. Salgues, Données d'ordre biochimique relevées au cours de divers essais de culture fourragère et maraîchère dans le midi de la France. — P. Elsocht et F. Hoed, Essais de fumures organisés en 1938 par le cercle d'études et de recherches pour l'amélioration du houblon en Belgique. — P. Desaymard, Application des méthodes statistiques de R.-A. Fisher aux expériences culturales. — Documentation. — Bibliographie. — Sommaire des périodiques.

Annales Agronomiques, Organe des Stations de Recherche Agronomique. Redacteur en chef: A. Demolon, 9. année, No. 6, Novembre-Décembre 1939, p. 771 à 856.

Sommaire: H. Burgevin et S. Henin, Dix années d'expériences sur l'action des engrais sur la composition et les propriétés d'un sol de limon. — G. Barbier, Le rôle de l'analyse du sol dans la fertilisation d'après la statistique des terres analysées dans les Stations Agronomiques. — L. A. Reiss, Essai de détermination des quantités d'eau nécessaires aux champs cultivés en se basant sur les données météorologiques. — Documentation. — Bibliographie. — Sommaires des Périodiques. — Table des matières.

Bodenkunde und Pflanzenernährung. 15. (60.) Bd., 1939, H. 5/6. Verlag Chemie G.m.b.H. Berlin.

Inhalt (Bodenkunde): Pozdena, L., Dreijährige Versuche über den Wasserhaushalt des Bodens. — Schmidt, L. u. W. Breitwieser, Die Anwendbarkeit der Kalium- und Phosphorsäure-Meßgeräte nach Schuhknecht. — Weibel zur flammenphotometrischen und kolorimetrischen Bestimmung von Kalium und Phosphorsäure in Bodenauszügen und Pflanzenaschen. — Scheffer, F. u. G. Halfter, Einfluß der Kationenbelegung auf die Farbtiefe der Humusstoffe. II.

Bodenkunde und Pflanzenernährung. 16. (61.) Bd., 1939, H. 1/2. Verlag Chemie, G.m.b.H. Berlin.

Inhalt (Bodenkunde): Rheinwald, H. u. G. Constantin, Über eine Einrichtung zur Durchführung der Laktatmethode von Egnér zur Bestimmung der leichtlöslichen Bodenphosphorsäure. — Woynoff, K., Ein weiterer Beitrag

zur Kenntnis einiger bulgarischer Böden. II. — Dittrich, H., Untersuchungen über die Bodengase. — Pfeffer, P., Eine Methode zur raschen titrimetrischen Bestimmung von Eisenoxyd und Tonerde nach deren Fällung mit Oxychinolin in Bodenauszügen und ihre Anwendung zur Erkennung von Anreicherungshorizonten.

Bodenkunde und Pflanzenernährung. 16. (61.) Bd., 1940, H. 3/4. Wiss. Schriftwalter: Prof. Dr. F. Giesecke, Berlin. Verlag Chemie, G. m. b. H. Berlin.

Bodenkundliche Arbeiten: Jung, E., Über einige bei Reaktion mit Humussäuren auftretende Wärmestörungen. — Jung, A., Pyknometrische Bestimmung des Wassergehalts und des spez. Gewichts von Böden.

Erdészeti Kisérletek. A. M. Kir. Földmivelésügyi Miniszter Fonhatósága Alatt Alló M. Kir. Erdészeti Kurató intézet folyóirata. — Forstliche Versuche, Forest Researches, Recherches forestières. — Szerkeszti: Roth, Gyula, Sopron, Ungarn, XLI, Evfölyam, 1—4, Szám. 1939.

Inhalt (bodenkundlich): Dipl.-Ing. E. Ijjász, Grundwasser und Baumvegetation unter besonderer Berücksichtigung der Verhältnisse in der Ungarischen Tiefebene (S.1—108). — K. Botvay, Adatok a szus penzió-oszlop forgómozgásának a szedimentácion elemzésnél megnyilvánuló hatósára. (Bodensuspensionen und Sedimentationen) S. 243—255. — K. Botvay, Beiträge über die Auswirkung der Drehbewegung der Suspensionssäule bei der Sedimentationsanalyse (S. 253 bis 255) u. a.

Journal of the American Society of Agronomy, published monthly by the Society Geneva, New York, vol. 31, No. 10, October 1939, p. 841—902.

Contents: R. S. Dyal, F. B. Smith and R. V. Allison, The Decomposition of Organic Matter in Soils at Different Initial pH. — J. M. Blume and E. R. Purvis, The Fixation and Release of Applied Potash on Three Coastal Plain Soils. — Bryon Shaw and L. D. Baver, Heat Conductivity as an Index of Soil Moisture.

Notes: Long-time Storage of Winter-Wheat. An Apparatus to Facilitate Photography of Small Macroscopic Objects. — Book Reviews: Melhus and Kent's Elements of Plant Pathology — de Vries' German-English Dictionary — Matlin's Growing Plants Without Soil — Lange's Handbook of Chemistry. — Agronomic Affairs: Professor Shaw, Professor Musbach, and Professor Hutton. — The Transactions of the Third Commission — The 1940 Tobacco Fertilization Recommendations. — Abstracts of Literature pertaining to Bioclimatology and Biometeorology.

Journal of the American Society of Agronomy, published monthly by the Society Geneva, New York, vol. 31, No. 11, November 1939, p. 903—989.

Contents: T. F. Buehrer, W. P. Martin and R. Q. Parks, The Oxidation-Reduction Potential of Alkaline Calcareous Soils in Relation to Pudling and Organic Matter Decomposition. — H. T. Rogers, The Relation between Soil Reaction, Erosion, and Aggregation of Silt and Clay in Clarksville Loam. — Hubert Allaway and W. H. Pierre, Availability, Fixation, and Liberation of Potassium in High-lime Soils.

Note: A Soil Moisture Tensiometer witch a Compact Manometer. Book Reviews: Goulden's Methods of Statistical Analysis. — Robbins and Rickett's Botany. — Treloar's Elements of Statistical Reasoning.— Buros' Research and Statistical Methodology.

Journal of the American Society of Agronomy, published monthly by the Society Geneva, New York, vol. 31, No. 12, Dec. 1939.

Contents: Clarence Dorman, Frederick H. Tucker, and Russell Coleman (p. 1020), The Effect of Calcium Arsenate upon the Productivity of several important Soils of the Cotton Belt.

Journal of the American Society of Agronomy, published monthly by the Society Geneva, New York, vol. 32, No. 1, January 1940.

Contents: W. B. Andrews, The Effect of the Vetch Cropping History and Chemical Properties of the Soil on the Longevity of Vetch Nodule Bacteria Rhizobium leguminosarum. — John P. Conrad and C. N. Adams, Retention by Soils of the Nitrogen of Urea and Some related Phenomena. — Book Reviews, Papadakis' Ecology of Field Crops. — Bennett's Soil Conservation. — Agronomic Affairs: A New Editorial Board for the Journal. — Student Section Essay Contest for 1940. — Eighth American Scientific Congress.

Journal of the Science of Soil and Manure, Japan (Nippon Dozyo-Hiryo-Gaku Zassi) vol. XIII, Nr. 4—7, 1939. (President S. Osugi, Vice-President S. Kasugari).

Contents Nr. 4: Y. Kamoshita u. M. Koyama: Removal of Absorbed Phosphoric Acid and Potassium form Soils by Means of Electrodialysis. — K. Tazaki, T. Ebihara u. Y. Ishigari: On the Water Culture of Citrus (Unshu-mikan). — R. Kawashima: On the Brown Forest Soil of warm and humid Type in Corea. — M. Tokuoka u. O. Gyo: Über den Einfluß des Zinks auf das Wachstum der Reispflanze. — T. Hirano: The Effect of Reaction and Lime Content of Soil on the Yield of Suger Cane. — M. Takasaki: Studies on the Utilization of Wild Grass. — H. Ishibashi: On the Relation between the Effects of Silica and Nitrogen, Silica and Phosphorus, in the Nutrition of Rice Plant.

Consents Nr. 5: Original Papers. — R. Kawashima: On the Brown Forest Soil in Forest Area of Northern Corea. — S. Morita: Studies on the Soils of Citrus Orchard in Japan (I), On the Soils of Citrus Orchard in Shizuoka Prefecture.

Contents Nr. 6: Original Papers: — S. Tesima: Change in Paddy-Field Soil Reaction Produced by Long-continued Use of Artificial Fertilizers. — M. Takasaki: Studies on the Fowl Excrement III, Excretive Quantity and its Treatment. — A. Fuyiwara: On the Soils Affected by Fumaroles. — M. Aoki: On the Nitrate-reduction in Paddy-Field Soil Part I. — K. Konishi and A. Imanishi: On the Respiration of Nodule Bacteria. Part 4. — M. Tokuoka and H. Morooka: Studien zur Eigenschaft Formoser Tonen (Ergänzung).

Contents Nr. 7: Original Papers. — J. Onodera: A Mathematical Expression of the Law of Minimum and the Method of Calculation of Economical Quantity of Fertilizer Appliable in Connection with the Law of Diminishing Return. — H. Misu: On the Nitrogen Absorption of Soils in Chorea (I). R. Kawashima: On the Reaction and Lime Saturation of Citrus Soil in Kjushu.

— S. Arakawa: Studies on the Decomposed Punices in Oita Prefecture. — M. Tokuoka und S. Gyo: Über die Beziehung von der Konzentration der Nährlösung dem Pflanzen, insbesondere Wurzelwachstum. — S. Morita: Studies on the Oxidation-reduction Potential of Soils (I), On the Oxidation-reduction Potential of Orchard and Tea Garden Soils and their Productivities. — K. Suminoe and M. Tanaka: Soil Micro-organismus in North China and Inner Mongoria (I).

Pedology, Editors W. Williams, D. Vilensky, L. Prasolov, A. Yarilov, Nr. 10, 1938.

Contents: W. R. Williams, M. A. S., Allunion Society of soilscientists at the Academy og Sciences of the USSR. and its tasks, next in turn. — Sakharov, J. P., Influence of perennial grasses on structure formation of leached out chernozems-Vershinin P. V. Some, Physical constants as influenced by organic matter. — Gladilovich, V. R., Influence on the dynamics of soil processes of different methods of tilling virgin podzolized soils. — Rüger, A. A., Contribution to the problem of soil resistance at working with plough ard plough point. — Gotschalk, J. F., Influence of forests on the water content of soilgrounds and the ground waters. — Isiumov, A. N., On the struggle against soil crust. — Ryshov, S. N., Durnovtzev, D. J., Ustinovich, A. F., The causes of the formation of a dense subarable layer in the irrigated lands of Middle Asia. — Merzliakov, J. P. and Silin, A. G., Experiments in the measurement of oxidation-reduction potenzial and of pH of meadow peats. — Gorkova, J. M., Nature of hydration water and its rôle in the formation of bounds between soil and ground particles. — Bibliography.

Pedology, Editors W. Williams, D. Vilensky, L. Prasolov, A. Yarilov, Nr. 1, 1939.

Contents: The XVIIIth Congress of the All-Union Communist Party (Bolsheviks). — A. A. Yarilov, V. V. Dokuchaev. — S. Zakharov, The last years of prof. V. V. Dokuchaev. — V. P. Smirnov-Loginov, In memory of V. V. Dokuchaev. — J. M. Schokalsky, The importance of V. V. Dokuchaevs work for geography. — J. S. Edelstein, In memory of V. V. Dokuchaev. — A. T. Kalachikov, V. V. Dokuchaev and his scientific heritage in the Ukrainian SSR. — L. J. Prasolov, The world soil map. — G. N. Vysotzky, Hydromelioration of our plain mainly with the aid of forests. — J. D. Sedletzky, Classification of colloidal minerals of soils. — K. P. Gorshenin, One of the unsolved pedological questions. — O. N. Mikhailowskaya, Must we follow Dokuchaev? — A. F. Tyuilin, The Dokuchaev soil science in the past and perspectives of its further development. — M. V. Chapek, Soil science and the science of colloids. — A. Yarilov, The Dokuchaev Soil-Commission. — P. A. Zemyatschensky, V. V. Dokuchaev as personality. — L. S. Berg, V. V. Dokuchaev as geographer. — N. P. Remesov, Dokuchaev soil science for socialist forestry. — M. M. Filatov, Dokuchaev soil science and the science of grounds. — V. J. Vernadski, M. A. S., The biogeochemical role of Aluminium and Silicium in soils. — J. N. Antipov-Karataev and V. N. Filippova, On the rate of the levelling out of the composition of exchangeable cations after the mixing of different soil Horizons. — M. J. Roshanetz, On the classification of soils. — S. A. Kudrin and A. N. Rosanov, Fossil peat-swampy soils in the pre-mountainregion of Mogol-Tau (Tadzhikistan). — Bibliography.

Pedology, Editors W. Williams, D. Vilensky, L. Prasolov, A. Yarilov, Nr. 2, 1939.

Contents: Yarilov, A., The Dokuchaev Soil-Commission. — Zemyatschenski, P. A., V. V. Dokuchaev as personality. — Berg, L. S., V. V. Dokuchaev as geographer. — Remesov, N. P., Dokuchaev soil science for socialist forestry. — Filatov, M. M., Dokuchaev soil science and the science of grounds. — Antipov-Karataev, L. N. and V. N. Filippova, On the rate of the levelling out of the composition of exangeable cations after the mixing of different soil horizons. — Vernadsky, V. J., The biogeochemical role of Aluminium and Silicium in soils. — Rozhanetz, M. J., On the classification of soils. — Kudrin, S. A. and Rosanov, A. N., Fossil peat-swampy soils in the pre-mountain-region of Mogol-Tau (Tadzhikistan). — Gorshenin, K. P., One of the unsolved pedological questions. — Mikhailowskaya, O. N., Must we follow Dokuchaev? — Tyuilin, A. F., The Dokuchaev soil science in the past and perspectives of its further development. — Bibliography.

Pedology, Editors W. Williams, D. Vilensky, L. Prasolov, A. Yarilov, Nr. 3, 1939.

Contents: 40 years "Pedology". A. A. Yarilov, The heritage of V. V. Dokuchaev. — F. N. Ghermanov, The genesis of the soil and its fertility. — M. G. Chizhevsky and N. A. Makarov, Biologic amelioration of alkali soils (solonets). — M. P. Petukhov, To the question regarding the mobility of phosphoric acid in podsolic and chernozem soils. — B. G. Gheitman and Kh. A. Pissokov, Investigations in the draining of forming lands of the non-chernozem zone of the USSR. — T. A. Malomakhova, A simplified method for separating loosly bound humic substances from chernosems. — G. Kh. Molotkovsky, A new method for taking their monolyths in the field. — A. Zavalishin, Conference for soil classification. — Conference at the Dokuchaev, soil Institute for large scale cartography of the soils of collective and soviet farms. — D. J. Tarrassov, Investigation of range and bogar lands in Tadzhikistan. — Nikitina, Pevelman, Research work of students of the Geol.-Pedol. faculty of the State University in Moscow. — Bibliography.

Pedology, Editors W. Williams, D. Vilensky, L. Prasolov, A. Yarilov, Nr. 4, 1939.

Contents: The third quinquennium—quinquennium of chemistry. — N. P. Remesov, D. N. Prianischnikov and the science of soils (50 years of scientific work). — A. V. Sokolov, Development and aims of scientific research works in the domain of agricultural chemistry in the USSR. (50 years jubilee of D. N. Prionischaikov, M. A. S.). — E. V. Bobko and A. A. Aghinyan, On the action of microelements on salizined soils. — F. V. Chirikov and V. V. Volkova, The transformation on the P_2O_5 of phosphate fertilizers in the main types of soils. — D. L. Askinasi and A. N. Shaposhnikova, The raising of the effectivity of phosphates on red soils. — V. A. Kovda and L. Y. Mamaeva. Salts toxisity limits in soils of Pokhta-Aral (Golodnaya Steppe) for alf-alfa and the cotton plant. — P. J. Romashey, The utilization of the nitrogen of leguminous grosses in meadow farming. — K. A. Dimitriev, The action of microelements on the development and yield of red clover on limed podsolized soils. — T. D. Koritzkaya, The utilization of the nutrient substances of dry soils by the

roots of plants. — D. V. Fedorovsky, Determination of water, in accessible to the roots of plants, in the soil. — History and present state of soil science. — Bibliography.

Pedology, Editors W. Williams, D. Vilensky, L. Prasolov, A. Yarilov, Nr. 5, 1939.

Contents: The tasks of soil science in the third quinquennium. — G. N. Vyssotzki, Cultivation of the medium and growths- an extrapolation of V. V. Dokuchaevs ideas. — J. J. Sinyaghin, To the question of the Genesis of grey soils. — F. E. Kolyassev, The evaporation of water by soil. — M. A. Pavlovsky, The waterpermeability of sod-podsolized virgin grey soils (in connection with their reclamation and tilling). — A. P. Malyanov, Soil swamping after total cutting down of woods. — J. J. Dobrogaev, Microbiological life of forest soil in connection with its swamping. — P. V. Protassov, The methods for the determination of exchangeable potassium in carbonate soils. — P. G. Grabarov, Comparative study of the methods for the determination of total humus in carbonatic soils. — A. F. Makarova, Comparative evaluation of the methods for the preparation of soil for microaggregate analysis. — History and present state of soil science. — Bibliography.

Pedology, Editors W. R. Williams, D. G. Vilensky, L. J. Prasolov, A. A. Yarilov, Nr. 6, 1939.

Contents: M. S. Gilyarov, The soil fauna and the life of the soil. — Ch. P. Mirimanyan, The chernozems of the Armenian S. S. R. — N. G. Jovenko, The influence of cultivating of loosely-busky grasses and of leguminous plants on the hydro-physical properties of chestnut soils. — V. V. Koperzhinsky, The physical properties and the ceration of meadow soils and their fertility. — L. P. Rozov, Artificial solonetsization of soil as a method of fighling water-losses due to filtration in irrigation-systems. — S. N. Zolotarev and Z. J. Dashevsky, An experiment in decreasing the filtration of water in the ground by means of sodium chloride. — N. K. Krupsky and Z. J. Kovdrja, Characteristic of mutual action of Ca-carbonate and gypsum with silicic-acid. — M. F. Budanov, Influence of the irrigation with sewage waters upon soils of the Odessa sewage farms. — History and present state of soil science. — Bibliography.

Pedology, Editiors W. R. Williams, D. G. Vilensky, L. J. Prasolov, A. A. Yarilov, Nr. 7, 1939.

Contents: 40-years jubilee of the scientific activity of L. J. Prasolov, M. A. S. — J. P. Hherassimov, A. A. Zavalishin and N. E. Ivanova, A new scheme of a general soil classification for the USSR. — E. N. Ivanova and A. N. Rosanov, The classification of salinized soils. — J. P. Gherassimov and N.N. Rozov, Main stageses of the development of small scale soil cartography in the USSR. — V. A. Kovda, The salt regime of the irrigated soils of Golodnaya Steppe (State Farm Pakhta-Aral). — J. N. Antipov-Karataev. To the question of the genesis of the illuvial horizons in solonssy. — A. F. Tiulin, Heterogenity of soil organomineral colloids as connected with the different quantitative and qualitative content of sesquioxides. — V. A. Franzesson, About varieties of forest-steppe and podsolic soils with a different content of manure. — G. M. Tarassashvili, About mountain-forest brouwn-eards of Abkhasia. —

A. G. Trutnęv, The soils of the southern part of Vologda Region. — S. S. Sobolev, Spreading of the erosion in the European part of the USSR. and measures for erosion control. — F. J. Gavriliuk, About large-scale soil survey. — Soil investigations in Azerbaidzhan by A. Oganessian.

Physical an Chemical Investigations of Soils. Bd. XX. Academy of Sciences of the USSR, Transactions of the Dokuchaiev Soil Institute Redaktion: J. N. Antipov-Karataev, Moskau 1939, p. 1—122, (russisch).

Contents: J. N. Antipov-Karataev, S. P. Onatzky and V. A. Chernov, On the laws governing the phenomena of interaction of clays and soils with electrolytes. — V. A. Chernot, The adsorption capacity of gels of Al_2O_3 and SiO_2 (alumosilicates) in dependence on the age and on the reaction of the medium. — V. A. Chernot, Quantitative regularities of the diffusion of anions in soils — L. P. Serdobolsky, Comparative evaluation of some methods for the determination of the stores of available potassium in the carbonatic soils of Central Asia. — P. A. Kriukov, Construction and devices for the determination of pH by means of a glass electrode. — E. A. Yarilova, A potentiometrical method of determining manganese.

Soil Science, Editor in Chief: Jacob G. Lipman. — Associate Editor: Herminie Broedel Kitchen, Vol. 48, No. 3, September 1939, p. 161—281.

Contents: V. Sadasivan and A. Sreenivasan, Solubilization and Movement of Organic Forms of Nitrogen in the Soil. — G. S. Fraps and A. J. Sterges, Possible Losses of Nitrogen from Acid Soils Trough the Decomposition of Nitrites. — Irvin C. Feustel, A. Dutilly and M. S. Anderson, Properties of Soils from North American Arctic Regions. — W. P. Kelley, W. H. Dore, A. O. Woodford and S. M. Brown, The Colloidal Constituents of California Soils. — Sterling B. Hendricks and Lyle T. Alexander, Minerals Present in Soil Colloids: I. Descriptions and Methods for Identification. — L. T. Alexander, S. B. Hendricks and R. A. Nelson, Minerals Present in Soil Colloids: II. Estimation in Some Representative Soil.

Soil Science, Founded 1916 by Jacob G. Lipman. — Associate Editor: Herminie Broedel Kitchen, Vol. 48, Nr. 4, October 1939, p. 281—360.

Contents: T. M. Mc Calla, The Adsorbed Ions of Colloidal Clay as a Factor in Nitrogen Fixation by Azotobacter. — Allan G. Sandhoff and C. E. Skinner, The Nitrification of Ammonium Thiocyanate (a Weed Eradicant) and the Effect of this Compound upon the Soil Population. — D. I. Arnon, Effect of Ammonium and Nitrate Nitrogen on the Mineral Composition and Sap Characteristics of Barley. — H. D. Chapman, Absorption of Iron From Finely Ground Magnetite by Citrus Seedlings. — A. Barreto, Summary of Recent Investigations on Brazilian Soils. — Feng Chao-Lin, An Indirect Method for Determining the Moisture Content of Soils at the "Sticky Point". — W. M. Broadfoot and W. H. Pierre, Forest Soil Studies: I. Relation of Rate of Decomposition of Tree Leaves to their Acid-Base Balance and Other Chemical Properties.

Soil Science, Founded 1916 by Jacob G. Lipman. — Associate Editor: Herminie Broedel Kitchen, vol. 48, Nr. 5, November 1939, p. 361—442.

Contents: F. Hardy and G. Rodrigues, Soil Genesis from Andesite in Grenada, British West Indies. — S. J. Toth, The Effect of Free Iron Oxide

Removal on Some Properties of Soil Colloids. — R. M. Pinckney and F. J. Alway, Reliability of the Proposed Suction Method of Determining the Moisture Equivalent of Soils. — Wilbur H. Duncan, Wilting Coefficient and Wilting Percentage of Three Forest Soils of the Duke Forest. — Frank Moser, The Influence of Cropping Practices on Some Physical and Chemical Properties of Soil. — Frank L. Stark, jr., John B. Smith and Frank L. Howard, Effect of Chloropicrin Fumigation on Nitrification and Ammonification in Soil.

Soil Science, Founded 1916 by Jacob G. Lipman. — Associate Editor: Herminie Broedel Kitchen, vol. 48, Nr. 6, December 1939, p. 443—527.

Contents: H. Jenny and A. D. Ayers, The Influence of the Degree of Saturation of Soil Colloids on the Nutrient Intake by Roots. — Horace J. Harper, The Effect of Natural Gas on the Growth of Microorganisms and the Accumulation of Nitrogen and Organic Matter in the Soil. — L. E. Ensminger and J. E. Giesekiug, The Adsorption of Proteins by Montmorillonitic Clays. — O. W. Beale, Dispersion of Lateritic Soils and the Effect of Organic Matter on Mechanical Analysis. — J. E. A. den Doop, The Genesis of Davidson Clay Loam. F. Hardy and G. Rodrigues, Factorial Diagrams. — Amar Nath Puri, Physical Characteristics of Soils. V. The Capillary Tube Hypothesis of Soil Moisture. — Thomas D. Rice, 1878—1939. — Charles Frederick Shaw, 1881—1939.

Soil Science, Founded 1916 by Jacob G. Lipman. — Associate Editor: Herminie Broedel Kitchen, vol. 49, Nr. 1, January 1940, p. 1—73.

Contents: J. G. Shrikhande, Effect of Narrow Carbon-Nitrogen Ratio and of Naturally Occurring Tannins in Decomposing Plant Materials upon the Production of Mucus. — J. E. Greaves, Louis Jones and Alice Anderson, The Influence of Amino Acids and Proteins on Nitrogen Fixation by Azotobacter Chroococcum. — H. Katznelson, Survival of Azotobacter in Soil. — J. B. Spulnik, R. E. Stephenson, W. E. Caldwell and W. B. Bollen, Effect of Waste Sulfite Liquor on Soil Properties aud Plant Gowth. — Bert E. Christensen, Glenn Simkins and Virgil Hiatt, A simple Apparatus and Procedure for the Determination of the Carbon Content of the Soil. — V. P. Sokoloff, A Rapid Method of Checking the Accuracy of Reported Water Analyses. — P. L. Hibbard, A Soil Zinc Survey in California. — Hans F. Winterkorn and George W. Eckert, Consistency and Physicochemical Data of a Loess Pampaneo Soil. I. Physicochemical Properties of Samples from Different Depths of a Profile.

The Empire Journal of Experimental Agriculture, vol. VII, No. 28, Octobre 1939.

Contents: A. Reifenberg, The Loess Soils of the Beersheba Region of Palestine. — E. S. West and A. Howard, Spray Irrigation. White Plate 9. — H. T. Cranfield, Experiments on the Manurial Value of Sewage Sludge from Septic Tanks. — H. N. Turner, The Residual Effects of Organic Fertilizers. — H. V. Garner and J. W. Weil, The Standard Errors of Field Plots at Rothamsted and Outside Centres.

Transactions of the Third Commission of the International Society of Soil Science. — Comptes Rendus de la Troisième Commission Intern. de la Science du Sol. — Verhandlungen der Dritten Kommission der Intern. Bodenkundlichen Gesellschaft; August 30—September 1. 1939, vol. A, p. 183 + vol. B, p. 44. New Brunswick, New Jersey, U.S.A. 1939.

General — Allgemeines — Généralités

Giesecke, F. Die bodenkundliche Forschung 1927/28—1937. Ein Überblick (betr. alle Länder der Erde). Geogr. Jahrbuch, 54. Jahrg., 1. Halbbd. Gotha, J. Perthes, 1939, S. 181—302.

van der Speek, J. David Jacobus Hissink, zijn werk als bodenkundige. Chem. Weekblad, Deel 36, Nr. 44 (1939), p. 732—737.

Yarilov, A. A. Charles Darwin. — Founder of Soil Science, Pedology, Nr 4, 1936 (englisch), p 523—529.

Yarilov, A. A. Biosphere, Hypergenesis, Soil. Pedology, No. 8, 1937 (russisch, with summary), p. 1095—1118.

Yarilov, A. A. The sources of Pedology in Russia. Pedology, No. 2, 1937 (russisch), p. 154—175

Yarilov, A. A. and **M. G. Pavlov.** The „Russian Thaer". Pedology Nr. 7/8, 1938 (russisch), p. 1013—1031.

Yarilov, A. A. Struggle of the living and the dead matter in nature and its reflection in the science of soil. Pedology, No. 10, 1937 (russisch), p. 1461—1488.

Yarilov, A. A. Geotaxierung. Pedology, Nr. 6, 1937 p. 908—912 (russisch mit deutschem Auszug).

Agricultural, plant nutrition and fertilization — Landwirtschaft, Pflanzenernährung und Düngung — Agriculture, nutrition des plantes et fertilisation

Albrecht, Wm. A., E. R. Graham and **C. E. Ferguson.** Plant growth and the break down of inorganic soil colloids. Contribution from the Department of Soils, University of Missouri, Columbia, Mai 1939. Soil Science, Vol. 47, Nr. 6, p. 455—458, June 1939.

Almeida, L. A. V. Beitrag zur Frage des Einflusses des physiologischen Charakters der Düngung auf den Wasser- und Humusgehalt des leichten Bodens. Diss. a. d. Inst. f. Pflanzenernährung d. Univ. Berlin, 35 S., 1939.

Bennett, H. H. Soil Conservation 993 + XVII pp. illus. 1939, ($ 6.00) McGraw-Hill. New York.

Eriksson, S. Über die Einwirkung der Kalidüngung auf die Festlegung der Phosphorsäure im Boden. Annalen der Landw. Hochschule Schwedens, Vol. 8, Uppsala, 1940, S. 87—130.

Garberg, E. Gransking av dyskingsjord innan Orkdal herad, Soer-Troendelag fylke. Landbrukstidende 1939, 8 S.

Giesecke, F. Die Phosphorsäurefrage in der Erzeugungsschlacht und ihre wissenschaftliche Bearbeitung. (Vortrag.) Aus: Die Phosphorsäure. Folge 2, Bd. 1939. Deutsche Verlagsges., Berlin SW 11, 10 S.

Giesecke, F. Pflanzenernährung. Aus: Gefüge und Ordnung der deutschen Landwirtschaft. Reichsnährstand-Verlags-Ges. Berlin 1939, 8 S.

Holzapfel, E. Der Einfluß verschiedener Nährsalzionen auf die Transpiration von Getreidepflanzen mit besonderer Berücksichtigung der Untersuchungsmethodik. Diss. aus Institut f. Pflanzenernährung usw. d. Univ. Berlin 1939.

Mitscherlich, E. A. Die Steigerung unserer Pflanzenerträge. Vortrag. Schriften der Königsberger Gelehrten-Gesellschaft, 16. Jahrg. Naturw. Klasse, H. 1. Verlag M. Niemeyer, Halle (S.) 1939, 12 S., XII Taf.

Semb, G. Noen undersoekelser over jordtemperaturen og forbold som har innflytelse på den. (Some Investigations on the soil temperature in the period of crowth and the conditions influencing it.) Meldinger fra Norges Landbrukshoegskole 1939.

Yarilov, A. A. Materials to the question of the evolution of natural soil fertility. Pedology, No. 4, 1937, p. 479—491. (Russisch.)

Yarilov, A. A. Discussion on crop rotations. Pedology, Nr. 4, 1938, p. 479—493. (Russisch.)

Soil biology — Biologie des Bodens — Biologie du sol

Aso, K., M. Migita and **T. Ihda.** The mechanism of nitrogen utilization by azotobacter. Soil Science, Vol. 48, Nr. 1, July 1939, 8 pp.

Káš, V. Mikrobiologická characteristica Klimatogenetických pudních typů. (Mikrobiologische Charakteristik der klimatogenetischen Bodentypen.) Annalen der Tschechischen Akademie der Landwirtschaft, XIV, 30, p. 86—100, 1939. (Tschechisch mit deutscher Zusammenfassung.)

Spirhanzl, J. Porronáni půd tretihornich rulových a žulových z jižnich Čech podie mikrobiologického prozkumu. (Ein Vergleich der südböhmischen Tertiär-Gneis und Granitböden auf Grund einer mikrobiologischen Durchforschung.) Annalen der Tschechischen Akademie der Landwirtschaft, Bd. XIV, 30, 1939, p. 120 bis 126. (Tschechisch mit deutscher Zusammenfassung.)

Yarilov, A. A. Geobiology. Pedology, Nr. 7, 1937 (russisch, with summary), p. 307—320.

Forest soils — Forstliche Bodenkunde — Sols forestiers

Hartman, F. Waldbodenprofil-Charaktertypen, ihre Naturgesetzlichkeit, Eigenart und waldbauliche Bedeutung. Centralbl. f. d. gesamte Forstwesen, H. 7/8, 9—11, 64. Jahrg., 1939.

Krauß, G., F. Härtel, K. Müller, G. Gärtner, H. Schanz. Standortsgemäße Durchführung der Abkehr von der Fichtenwirtschaft im nordwestsächsischen Niederland (vgl. diese Zeitschr., Nr. 6, 1939, S. 358). Berichtigung: es muß im Untertitel heißen „glei-artige" Bodenbildungen (statt gleichartig). Die Arbeit hat allgemein-bodenkundlichen Inhalt.

Peaty soils — Moorkunde — Sols de tourbières

Lundblad, K. Gulspetssjukan på Gisselås försöksgård. Resultat av en serie fältförsök åren 1928—1936. (Heidemoorkrankheit.) Mit deutscher Zusammenfassung. Svenska Vall- och Mosskulturföreningens Meddelanden, No. 2, 1939, p. 71—127.

Spirhanzl, J. Zur Frage der Einteilung und Untersuchung der Moore in der Tschechoslowakischen Republik. Verh. der 6. Komm. der Intern. Bodenkdl. Gesellschaft Zürich 1937, S. 281—285.

Großkopf, W. Über Vorerkundung und Bewertung unerschlossener Tropenböden. Kolonialforstliche Mitteilungen, Bd. II, H. 2. Verlag J. Neumann, Neudamm, S. 188—203.

Utescher, K. Chemische Untersuchung von Kamerunböden. Mitteilungen der Gruppe Deutscher Kolonialwirtschaftlicher Untersuchungen, Bd. I. Verlag W. de Gruyter u. Co., Berlin W 35, 1939, S. 203—229.

Regional soil science — Regionale Bodenkunde
Géographie pédologique régionale

Jonescu-Şişeşti, G. und **Gr. Coculescu.** Die Hauptbodentypen Rumäniens, Verbreitung, Beschreibung, Zusammensetzung, Fertilitätszustand, Düngerbedürfnis. Die Versuche der Jahre 1933—1936. Extras din Analele Institutuli de Cercetari Agronomice al Românici, Vol. X, 1938, Anul IX, Bucureşti 1939, S. 15—111.

Najmr, St. Polní a Lesní Půdy, soudniho okresu Mlada Boleslav. (Die Böden des Bezirks Jung-Bunzlau in Böhmen.) (Begleitbericht zur Bodenkarte.) Annalen der Landw. Forschungsanstalten (Direktor Ing. Dr. Jar. Spirhanzl), 167. Bd., 174 S., Prag 1939. (Tschechisch mit deutscher Zusammenfassung.)

Nevros, K. J. Die Bodenerosion. Eine Volksgefahr, die die Böden Griechenlands zerstört. Institut für Chemie u. Landwirtschaft „Nikolaos Kanellopulos", Drapetsona-Piräus, 1938, 58 S.

Spirhanzl, J. Porovnani půd třetihornich, rulovych a žulových 3 jiznich Čech podle agronomicko-pedologického výzkumu. (Ein Vergleich der südböhmischen Tertiär-Gneis- und Granitböden auf Grund einer landwirtschaftlichen bodenkundlichen Durchforschung.) Annalen der Tschechischen Akademie der Landwirtschaft, XIV, 24, 1939, S. 21—28. (Tschechisch mit deutscher Zusammenfassung.)

Zvorykin, J. A. Soil map of the Island Euboea; scale 1:200000 (Soil species + Soil types). Institut de Chimie et d'Agriculture „Nicolaos Canellopoulos", Piraeus—Griechenland. (Direktor Dr. K. J. Nevros).

Zvorykin, J. A. Soil map of the Island Zakynthos; scale 1:200000 (Soil pecies and Soil types). Institut de Chimie et d'Agriculture „Nicolaos Canellopoulos", Piraeus—Griechenland. (Direktor Dr. K. J. Nevros).

Yarilov, A. A. The soils of Egypt in ancient and modern times. Pedology, No. 1, 1937, p. 12—32. (Russisch with summary.)

Methods of investigation — Untersuchungsmethoden — Méthodes de recherches

Liu, Yi-Lung. Zur photometrischen Messung von Alkali- und Erdalkalimetallen. Diss. v. d. Institut f. Pflanzenernährung d. Univ. Berlin, 1939.

Mitscherlich, E. A. Zweiter Bericht über die Arbeiten und über die Tagung der Arbeitsgemeinschaft zur Prüfung der Laboratoriumsmethoden für die Bestimmung des Kali- und Phosphorbedürfnisses der Böden. Verhandelt in Stockholm am 5. Juli 1939, 56 S. Intern. Bodenk. Gesellschaft.

Neubauer, H. Die Keimpflanzenmethode. 168 S., 9 Textabb., Halbl.-Bd. Verlagsgesellschaft für Ackerbau m. b. H., Berlin SW 11. RM. 4,60.

Thun, R. Die Bodenuntersuchung im landwirtschaftlichen Betriebe. Arbeiten des Reichsnährstandes, Bd. 58, 84 S. Reichsnährstandsverlagsg. m. b. H., Berlin N 4. RM. 2,—.

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