STUDIES ON CEYLON SOILS

XVII.—THE PHYSICAL AND PHYSICO-CHEMICAL CHARACTERISTICS OF THE MAJOR SOIL TYPES OF CEYLON

BY

A. W. R. JOACHIM, Ph.D., B.Sc. (Lond.), Dip. Agric. (Cantab.), F.I.C.
CHEMIST

AND

S. KANDIAH, Dip. Agric. (Poona)
ASSISTANT IN SOIL SURVEYS

SUMMARY.

THE study of the physical and physico-chemical characteristics of the major soil types of Ceylon has revealed that :—

(i) In respect of specific gravity, pore space, water holding capacity, ignition loss, sticky point moisture and volume expansion, Ceylon soils are not dissimilar to the laterite and red soils of India and those of other tropical countries. Where marked divergences occur, they relate to local soils of high organic matter content.

(ii) High positive correlations exist between clay content and the water hoding capacity, sticky point moisture, moisture equivalent (Bouyoucos) and loss on ignition of the soils. The organic matter content is similarly correlated. Regression equations between the various factors have been worked out and discussed.

(iii) The rate of percolation and degree of friability of the soils are determined by the nature and amount of the clay in them.

(iv) The ultimate pH (U) of the soils is related to the nature of their clays, as characterized by the silica/sesquioxide molecular ratios of the latter (M). The relationship is an inverse one and is expressed by the regression equation $U = 4 \cdot 46 - 0 \cdot 43M$.

(v) The degree of dispersion of the soils and hence their erodibility appears to be governed mainly by the nature of the clay, the non-lateritic soils showing highest and laterite soils lowest dispersion ratios.

(vi) The base exchange capacity of the soils is determined by the amount and nature of both the clay and the organic matter. The contribution of these constituents to the exchange

capacity of our soils varies from 0·05 to 0·55 mgm. equivalents per gm. of clay and from 1·1 to 4·7 mgm. equivalents per gm. of organic matter.

(vii) There is, in general, a parallelism between the pH values and (*a*) the silica/sesquioxide ratios of the soils, (*b*) their degrees of saturation with respect to bases.

The soils of the dry zone of the Island are lateritic or non-lateritic in nature. They generally have high exchangeable base capacities when of high or medium clay content, low ultimate pH values, and frequently high base saturation percentages. They are thus neutral or moderately acid in reaction and fairly rich in available mineral nutrients. Their dispersion ratios are relatively high. They, therefore, tend to be easily erodible. Some of them are not friable when dry, and, when wet, are sticky and difficultly permeable to water. They would need careful cultivation if a fine soil tilth is desired.

The soils of the wet zone are invariably of the lateritic or laterite type. As compared with the dry zone soils they have generally lower exchangeable base capacities and are hence of lower mineral nutrient status. They are less saturated with bases and consequently more acid in reaction. Being more permeable to and less dispersible in water they drain better and are not so erodible as the former soils. They are also more friable when dry. They are, therefore, more amenable to cultivation under varying moisture conditions than the dry zone soils.

INTRODUCTION.

The study of the physical characteristics, particularly of the " single value constants " of soils has been the subject of investigation by a number of workers in other countries, notably Keen and Coutts (1) in Britain, Coutts (2) and Marchand (3) in South Africa, Prescott and Poole (4) in Australia, Hardy (5) in the W. Indies, Sen & Deb (6) in India, and Bennett in the U. S. A. (7). Little or no work has been hitherto done on this aspect of Ceylon soils, and it is with the objects of ascertaining (*a*) whether our soils conform generally in respect of their physical characteristics to those of other countries and (*b*) the significance of " single value constants " in the classification of local soils, that these investigations were undertaken. Simultaneously with these studies, the investigation of the relationships between the physical and physico-chemical properties and the chemical nature of our soils was carried out.

It would be useful here to review briefly the findings of previous workers on the subjects under discussion. All the earlier work had pointed to a very close relationship between the moisture status of the soil and the loss on ignition, which is a measure of the inorganic and organic colloid content of the soil. The sticky point moisture, moisture equivalent and hygroscopic water show a high degree of correlation with this factor. Most workers have found a positive correlation between these characteristics and the clay content of the soil, but when the partial correlations between the various factors are calculated, the relationships become much less definite in some cases.

The chemical nature of the soil has been found to have marked influence on the physical and physico-chemical properties of the soils. Laterite and lateritic soils of tropical countries, characterized by a silica/alumina molecular ratio of less than 2 in their clay fraction, have markedly different properties to the non-lateritic soils of tropical and temperate regions. The former are much less plastic and more friable, have higher combined water contents, lower swelling coefficients, expansion values and cohesiveness, and are less erodible and more permeable to water than non-lateritic soils. Their clays have appreciably lower base exchange capacities and higher ultimate pH values than non-lateritic clays. Laterite and lateritic soils, being formed under conditions of high rainfall and temperature, are of lower exchangeable base content, more unsaturated and hence more acid in reaction than non-lateritic soils. These physical and physico-chemical properties have, therefore, a close bearing on the agricultural values of local soils.

EXPERIMENTAL.

Under the temperature and rainfall conditions in Ceylon generally, the soils tend to be of the lateritic or less frequently of the laterite type, but large extents of non-lateritic soils occur in the "dry" zones of the Island. This has made possible the selection of local soils of somewhat widely-differing character. Thirty three soils have been included in the study. The physical characteristics investigated, the methods of determination adopted and the letters by which they are designated in the tables are as follows :—

1. Clay content (C) by the international method of mechanical analysis.

2. Hygrosopic water (R) by heating to constant weight at 105°C.

3. Sticky point moisture (S) by Keen and Coutt's method.

4. Loss on ignition (I) by heating in a muffle furnace to constant weight.

5–9. Waterholding capacity (W), volume expansion (V), pore space (P), apparent (So), and real specific gravity (Si), by Keen & Raczkowski's box method (8).

10. Moisture equivalent (E) by Bouyoucos' method (9).

11. Dispersion ratio by a modification of Middleton's method (10), using the settling times now adopted for silt and clay.

12. Rate of percolation (Rn) by Singh's (11) modification of Bouyoucos' technique.

13. Crushing force (P) by a simple modification of Papadakis' (12) method. The procedure adopted was as follows :—5 gms. of air dry soil are brought to the sticky point and made into a ball which is allowed to dry at air temperatures and then at 100°C. The ball is placed in a slight depression at a fixed point on a slab of wood partly faced with a metal sheet, to one end of which is hinged a similar slab of known weight. To the other end of the latter is fixed a pan. Weights are added to the pan till the ball just begins to crumble. The mean of 3 to 5 determinations per soil sample is taken. The crushing force is then calculated.

14. Friability index (F) of the clay. This is obtained from the formula $C/P \times 100$, C being the clay content and P the crushing force.

15. Base exchange capacity (B) Olson and Bray's (13) method. Organic matter (O) was estimated by the Budapest or dichromate method and the silica/alumina and silica/sesquioxide ratios from fusion analysis of the clay fraction.

PHYSICAL CHARACTERISTICS.

Results and Discussion.

The results of the determination of the physical characteristics are presented in *Tables I.* and *II.* The correlation coefficients and partial correlations between some of these factors are shown in *Table III.* In *Table IV.* are set down the range of variation of the more important characteristics of local soils, of the red laterite and lateritic soils of India and the tropical soils of Natal and Transvaal. The regression lines showing the relation between certain pairs of factors are shown in diagrams *I to V.*

An examination of the data in *Tables I, II. and IV.* will indicate that in respect of the specific gravity, pore space, water holding capacity, ignition loss, sticky point moisture and volume expansion, Ceylon soils are not dissimilar to the laterite and red soils of India and of other tropical soils generally. Where marked divergences occur, they relate to local soils of high organic matter content.

It will be observed from *Table III.* that there is a significantly high correlation between clay content and ignition loss, sticky point moisture and moisture equivalent, while that between clay content and hygroscopic water, though significant, is not marked. In other words the heavier soils have generally the higher values for these characteristics. The correlations are, however, reduced, and in the case of that between clay and hygroscopic water, becomes insignificant when the contribution of the loss on ignition to this correlation is eliminated. The highest correlation observed is that between ignition loss and sticky point. Confirmation is thus afforded of the finding of previous workers that the sticky point is largely controlled by the ignition loss (organic and inorganic colloidal material) and to a lesser degree by the clay content.

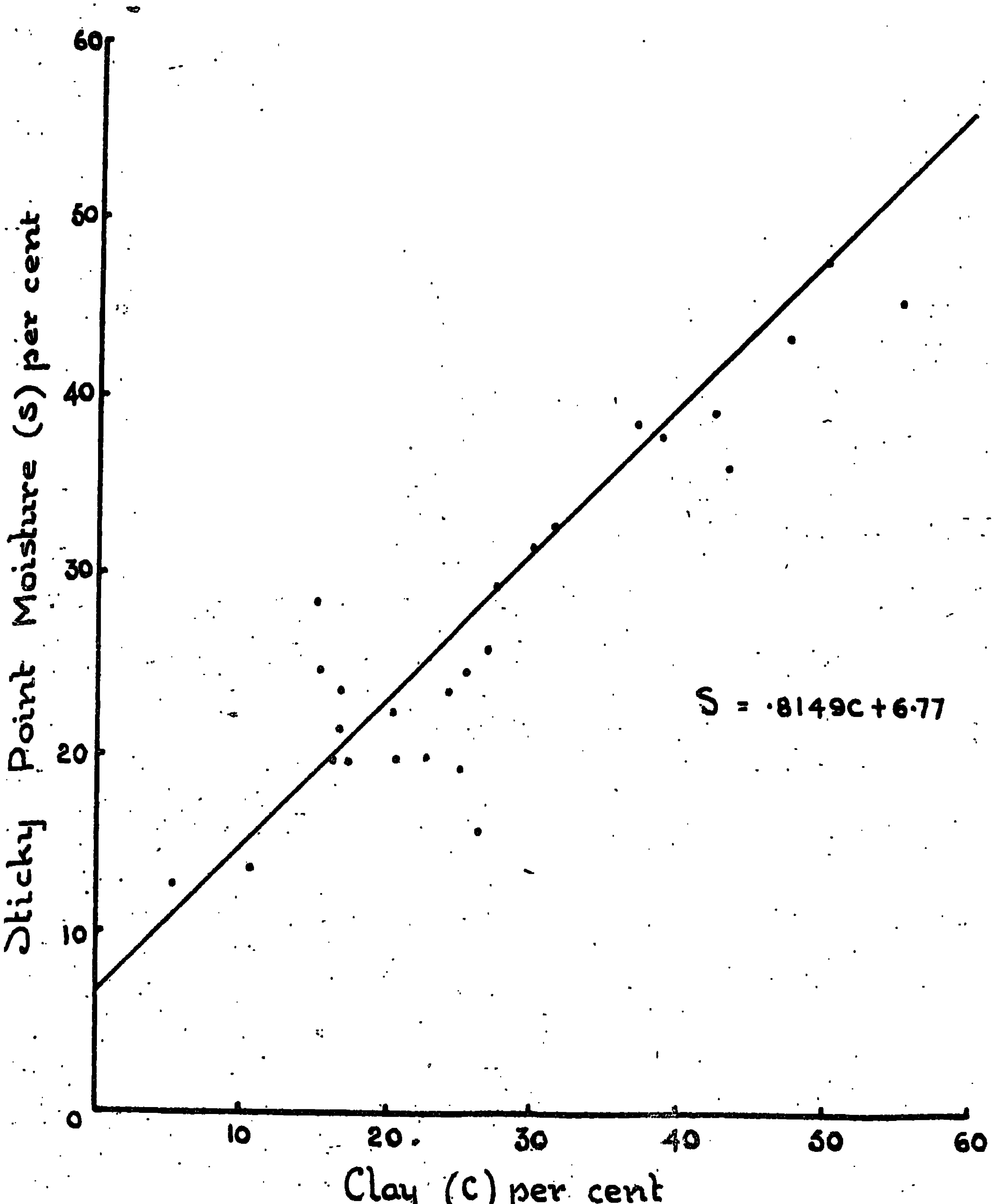
The equations showing the relative contributions of the clay (C) and organic matter (O) contents to the ignition loss (I) and the sticky point moisture(S) have been worked out by the method of partial regression coefficients and are as under :—

$$I_{oc} = 1{\cdot}93\ O + 0{\cdot}24\ C - 0{\cdot}3 \quad (R = {\cdot}9406) \quad (PI = 66{\cdot}1\%)$$

$$S_{oc} = 0{\cdot}88\ O + 0{\cdot}66\ C + 8{\cdot}8 \quad (R = {\cdot}7969) \quad (PI = 39{\cdot}6\%)$$

The multiple correlation coefficients (R) between the various factors are shown in brackets. From these the precision index (P.I) values have been calculated. It will be observed that the *amounts* of clay and organic matter of the soil samples account, on the average, for about 66 per cent. of the ignition loss and only about 40 per cent. of the sticky point moisture. Other factors such as the *nature* of the clay and the organic matter, &c., will account for the remainder.

Our data also confirm Sen and Deb's observation that the hygroscopic moisture (in their data, the moisture at 50 per cent. vapour pressure) is determined less by the clay content than by the ignition loss.



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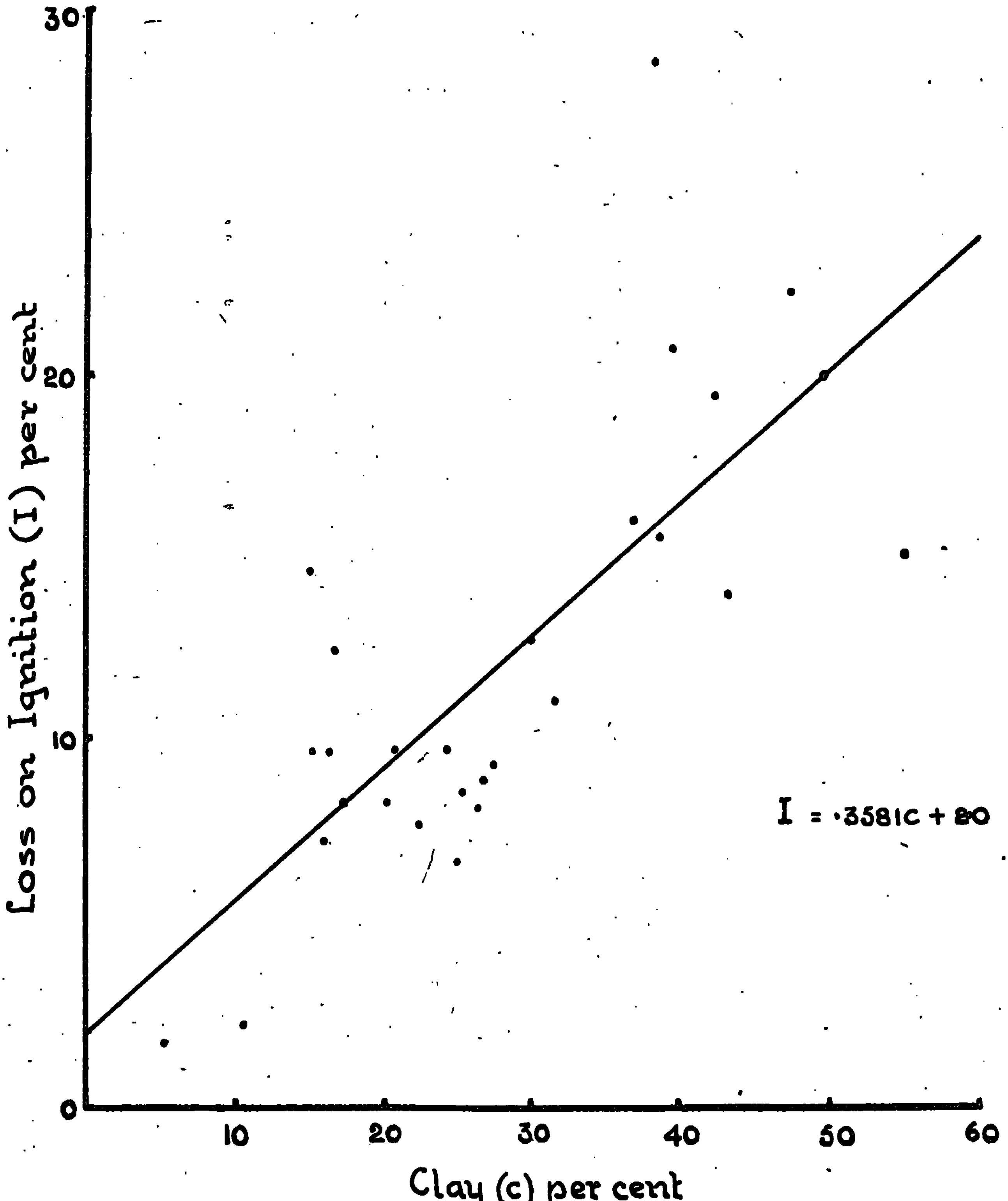

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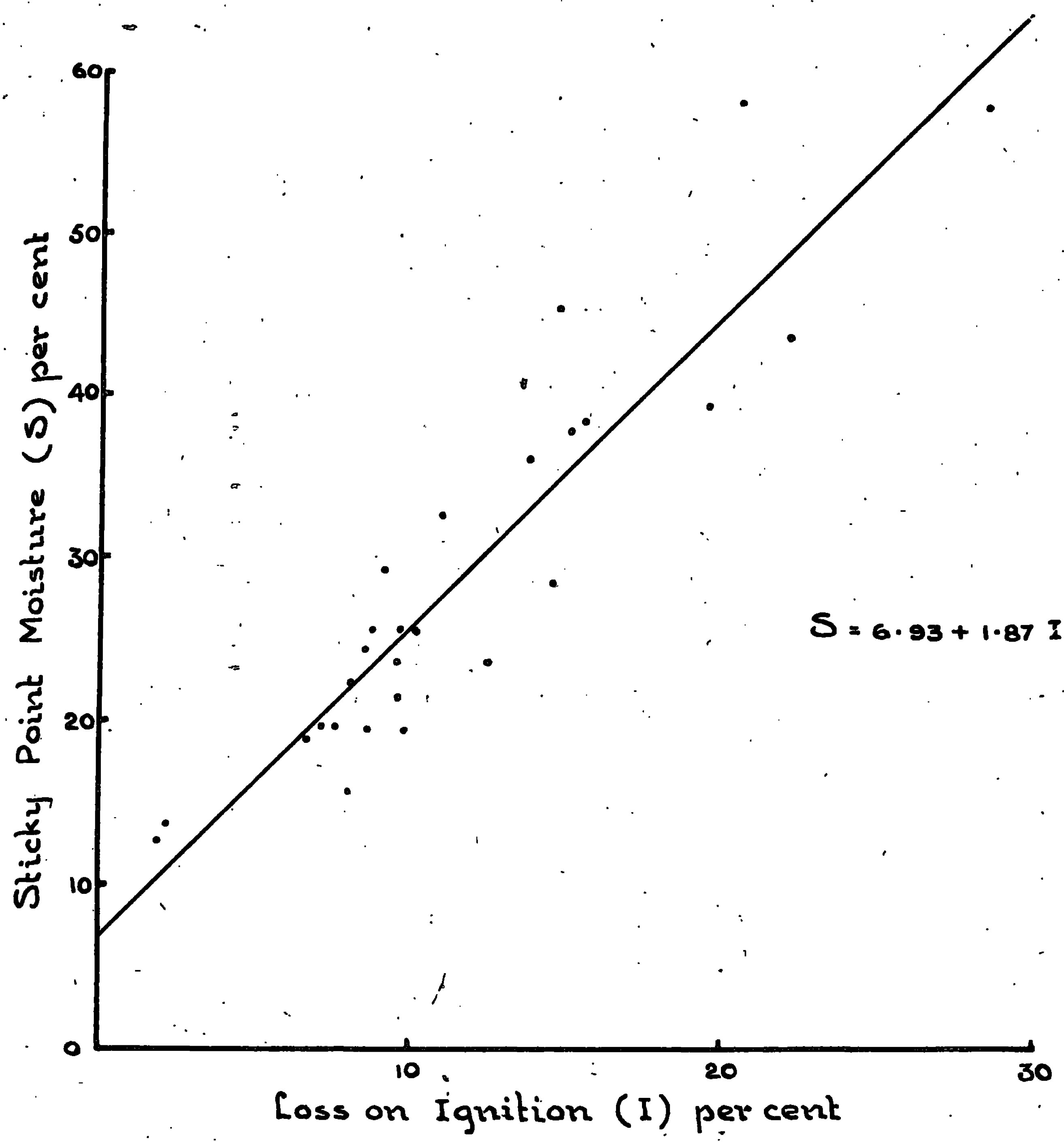

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TABLE I

Location.	Clay. Per Cent. C	Organic Matter. Per Cent. O	Appropriate Specific Gravity. So	Real Specific Gravity. S1	Maximum Water holding Capacity. Per Cent. W	Pore Space. Per Cent. p	Volume Expansion. Per Cent. V	Rate of Percolation. Min. Sec. Rn
Non-Lateritic Soils.								
1. Minneriya, Jungle A. Low country dry zone	20·7	2·39	1.32	2.66	41·1	45·1	5·9	24— 0
2. Minneriya, Damana A. Low country dry zone	25·3	1·39	1.31	2.64	37·8	45·9	9·1	20— 8
3. Minneriya, Damana C. Low country dry zone	27·5	1·02	1.30	2.04	36·6	45·5	—	35—40
4. Minneriya, Damana A. Low country dry zone	20·2	1·64	1.25	2.59	38·5	44·5	12·9	42—10
5. Minneriya, Damana C. Low country dry zone	26·9	0·98	1.34	2.66	39·4	42·7	—	7—hrs.
6. Vavuniya A. Low contry dry zone	22·6	2·82	1.33	2.36	35·8	43·9	4·4	27— 0
7. Vavuniya C. Low country dry zone	18·7	1·25	1.36	2.42	33·0	44·2	5·3	16— 5
8. Nalanda A. Low country dry zone	25·0	2·07	1.35	2.43	37·1	46·3	5·8	20— 0
9. Nalanda C. Low country dry zone	32·8	1·14	1.32	2.29	39·9	46·0	6·2	
10. Marawila A. Low country semi dry zone	5·2	0·72	1.54	2.44	23·1	35·1	—	8— 0
11. Marawila C. Low country semi dry zone	10·6	0·60	1.47	2.47	24·2	35·9	—	2— 0
Lateritic Soils.								
12. Jaffna A. Low country dry zone	26·2	0·77	1.35	2.47	36·7	44·8	4·1	21— 5
13. Jaffna C. Low country dry zone	41·7	0·57	1.31	2.43	40·4	47·6	4·3	13—10
14. Sigiriya A. Low country dry zone	24·2	3·41	1.27	2.32	42·7	48·1	6·8	16— 0
15. Sigiriya C. Low country dry zone	41·1	0·75	1.28	2.38	41·8	49·2	5·3	9— 0
16. Rikiligaskada A. Mid country wet zone	37·0	3·90	1.21	2.15	48·6	51·2	7·0	11— 0
17. Rikiligaskada C. Mid country wet zone	39·5	3·17	1.19	2.24	47·0	49·2	5·5	4— 0
18. Ambepussa A. Low country wet zone	43·2	3·13	1.18	2.06	46·2	46·8	9·6	9 —0
19. Ambepussa B. Low country wet zone	55·0	1·61	1.15	2.00	53·7	49·1	8·7	11— 0
20. Peradeniya A. Mid country wet zone	39·6	4·02	1.00	2.06	67·2	61·3	9·6	4— 0
21. Peradeniya B. Mid country wet zone	47·4	4·29	1.05	2.13	63·2	54·3	7·9	5— 0

Location.	Clay. Per Cent. C	Organic Matter. Per Cent. O	Appropriate Specific Gravity. So	Rea Specific Gravity. S1	Maximum Water holding Capacity. Per Cent. W	Pore Space. Per Cent. P	Volume Expansion. Per Cent. V	Rate of Percolation. Min. Sec. Rn
Laterite Soils.								
22. Bopath. Forest A. Up country wet zone	36·4	12·92	0.99	2.34	70·7	57·7	—	2— 7
23. Bopath. Forest B. Up country wet zone	43·4	1·83	1.07	2.46	66·0	56·5	—	2— 0
24. Bopath. Patana A. Up country wet zone	38·3	9·49	0.88	2.36	94·9	62·7	—	1—40
25. Bopath. Patana A. Up country wet zone	47·5	4·76	1.01	2.67	68·5	62·1	—	1—50
26. Balangoda A. Mid country wet zone	42·4	4·32	1.19	2.18	54·5	52·3	—	1— 8
27. Balangoda C. Mid country wet zone	38·7	1·24	1.13	2.10	46·2	49·5	—	0—54
28. Pasdun Korale Forest A. Low country wet zone	16·7	2·45	1.15	2.62	38·6	56·1	—	2—55
29. Pasdun Korale Forest C. Low country wet zone	17·3	1·43	1.24	2.61	35·5	52·5	—	2—41
30. Pasdun Korale— Fernland A. Low country wet zone	15·0	5·00	1.00	2.05	39·5	57·9	—	2—09
31. Pasdun Korale— Fernland C. Low country wet zone	16·6	2·33	1.23	2.54	37·8	51·5	—	2—49
32. Horana A. Low country wet zone	16·1	2·37	1.29	2.09	35·7	41·2	7·4	6— 0
33. Horana C. Low country wet zone	17·1	1·19	1.37	2.17	34·8	39·7	5·4	2— 0

TABLE II.

Location.	Clay Si/Al ratio.	Si/R ratio.	Clay. Per Cent.	Organic matter. Per Cent.	Loss on ignition. Per Cent.	Combined water. Per Cent.	Hygros copic water. Per Cent.	Sticky point moisture. Per Cent.	Moisture equivalent. Per Cent.	Dispersion ratio.	Crushing force.	Friability Index.
	A	M	C	O	I	H	R	S	E	D	P	F
Non-Laterite Soils												
1. Minneriya Jungle A Low country dry zone	4.68	3.45	20.7	2.4	9.7	2.5	4.8	19.8	18.9	—	94.4	21.9
2. Minneriya Damana A Low country dry zone	3.07	2.41	20.2	1.6	8.3	3.0	3.7	22.3	20.4	17.1	124.1	16.3
3. Minneriya Damana C Low country dry zone	3.07	2.36	26.9	1.0	8.8	3.1	4.7	25.7	24.2	13.2	—	—
4. Minneriya Damana A Low country dry zone	2.86	2.26	25.3	1.4	8.5	3.2	3.9	24.2	19.4	17.7	97.7	25.9
5. Minneriya Damana C Low country dry zone	2.80	2.23	27.5	1.0	9.3	3.5	4.8	29.3	28.1	16.7	107.5	25.6
6. Tunnukkai A. Low country dry zone	2.81	2.56	31.7	.09	11.1	4.2	6.0	32.8	—	—	83.7	37.9
7. Nalanda A. Low country dry zone	2.34	1.69	25.0	2.1	6.6	2.6	1.9	19.0	18.2	8.9	45.0	55.6
8. Vavuniya A. Low country dry zone	2.11	1.79	22.6	2.8	7.6	2.3	2.5	19.9	14.7	12.6	35.4	63.8
9. Marawila A. Low country semi dry zone	2.02	1.67	5.2	0.7	1.9	0.7	0.5	12.6	8.1	10.4	5.4	96.3
10. Marawila C. Low country semi dry zone	1.94	1.63	10.6	0.6	2.1	1.0	0.5	13.6	9.0	10.8	—	—
Lateritic Soils.												
11. Jaffna A. Low country dry zone	1.93	1.56	26.2	0.8	8.2	4.5	2.9	15.3	15.8	9.6	31.8	82.4
12. Mannampitiya A. Low country dry zone	1.84	1.45	15.1	0.9	9.8	3.1	3.8	24.6	—	—	—	—
13. Sigiriya A. Low country dry zone	1.72	1.45	24.2	3.4	9.6	3.5	2.7	23.6	21.6	9.0	31.8	76.1
14. Ambepussa B. Low country wet zone	1.69	1.47	55.0	1.6	14.9	9.8	3.5	45.2	32.4	5.9	97.8	56.2
15. Peradeniya A. Mid country wet zone	1.62	1.21	39.6	4.7	20.6	9.9	6.0	57.9	46.1	11.3	45.0	88.0
16. Ambepussa A. Low country wet zone	1.59	1.40	43.2	3.1	13.9	7.8	3.0	36.0	28.3	6.3	56.8	76.1

Location.	Clay Si/Al ratio. A	Si/R ratio. M	Clay. Per Cent. C	Organic matter. Per Cent. O	Loss on ignition. Per Cent. I	Combined water. Per Cent. H	Hygroscopic water. Per Cent. R	Sticky point moisture S	Moisture equivalent. Per Cent. E	Dispersion ratio. D	Crushing force. P	Friability Index. F
17. Rigiligaskade A. Mid country wet zone	1.59	1.26	37·0	3·9	15·7	8·3	3·5	38.3	32·2	4.7	54.2	68.3
18. Balangoda A. Mid country wet zone	1.40	1.11	42·4	4·3	19·3	10·9	4·1	39.1	29·7	1.9	18.6	228.0
19. Balangoda B. Mid country wet zone	1.38	1.08	38·7	1·2	15·3	10·6	3·5	37.9	27·1	1.9	39.3	98.5
Lateric Soils												
20. Bopath. Patana B. Up country wet zone	1.30	0.92	47·5	4·8	22·2	11·5	5·9	43.1	35·8	2.8	—	—
21. Pasdunkorale Forest C. Low country wet zone	1.27	0.95	17·3	1·4	8·3	5·7	1·2	19.7	14·1	—	21.1	82.0
22. Pasdunkorale. Fern-land B. Low country wet zone	1.19	0.89	16·6	2·3	9·6	4·9	2·4	21.4	15·5	—	26.1	63.6
23. Bopath. Patana A. Up country wet zone	1.15	0.81	38·3	9·5	28·5	12·8	6·2	57.5	37·2	3.1	5.4	709.3
24. Pasdunkorale Fern-land A. Low country wet zone	1.02	0.81	15·0	5·4	14·7	5·8	3·5	28.2	20·6	3.3	5.4	277.8
25. Pasdunkorale Forest A. Low country wet zone	0.96	0.79	16·7	2·5	12·5	6·6	3·4	23.4	14·4	—	—	—
26. Horana A. Low country wet zone	0.84	0.71	16·1	2·4	7·1	2·8	1·9	19.7	14·3	4.0	5.4	298.1

The regression equations between the pairs of factors discussed above are as follows :—

$$C = 4{\cdot}5\,R + 11{\cdot}1$$
$$C = 0{\cdot}82\,S + 3{\cdot}4$$
$$C = 1{\cdot}53\,I + 9{\cdot}2$$
$$S = 1{\cdot}87\,I + 6{\cdot}9$$
$$S = 0{\cdot}82\,C + 6{\cdot}8$$

From the above the following conclusions may be drawn for the range of soils examined :—

(1) the colloidally held water is approximately 1·9 times the ignition loss ;

(2) the interstitial water is 6·9 per cent. This compares very closely with the value of 7·0 per cent. obtained by Keen (14) for a wide range of 250 soils of varying character from different countries, but differs markedly from the figure 16·0 per cent. obtained by him for English soils (1). This demonstrates clearly that the soil characteristics vary appreciably with the nature of the soils.

(3) the amount of mineral colloid is roughly 1·5 times the ignition loss ;

(4) about 9 per cent. of the clay in local soils does not function as such. This figure is identical with that obtained by Sen and Deb (6) for the Indian lateritic soils.

Reverting to the data of *Table III.* it will be seen that the correlations between the clay content on the one hand and pore space and water absorption capacity on the other, while being significant are not markedly so. Our results here differ somewhat from those of some earlier workers who found a very high correlation between these factors. The reason for the divergence is to be found in the widely differing nature of our soils espacially in respect of organic matter content. The simple and multiple regression equations between these factors are shown below :—

$$W = 0{\cdot}83\,C + 17{\cdot}8$$
$$W = 0{\cdot}68\,C + 4{\cdot}76\,O + 13{\cdot}8\ (R = {\cdot}8663)$$
$$C = 0{\cdot}59\,W + 3.0$$
$$p = 0{\cdot}30\,C + 40{\cdot}1$$

It will also be noted that there is a significant positive correlation between water absorption capacity and organic matter content, and that the latter contributes appreciably to the former in humic soils. The total contribution of both clay and organic matter to water absorption capacity is, however, only about 50 per cent. on the average. Pore space no doubt largely determines the remainder.

The regression between P and C for Natal soils has been found by Coutts (2) to be $p = 0{\cdot}50\,C + 37{\cdot}1$. " The pore space at zero clay ", viz., 37 per cent. is not very different to that found by us, viz., 40 per cent.

The relations between the nature of the clay and ignition loss, dispersion ratio, friability and rate of water percolation will now be examined. It will be seen from *Table III.* that there is a significant, though not very high negative correlation between the silica[1] sesquioxide molecular ratio of the clay fraction (M) and the loss on ignition. This would have been higher if the soils of the ultra-wet low country had been omitted. Sen and Deb (6) found a much higher correlation between these factors for the red lateritic group of soils. The regression equation between the two factors for our soils is $I = 17{\cdot}3 - 3{\cdot}64\,M$. It has to be emphasized that this relation is only of general applicability and would show wide discrepancies with individual soil samples. Laterite and lateritic soils generally show higher ignition losses than non-lateritic soils, especially when the effect of clay content is eliminated.

TABLE III.

Correlation Coefficients between Physical Characteristics and Clay Content.

	I	S	R	E	W	P	M
C	·7336*	·8187*	·5870*	·8487*	·6990*	·5399*	—·1097*
I	—	·9186*	·7286*	—	—	—	—.4082
R	—	·7236*	—	—	—	—	—
S	—	—	—	—	—	—	·2949

Partial Correlation Coefficients.

SI. C	·8298*	RI. S	·2344
SC. I	·5391*	SC. R	·7044*
RC. I	·1128	MS. C	—·3594
RI. C	5411*	MI. C	—·4851*

Correlation Coefficients between Organic Matter Content and Physical Characteristics.

	I	S	W	C
O	·8218*	·6711*	·7372*	·3767

*Indicates Significance.

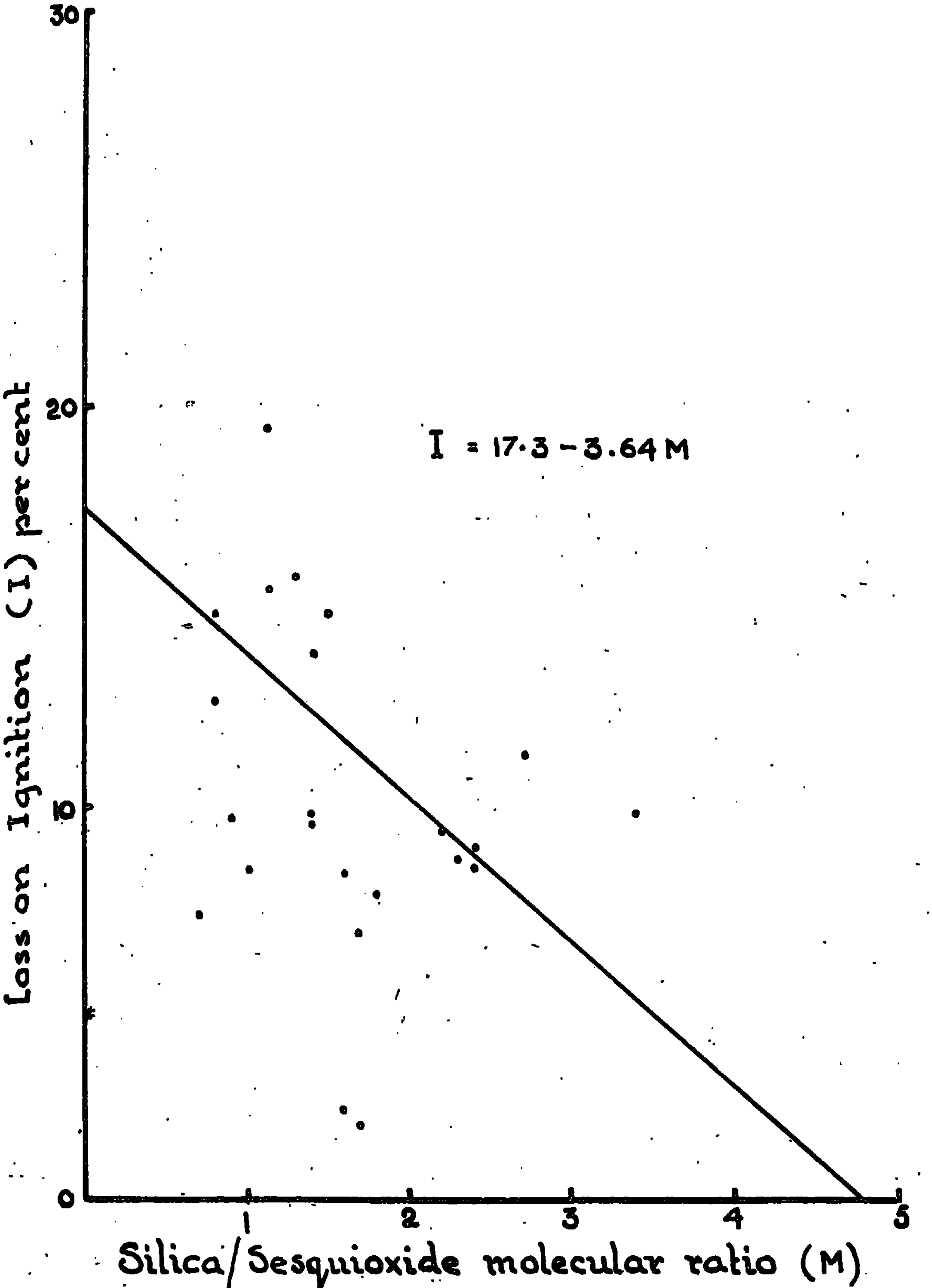
An examination of the dispersion ratios of the soil samples shows that the degree of dispersion in water and hence the erodibility of the soils is governed mainly by the nature of the clay and not by its amount, non-lateritic soils showing highest and laterite soils lowest dispersion ratios. Calculations of the "erosion ratios" of the samples by Middleton's (10) formula have given very similar figures to the dispersion ratios in the majority of instances. This points to the conclusion that the dispersion ratio would furnish a rough index of the erodibility of local soils.

The crushing force data show that the cohesiveness of soils is determined both by the nature and the amount of clay. Laterite soils have highest friability index values and non-lateritic soils lowest values. The wet zone soils of the Island should, therefore, be more amenable to cultivation when dry than those of the dry zone.

Similar observations have been noted in respect of the permeability of our soils to water. The rate of percolation is determined both by the nature of the clay and its amount. Laterite soils are most readily permeable to water, while non-lateritic soils are least so.

TABLE IV.

Physical Characteristics.	Ceylon Soils.	Indian Red Soils. (Sen and Deb).	Transvaal Soils. (Merchand).	Natal Soils (Coutts).
Apparent Specific Gravity	0.94— 1.54	1.07— 1.78	1.27— 1.62	—
Real Specific Gravity	2.00— 2.66	2.28— 2.96	2.18— 2.51	—
Volume Expansion	4.1 —12.9	2.0 —10.0	3.7 —45.	4.2 —16.8
Pore Space	35 —63	30 —54	33 —57	33 —67
Sticky Point Moisture	12.6 —57.9	12.7 —48.3	—	19.5 —67.8
Moisture Equivalent	8.1 —46.1	—	—	—
Water holding Capacity	23 —95	22 —63	22 —63	20 —74
Ignition Loss	2.1 —28.5	2.6 —23	1 —9	2.9 —25.3



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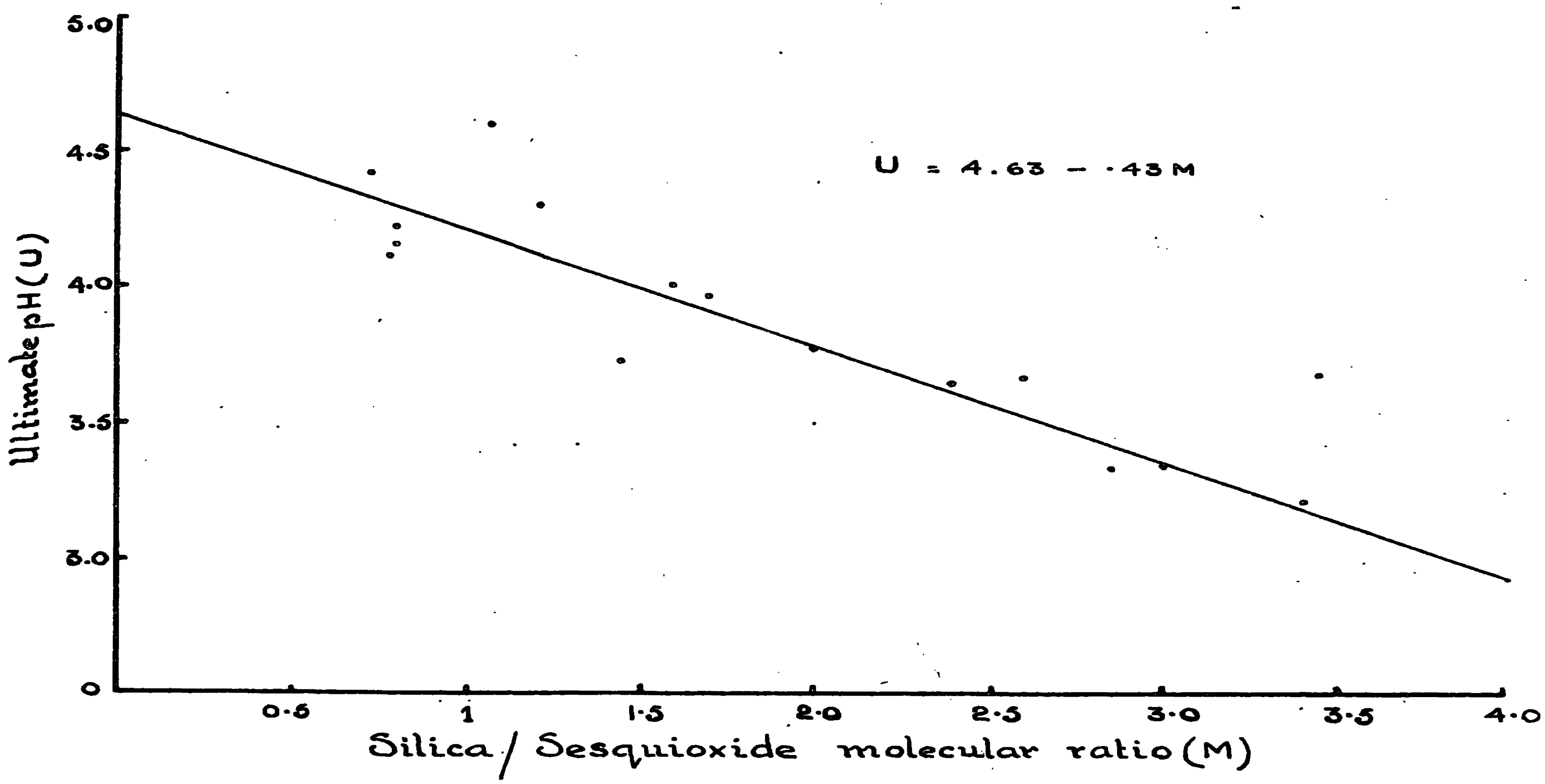

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PHYSICO—CHEMICAL CHARACTERISTICS.

Sixteen typical soil samples were examined for the following physico-chemical characteristics :—base exchange capacity, total base exchange content, original and ultimate pH, and degree of base saturation. The ultimate pH was determined by the quinhydrone method on electrodialysed samples of the soils. The results are shown in *Table V*.

Attempts were also made to ascertain the relative contribution of the clay and organic matter to the base exchange capacity of selected local soil types. This was done by three methods : (*a*) by determining the base exchange capacity, clay and organic matter contents of the A and C horizons or one of two representatives soil profiles of each of the three groups of soils and calculating the unit clay and organic matter base capacities by algebraic methods ; (*b*) by ascertaining the clay, organic matter and base capacities for a number of soils in each group, averaging the results, and solving the indeterminant equation so obtained for positive, integral values ; (*c*) by Craig's (15) procedure which consisted in determining the base exchange capacity of the air-dry soil and of soil heated to 250°C with ammonium nitrate, at which temperture he found that the organic matter was destroyed. This method was found, however, to give in certain cases appreciably lower values for the base capacity of the clays than those obtained by the first two methods indicated.

RESULTS AND DISCUSSION.

The relation between the ultimate pH and the nature of the clay (Si/Al and Si/R molecular ratios) is descernible from the high negative correlation coefficients between the two pairs of factors, viz.,—0·902 and—0·884 respectively and the regression equations

$$U = 4{\cdot}63 - 0{\cdot}43\ M_1$$
$$U = 4{\cdot}61 - 0{\cdot}34\ M_2$$

where M_1 is the Si/R molecular ratio, M_2 the Si/Al ratio and U the ultimate pH. These results confirm the work of Mattson (16) and Prescott and Arthur (17) who found that laterite and lateritic soils have higher ultimate pH values than non-lateritic soils. The regression line obtained by the Australian workers on a wide range of Australian, Indian and American soils, viz., $U = 5{\cdot}06 - 0{\cdot}488\ M$ is seen to be similar to that obtained by us.

The data of *Table V*. in respect of pH values, base saturation percentages and Si/R ratio show, in general, a parallelism between pH values and (*a*) the silica/ sesquioxide ratios, the more non-lateritic the soil the higher being the pH value, (*b*) base saturation percentages—the lower values being generally associated with the laterite and lateritic soils.

As regards the relative contribution of clay and organic matter to the base exchange capacity of our soils, it will be seen from *Tables V*. and *VI*. that this is dependent on both the nature and amount of each constituent. In the case of clay, the base capacity varies from 0·05 mgm. equiv. per gm. for laterite and lateritic clays to 0·55 mgm equiv. per gm. for non-lateritic clays. The data are in general conformity with those of Mattson in the U. S. A. (16), Prescott and Hosking (18) in Eastern Australia, and Craig in Mauritius (15), but our figures are generally low owing to the lateritic nature of our soils.

TABLE V.

Location.	Clay. (C) Per Cent.	Organic matter (O) Per Cent.	Si/Al (molecular) ratio.	Si/R (molecular) ratio.	Original pH	Ultimate pH	Total exch. bases m.e. Per Cent.	Base Capacity m.e. Per Cent.	Base capacity. per gm.	Base Saturation. Per Cent.
Non-Lateritic Soils.										
1. Tambelagam. Low country dry zone	38·6	0·8	4.38	3.41	6.80	3.20	21·4	27·3	—	78·4
2. Minneriya Jungle. Low country dry zone	20·7	2·4	4.68	3.45	6.83	3.68	12·3	14·5	C : 0.55	84·9
3. Minneriya Damana. Low country dry zone	20·2	1·6	3.68	2.41	6.84	3.64	16·7	18·3	O : 3.4	91·5
4. Unnichchai. Low country dry zone	6·8	0·4	3.32	2.85	5.13	3.33	0·3	0·8	—	35·0
5. Tunukkai. Low country dry zone	31·7	0·9	2.81	2.56	8.60	3.66	76·3	—	—	—
6. Nalanda. Low country dry zone	25·0	2·1	2.34	1.69	7.20	3.96	9·4	9·4	—	—
Lateritic Soils.										
7. Jaffna. Low country dry zone	26·2	0·8	1.93	1.66	7.76	4.00	8·5	6·7		—
8. Rikiligaskada. Mid country wet zone	37·0	3.9	1.59	1.26	5.5	—	4·0	10·4	C : 0.16	38·4
9. Sigiriya. Low country dry zone	24·2	3·4	1.70	1.45	6.90	3.73	4·2	12·7	O : 1.76	—
10. Peradeniya. Mid country wet zone	39·6	4·7	1.62	1.21	5.56	4.31	7·5	15·3		49·2
11. Balangoda. Mid country wet zone	42·4	4·3	1.38	1.05	6.40	4.60	0·8	9·2		8·9
12. Belunmahara. Mid country wet zone	57·6	1·8	—	—	4.60	—	3·6	8·4		40·5
Laterite Soils.										
13. Bopath Patana. Up country wet zone	38·3	9·5	1.15	0.81	4.56	4.23	2·0	20·1		7·6
14. Pasdun Korale. Fernland. Low country wet zone	15·0	5·0	1.02	0.81	5.00	4.16	1·4	13·3	C : 0.08 O : 2.2	10·0
15. Pasdun Korale. Jungle. Low country wet zone	16·7	2·5	0.96	0.79	5.20	4.13	1·0	7·2	or C : 0.05	13·7
16. Horana. Low country wet zone	16·1	2·4	0.84	0.71	6.20	4 13	0·8	7·2	O : 2.05	11·1

Table VI.

Non-Lateritic Soils.	Clay (C) Per Cent.	Organic matter (O) Per Cent.	Base Exchange Capacity m.e. Per Cent.	Base Exchange Capacity m.e. per gm.
Minneriya A	25.3	1·39	15·98	..C: 0·52
Do. C	27.5	1·02	19·03	..O: 4·7
Lateritic Soils.				
Sigiriya A	24·2	3·41	12·34	..C: 0·19
Do. C	41·1	0·75	9·45	..O: 2·1
Balangoda A	42·4	4·32	9·24	..C: 0·10
Do. C	38·7	1·24	5· 3	..O: 1·1
Laterite Soils.				
Bopath. Forest A	36·4	12· 9	38·20	..C: 0·15
Do. C	43·4	1· 8	11· 3	..O: 2·5

The base capacity of organic matter appears to vary with climatic conditions. Our figures range from 1·1 to 4·7 mgm. equiv. per gm. of organic matter as compared with an average value of 2·5 found by Craig for the tropical soils of Mauritius, 5·12 for the red basaltic soils of Eastern Australia and the range of 2·5 to 4·5 quoted by Robinson (19) as the exchange capacity of humus.

GENERAL DISCUSSION.

From this study of the physical and physico-chemical characteristics of representative samples of the major types of our soils, certain general conclusions of practical importance to Agriculture in the Island can be drawn, particularly with regard to the mineral nutrient status of wet and dry zone soils and their behaviour under cultivation during dry and wet weather.

The soils of the dry zone of the Island are lateritic or non-lateritic in nature. They generally have high exchangeable base capacities when of high or medium clay content, low ultimate pH values, and frequently high base saturation percentages. They are thus neutral or moderately acid in reaction and fairly rich in available nutrients. Their dispersion ratios are relatively high. They, therefore, tend to be easily erodible. Some of them are not friable when dry, and, when wet, are sticky and difficultly permeable to water. They would need careful cultivation if a fine soil tilth is desired.

The soils of the wet zone are invariably of the lateritic or laterite type. As compared with the dry zone soils they have generally lower exchangeable base capacities and are hence of lower mineral nutrient status. They are less saturated with bases and consequently more acid in reaction. Being more permeable to and less dispersible in water, they drain better and are not so erodible as the former soils. They are also more friable when dry. They are, therefore, more amenable to cultivation under varying moisture conditions than the dry zone soils.

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