Morley and Blount Soils: A Statistical Summary of Certain Physical and Chemical Properties of Some Selected Profiles from Ohio[1]

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ABSTRACT

Statistics including the mean, range, coefficient of variation, and standard deviation are reported for particle-size distribution, organic matter content, calcium carbonate equivalent, pH, depth of leaching, soil color, grade of soil structure, horizon thickness, and depth to mottling for 21 Morley and 38 Blount soil profiles sampled in Ohio. Of these properties, composite horizon thickness, hue and value variables of color, depth of leaching of free carbonates, silt content, and total clay content are least variable. The number of profile samples required to estimate the population mean of the above parameters within ± 10% using a .95 confidence interval was also computed. Cation-exchange data are also presented for representative Morley and Blount profiles.

In view of the ever present problem of determining central tendencies and limits of allowable variation within taxonomic units (such as soil series), morphological, physical, and chemical data should be interpreted statistically whenever sufficient information is available. Nelson and McCracken (4) note that the number of profiles ordinarily used in soil characterization studies is inadequate for estimating the mean within 25% for most properties important to crop yield. The purpose of this paper is to present central tendency and variance statistics for certain physical and chemical properties of 21 Morley and 38 Blount soils sampled in Ohio during the past 10 years. Such information should aid in the classification and interpretation of these soils by providing a more reliable basis for prediction statements concerning their properties.

Soils of the Morley and Blount series in Ohio were formerly included within the Miami catena and called, respectively, Miami or Celina silty clay loam, and Crosby silty clay loam (2). The texture nomenclature did not reflect surface texture but was used to indicate composite finer textured sola. More recently the moderately-well drained and the imperfectly drained Gray-Brown Podzolic soils in Ohio derived from moderately to strongly calcareous clay loam Wisconsin till deposits and having strongly developed B horizons have been classified as the Morley and Blount series. These soils generally occur from the Bloomer and Powell moraines north to the Ancient Lake Maumee Shore Line and east to the Olentangy River and Alum Creek in Delaware County, Ohio (Fig 1). Some soils in the extreme northwestern part of Ohio have also been classified as Morley and Blount soils.

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Soil-Forming Factors

Climate—The climate of the region in Ohio where these soils occur is humid with warm summers and mildly cold winters. Except for a slight summer maximum, precipitation is fairly evenly distributed throughout the year with a mean annual precipitation of 36 to 39 inches and a mean annual temperature of about 51°F. Winter temperatures average approximately 31°F. and summer temperatures 72°F. (8).

Vegetation—Prior to settlement, most of the area encompassed by these soils was covered by a deciduous forest vegetation[3] in which oak, maple, and beech were the more common species. Transeau (11) discusses in detail the vegetation of this area.

Relief—The area of occurrence of these soils is characterized by moderate or low relief and nearly level or gently undulating topography. Elevations vary from 800 to 850 feet along the Ancient Lake Maumee Shore Line in the northern sector to more than 1,000 feet on the Bloomer and Powell Moraines in the southern portion of this area. Morley soils commonly occur on the slightly convex crests of gentle undulations, whereas the Blount soils occur on the plane or slightly concave lower-slope positions. Pewamo soils, the Humic Gley member of this catena, are found in the slight depressions or nearly level uplands of this region.

Parent material and time—The location of sampling sites with relation to the Wisconsin morainal system in west-central Ohio is shown in Fig. 1. The Pleistocene geology of this area has been discussed by Goldthwait (3). According to radiocarbon data of wood samples buried in the outermost Cuba-Hartwell Moraine and lacustrine and swamp deposits on top of the Wabash Moraine, he interprets the age of the surficial glacial deposits of this area as being between 14,000 and 17,000 years before present.

EXPERIMENTAL METHODS

Sampling Methods

Soil profiles used in this investigation have been sampled during the past 10 years in conjunction with the soil survey program in Ohio. Sampling activities during this period were directed towards characterization of soils with respect to certain physical and chemical properties that would aid in their classification. Sampling was not restricted to profiles that represented only modal series concepts but rather encompassed (and sometimes exceeded) the series range. The only attempt to screen profiles for this study involved a critical evaluation of them with respect to the present concept of the Morley and Blount series. No attempt was made to screen for modal profiles but rather all profiles which were considered within the range of characteristics considered definitive for these series were incorporated. Although it is recognized that the requirements of random sampling are not strictly satisfied in this study, they are approximated as a result of: (*a*) the scope of the sampling program in Ohio as discussed above; (*b*) the wide geographical scattering of sampling sites within the state; (*c*) the relatively long-time span during which sampling occurred; and (*d*) the selection of sampling sites in different

[3]Dobbins, R. A. Vegetation of the northern "Virginia military lands" of Ohio. Ph.D. Thesis, The Ohio State University, Columbus. 1937.

areas of the state by different soil scientists. It was postulated at the initiation of the study that at least differentiating and accessory characteristics would approximate a normal distribution and encompass a range, as computed from statistical variation, similar to that defined in the established series description of these soils. Statistics of these properties do support this postulate. For accidental characteristics, those properties of individual classes which vary independently of the basis of grouping, random sampling is in essence satisfied.

The junior authors have examined most of the profiles at original sampling sites; and upon their recommendation, reinforced by horizon descriptions and laboratory data, horizon designations have been modified for some profiles. Those profiles which are described with A1 horizons were sampled under forest vegetation while all profiles described with Ap horizons were sampled in cultivated fields.

Laboratory Methods

All physical and chemical data were determined by the Agronomy Department, Ohio Agricultural Experiment Station. Organic matter was determined by the wet-oxidation procedure (5). Exchangeable Ca, Mg, and K were extracted with 1*N* NH_4OAc solution. Exchangeable Ca and Mg were determined by the EDTA method (1) and K was determined by flame photometry. Exchangeable H (which also includes titratable Al) was determined by the triethanolamine method (5) and cation-exchange capacities by the summation of exchangeable cations. Calcium carbonate equivalent was determined titrimetrically by the procedure of Hutchison and MacLennan (6). All pH measurements were made using a 1:1 soil-water ratio. Particle-size analyses were made by the pipette method outlined by Steele and Bradfield (10) but using sodium hexametaphosphate as the dispersing agent and a 10-g. soil sample.

Statistical Methods

For soil properties normally expressed in numerical form the following statistical variables were computed for each soil horizon from uncoded data: mean (X), standard deviation (S_x), coefficient of variation (V), and range (Rg). In the case of hue notations for matrix and coat colors the following arbitrary integers were used: 2, 3, and 4 for 2.5Y, 10YR, and 7.5YR hues,[4] respectively. Likewise, for grade of structure

[4]Mean hue notations and corresponding standard deviations are reported in Table 1 to the closest tenth. This does not imply that hue colors can be read to this degree of precision but rather it indicates the relative position of coded hue data between standard Munsell hue tables.

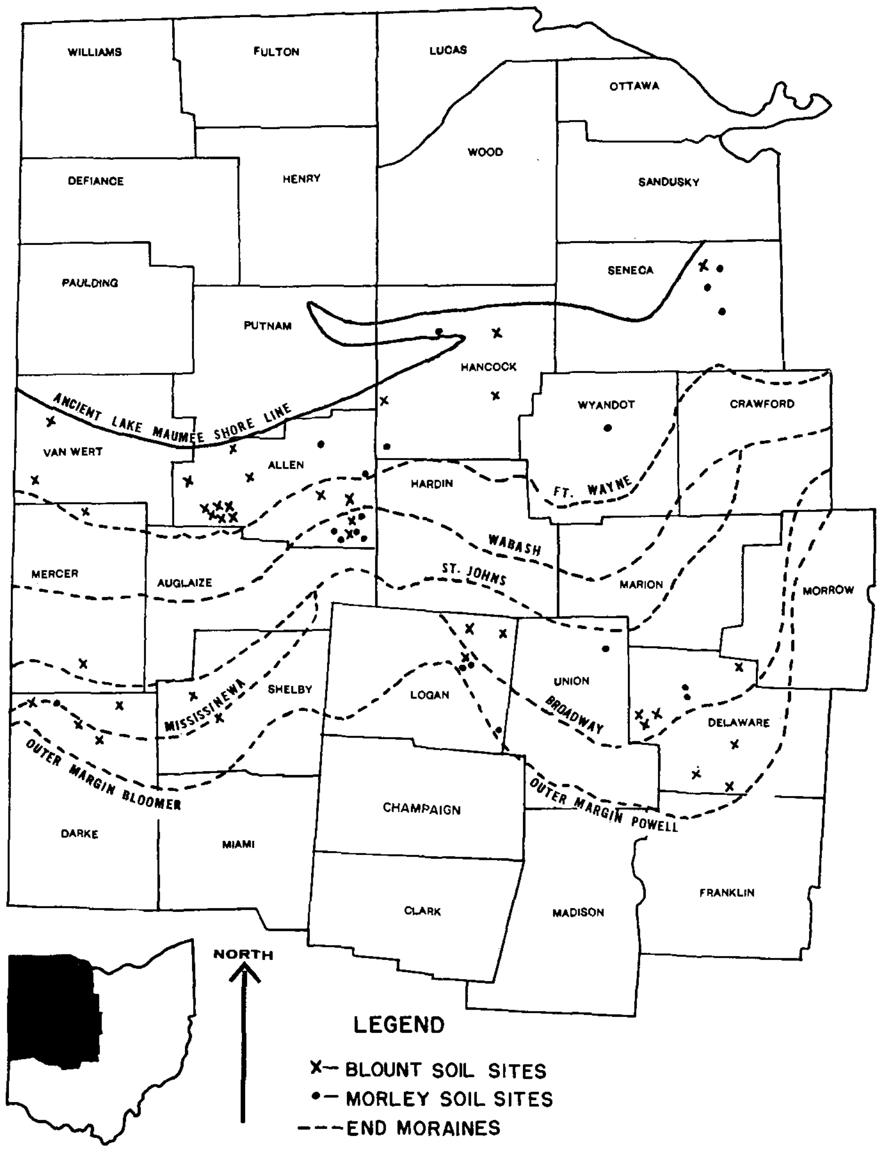

Fig. 1—Location of Morley and Blount soil sampling sites in relation to major glacial end moraines in northwestern Ohio.

the integers 1, 2, and 3 were used for weak, moderate, and strong structural grades. The number of profile samples required to estimate the population mean within ± 10% using a .95 confidence interval was computed for each soil property as an average for all horizons of the profile.

The standard deviation (S_x) is a commonly accepted measure of the dispersion of data about the mean. In a normally-distributed population approximately 68% of the individual observations will fall within ± 1 standard deviation of the mean, and 95% within ± 2 standard deviations of the mean. For the purpose of comparing the degree of variation within sampling groups with respect to different properties it is more convenient and appropriate to express the range indicated by the standard deviation as a percentage of the mean value. This quantity is called the coefficient of variation (V).

RESULTS

Morphology

A statistical summary of morphological properties (horizon thickness, grade of structure, soil color, and depth of leaching) of Morley and Blount soils included in this study are reported in Table 1.

A typical cultivated Morley soil profile composited from statistical data has the following morphological properties: A dark grayish-brown, friable, granular Ap horizon of silt loam texture 7 inches thick; a dark yellowish-brown, friable, platy or subangular blocky A2 horizon of silt loam texture 2 inches thick (this horizon is often absent because of its incorporation into the Ap horizon upon cultivation); a dark yellowish-brown, slightly firm, subangular blocky B1 horizon of silty clay loam texture 4 inches thick; a mottled, dark yellowish-brown, firm, compound prismatic-blocky B2 horizon of clay texture 13 inches thick; a mottled, dark yellowish-brown, firm, compound prismatic-subangular blocky partially leached BC horizon of clay loam texture 4 inches thick; and a mottled, dark brown, slightly firm, strongly calcareous, nearly massive C horizon of clay loam texture. Moderate to thick, continuous very dark grayish-brown organic-clay films coat vertical and horizontal B horizon ped surfaces.

A typical cultivated Blount soil profile composited from statistical data has the following morphological properties; a dark grayish-brown, friable, granular Ap horizon of silt loam texture 7 inches thick; a mottled, brown, friable, platy or subangular blocky A2 horizon of silt loam texture 3 inches thick (this horizon is often absent because of its incorporation into the Ap horizon upon cultivation); a mottled, yellowish-brown, slightly firm, subangular blocky B1 horizon of silty clay loam texture 3 inches thick; a mottled, brown or yellowish-brown, firm, compound prismatic-blocky B2 horizon of clay texture 15 inches thick; a mottled, yellowish-brown, slightly firm, compound prismatic-subangular blocky, partially leached BC horizon of clay loam texture 5 inches thick; and a mottled brown, slightly firm, strongly calcareous, nearly

Table 1—Morphological properties of Morley and Blount soils.

Property	Statistical variable*	Horizon							
		A1	Ap	A2	B1	B2‡	BC	C1	C2
					Morley (moderately-well drained)				
Horizon thickness, inches	X		7	2	4	13	4	7	7
	Rg		5-8	2-3	2-7	7-18	2-8	3-15	2-15
	S_x		1	5	2	2	2	3	3
	N		21	7	15	21	21	20	12
Grade of structure (1 = weak, 2 = moderate, and 3 = strong)	X		1.5	1.4	2.1	2.6	1.6	1.0	
	Rg		1-3	1-2	1-3	1-3	1-3	–	
	S_x		0.6	0.5	0.6	0.5	0.8	0	
	N		21	7	15	21	18	5	
Color (matrix) Hue (2 = 2.5 Y, 3 = 10 YR, and 4 = 7.5 YR)	X		3.0	3.0	3.0 2.8†	3.0 3.0†	2.9 2.8†	2.9	2.8
	Rg		–	–	– 2-3†	2-4 –	2-3 2-3†	2-3	2-3
	S_x		0	0	0 0.4†	0.2 0†	0.2 0.4†	0.2	0.4
	N		21	7	15 5†	21 8†	21 7†	21	5
Value	X		3.8	4.3	4.4 4.5†	4.1 3.8†	4.1 3.9†	4.3	4.2
	Rg		3-4	3-6	4-5 4-5†	3-5 3-4†	3-5 3-4†	3-5	3-5
	S_x		0.4	1.3	0.5 0.5†	0.6 0.5†	0.6 0.3†	0.6	0.4
	N		21	7	15 5†	21 9†	21 9†	21	15
Chroma	X		2.0	3.6	3.3 2.6†	3.2 2.4†	2.8 2.1†	3.0	2.9
	Rg		–	2-8	2-4 2-4†	2-8 2-4†	2-4 1-4†	2-4	2-4
	S_x		0	2.0	0.6 0.9†	1.4 0.7†	0.8 0.9†	0.8	0.7
	N		21	7	15 5†	21 8†	21 7†	21	15
Depth of leaching of free carbonates, inches (field determination)	X						24		
	Rg						20-30		
	S_x						3		
	N						19		
					Blount (imperfectly drained)				
Horizon thickness, inches	X	4	7	3	3	15	5	6	8
	Rg	2-8	4-10	2-5	0-8	9-25	2-11	3-9	5-21
	S_x	2	1	1	2	4	2	2	4
	N	8	30	20	37	38	37	27	23
Grade of structure (1 = weak, 2 = moderate, and 3 = strong)	X	1.3	1.3	1.3	1.7	2.4	1.6	1.5	
	Rg	1-2	1-2	1-2	1-3	1-3	1-3	1-3	
	S_x	0.5	0.5	0.5	0.5	0.6	0.6	0.7	
	N	8	29	29	36	37	31	13	
Color (matrix) Hue (2 = 2.5 Y, 3 = 10 YR, and 4 = 7.5 YR)	X	3.0	2.9	2.9	2.8 2.7†	3.0 2.8†	2.9 2.8†	2.9	2.9
	Rg	–	2-3	2-3	2-3 2-3†	2-3 2-3†	2-3 2-3†	2-4	2-3
	S_x	0	0.3	0.3	0.4 0.5†	0.4 0.4†	0.3 0.4†	0.4	0.3
	N	8	30	20	37 13†	38 27†	38 23†	38	36
Value	X	3.6	4.1	5.2	5.0 4.6†	4.6 4.1†	4.8 4.1†	4.7	4.7
	Rg	3-5	3-6	4-6	3-6 3-6†	3-5 3-6†	4-6 3-5†	3-6	3-6
	S_x	0.9	0.9	0.6	0.6 0.8†	0.5 0.8†	0.5 0.7†	0.6	0.6
	N	8	30	20	37 13†	38 27†	38 23†	38	36
Chroma	X	1.4	2.2	2.6	3.7 2.0†	3.5 1.5†	3.8 1.7†	3.8	3.4
	Rg	1-2	2-3	2-4	2-8 1-4†	1-6 1-4†	1-6 1-4†	1-8	1-8
	S_x	0.5	0.4	0.7	1.5 0.9†	1.3 0.7†	1.5 0.7†	1.6	1.4
	N	8	30	20	37 13†	38 27†	38 42†	38	36
Depth of leaching of free carbonates, inches (field determination)	X						28		
	Rg						21-40		
	S_x						4		
	N						38		

* Statistical notation: X = mean of observations, S_x = standard deviation of observations, Rg = range of observations, and N = total number of observations.
† Organic-clay coatings.
‡ Statistics for B21, B22, and B23 subhorizons were computed but only the composite B2 horizon thickness and maximum expression for soil colors and grade of structure are reported.

massive C horizon. Moderate to thick, continuous, grayish-brown to dark grayish-brown organic-clay films coat the vertical and horizontal B horizon ped surfaces.

Physical and Chemical Properties

Statistics for physical and chemical properties of Morley and Blount soils are reported as follows: particle-size distribution, organic matter content, pH, and calcium carbonate equivalent in Table 2; and cation-exchange data in Table 4. Cation-exchange data have not been analyzed statistically because information of this kind is available for only two Morley and two Blount profiles.

The $< 2\mu$ clay distribution with depth in Morley and Blount soil profiles is depicted graphically (Fig. 2 and 3, respectively) showing the dot array of all observations, the mean $< 2\mu$ clay distribution, and standard deviation about the mean.

DISCUSSION

Although a portion of the variability within morphological properties determined in the field is attributed to discrepancies in human judgment, it is assumed that a major cause of variance is due to differences in soils at different locations. Composite A and B2 horizon[5] thicknesses are less variable than individual horizon thicknesses. Mean composite A horizon thickness of Morley and Blount soil profiles exhibiting A1 or Ap and A2 horizons is 9 inches and 68% of the time would vary about this mean $\pm$ ½ inch for Morley and $\pm$ 1 inch for Blount soils. The range for the former is 8 to 10 inches and the latter 6 to 13 inches. Blount soils have more variable B2 horizons that average slightly thicker than do the B2 horizons of Morley soils (Table 1).

The advantage of knowing the magnitude of variability (Sx) for a parameter as compared to simply knowing its range (Rg) is demonstrated by statistics for grade of structure. Grade of structure ranges from weak to strong for all B horizons but in 68% of the cases would vary from moderate to strong for B2 horizons and from weak to moderate for B1 and BC horizons.

[5]Subdivisions of B2 horizons were statistically summarized for morphological, physical, and chemical properties, but with the exception of composite horizon thickness, all other morphological, physical, and chemical properties in Tables 1 and 2 are reported as the maximum expression of the property in question.

Table 2—Particle-size distribution, organic matter content, pH, and calcium carbonate equivalent of Morley and Blount soils.

Property	Statistical variable*	Horizon							
		A1	Ap	A2	B1	B2†	BC	C1	C2
					Morley (Moderately-well drained)				
Total sand	X		24.7	21.5	20.3	17.3	20.1	22.9	24.7
(0.05 mm. - 2 mm.), %	Rg		14.3-43.9	16.4-24.8	13.0-39.9	11.1-25.5	15.2-25.4	16.3-40.5	18.5-46.8
	S_x		6.1	2.8	7.0	3.6	3.1	5.2	6.6
	N		21	7	15	21	21	21	17
Total silt	X		54.7	54.6	46.8	34.7	40.6	42.5	42.9
(50μ - 2μ), %	Rg		42.3-63.0	45.2-64.5	39.9-56.5	28.0-43.5	34.8-48.1	32.8-49.6	36.0-51.4
	S_x		5.7	6.0	4.7	3.8	3.5	4.1	4.0
	N		21	7	15	21	21	21	17
Total clay	X		20.6	23.9	32.9	48.0	39.2	34.6	32.3
($< 2\mu$), %	Rg		11.6-27.5	16.2-31.9	20.2-41.3	39.5-55.0	29.6-50.0	26.7-44.4	17.2-40.2
	S_x		4.2	6.0	6.9	4.0	4.7	4.7	5.7
	N		21	7	15	21	21	21	17
Fine clay	X		3.8	5.0	9.7	19.0	12.6	10.0	8.7
($< 0.2\mu$), %	Rg		0.6-8.0	1.1-8.1	4.8-14.6	11.4-23.8	6.6-17.0	7.2-14.3	6.2-12.4
	S_x		1.9	2.5	3.1	3.5	2.9	1.9	1.7
	N		21	7	15	21	21	21	17
Organic matter, %	X		2.8	2.1	1.1	1.0			
	Rg		1.7-5.3	0.6-2.9	0.6-1.9	0.6-1.5			
	S_x		0.9	0.8	0.4	0.3			
	N		21	7	14	7			
pH	X		6.5	6.1	5.7	5.4	7.6	7.8	7.9
	Rg		5.3-7.7	5.2-7.1	4.8-6.8	4.5-7.2	6.8-8.0	7.4-8.1	7.6-8.1
	S_x		0.6	0.6	0.7	0.7	0.3	0.2	0.2
	N		21	7	15	21	21	21	16
Calcium carbonate	X						12.6	19.4	23.7
equivalent, %	Rg						1.4-26.1	9.9-28.6	17.3-36.0
	S_x						7.2	5.9	5.8
	N						18	21	16
					Blount (Imperfectly drained)				
Total sand	X	18.9	20.3	19.7	16.2	15.7	18.0	20.4	22.3
(0.05 mm. - 2 mm.), %	Rg	13.4-25.0	8.5-41.4	11.4-34.3	5.8-32.1	3.4-28.3	2.6-28.3	3.6-35.8	5.7-47.2
	S_x	5.4	7.5	6.9	6.0	5.2	6.0	5.8	7.4
	N	8	30	20	37	38	38	38	36
Total silt	X	63.0	58.8	59.4	54.2	38.8	44.0	45.0	44.4
(50μ - 2μ), %	Rg	55.1-71.2	43.8-70.6	47.7-66.9	39.1-64.4	29.8-52.9	36.5-56.4	37.8-53.2	28.2-53.6
	S_x	5.2	6.4	5.9	7.0	5.5	4.6	3.7	5.3
	N	8	30	20	37	38	38	38	36
Total clay	X	18.1	20.9	20.9	29.6	45.4	37.9	34.5	33.3
($< 2\mu$), %	Rg	12.6-23.9	13.9-28.7	15.9-29.2	19.8-39.4	38.1-53.1	28.2-46.5	23.0-44.1	24.6-46.5
	S_x	3.5	3.5	3.3	4.3	3.7	4.3	4.4	4.7
	N	8	30	20	37	38	38	38	36
Fine clay	X	4.2	4.4	4.3	8.9	20.5	12.6	10.2	9.8
($< 0.2\mu$), %	Rg	1.1-7.0	2.2-7.7	2.6-6.6	4.0-14.7	12.4-33.0	6.8-22.5	6.8-22.5	6.0-19.8
	S_x	1.8	1.5	1.1	2.4	4.3	3.4	2.6	2.6
	N	8	30	20	37	38	38	38	36
Organic matter, %	X	5.9	3.0	1.0	0.8	0.8			
	Rg	4.2-8.6	1.8-5.5	0.3-2.9	0.3-2.4	0.3-1.1			
	S_x	1.6	0.9	0.6	0.4	0.2			
	N	8	30	20	27	9			
pH	X	6.2	6.4	5.5	5.4	5.3	7.5	7.8	7.9
	Rg	4.8-6.7	5.2-7.7	4.7-7.5	4.6-7.2	4.5-7.0	6.2-8.0	7.2-8.1	7.5-8.2
	S_x	0.6	0.6	0.6	0.7	0.7	0.5	0.2	0.2
	N	8	30	20	27	38	38	38	36
Calcium carbonate	X						13.2	20.5	22.0
equivalent, %	Rg						0.9-27.0	11.4-39.5	9.0-35.0
	S_x						6.7	6.0	6.0
	N						26	38	36

* Statistical notation--see footnote of table 1.

† Statistics for B21, B22, and B23 subhorizons were computed but only the maximum expression is reported for the B2 horizon (i.e., maximum clay contents and minimum pH values).

Table 3—Number of samples (N) necessary to estimate the mean of the population within ±10% for various soil properties and respective coefficients of variation (V) for these properties.

Property	Morley		Blount	
	N*	V†	N	V
Sand content	20	22	49	35
Silt content	5	11	6	12
Total clay content	9	15	8	14
Fine clay content	30	27	31	28
Organic matter content	49	35	44	33
Calcium carbonate equivalent	30	27	31	28
pH	3	9‡	3	9‡
Color (matrix)				
Hue	1	5	1	5
Value	8	14	6	12
Chroma	36	30	36	52
Depth of mottling	64	40	74	43
Depth of leaching	7	13	8	14
Composite horizon thickness of A, and B2	6	12	16	20
Grade of structure	29	27	44	33

* N = number of profile samples required to estimate the population mean within± 10% using a 0.95 confidence interval,
$= (tS_x/0.1\bar{X})^2$ where t is approximately equal to 2 for a 0.95 confidence interval, and,

$= (tV/0.1)^2/10,000$ where V expressed as a percentage.

† V = coefficient of variation expressed as an average value over all horizons, and $= (S_x/\bar{X})\,100$.
‡ Since pH is a logarithmic function it is not appropriate to compare its coefficient of correlation directly with coefficients of correlation of arithmetic functions presented herein.

It is interesting to note that there is little difference in the matrix colors of these adjacent soil catena members. The imperfectly drained Blount soils do exhibit, especially in A and upper B horizons, a tendency toward somewhat yellower hues and slightly higher values (about ½ unit) than do the moderately-well drained Morley soils. It appears that the greatest difference in color between these soils is the higher chroma (about 1 unit) and tendency for browner hues of the organic-clay coatings in B horizons of Morley soils. The significance of statements regarding differences in coating colors may be questionable because of the few observations recorded (especially in case of

Table 4—Mean and range in exchangeable cations, cation-exchange capacity, and base saturation of two Morley and Blount profiles.

Horizon	Statistic*	Exchangeable cations: H	Ca	Mg	K	Cation exchange capacity‡	Base saturation,
		me./100g.				me./100g.	%
		Morley AL-121 and DL-24 (moderately well drained)					
Ap	X	6.8	6.4	2.6	0.2	15.6	58
	Rg	6.8-6.9	5.8-7.1	1.4-3.9	-	15.6-15.7	56-59
A2	X	9.3	6.4	2.6	0.2	19.5	48
	Rg	6.6-12.0	5.4-9.4	2.5-2.7	-	18.9-20.1	40-65
B21	X	13.2	13.2	3.1	0.3	24.8	46
	Rg	10.3-16.0	6.3-10.1	2.2-4.0	-	24.7-24.8	35-58
B22	X	9.4	10.0	3.9	0.3	24.2	61
	Rg	6.0-12.8	8.7-12.4	2.3-5.5	-	24.1-24.2	47-75
		Blount AL-S8 and DL-25 (imperfectly drained)					
Ap	X	4.7	10.4	3.6	0.2	18.0	74
	Rg	4.0-5.4	9.1-11.8	2.0-3.2	0.2-0.3	17.9-18.1	70-78
A2		7.4†	6.5†	1.9†	0.2†	16.0†	54†
B21	X	13.5	8.8	5.2	0.3	24.8	48
	Rg	11.3-15.7	7.8-9.7	3.1-7.4	-	24.4-25.1	42-54
B22	X	8.1	13.0	6.7	0.3	28.1	70
	Rg	6.6-9.6	7.8-18.1	6.0-7.4	-	25.1-31.0	62-79

* X = Mean of determination
Rg= Range of determination.
† Data available for only profile, AL-S8.
‡ Cation-exchange capacity obtained by summation of exchangeable cations.

the Morley soils) and the higher degree of variability in chroma evaluations. The few observations reported for color of ped coatings is due to the fact that in earlier descriptions clay films coating ped surfaces were either not observed or were observed but not recorded. Hue and value attributes of the Munsell color notation are less variable for these soils than chroma (Table 4). This means that either chroma is more difficult to determine with the same degree of precision as hue and value or that it is really more variable. The latter appears to be a more reasonable postulate based on the work of Pomerening and Knox (7) who found no difference in the degree of precision obtainable between value and chroma determinations of color.

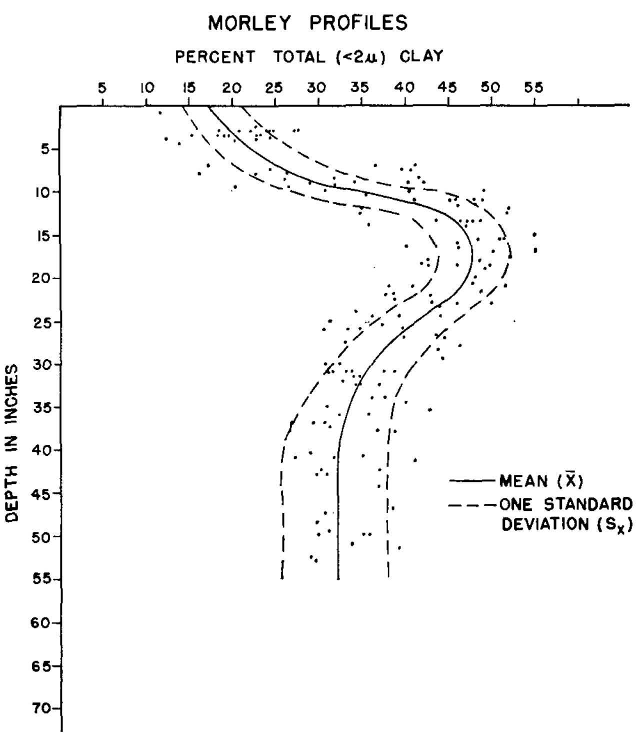

Fig. 2—Scatter diagram of total clay distribution in 21 Morley soil profiles.

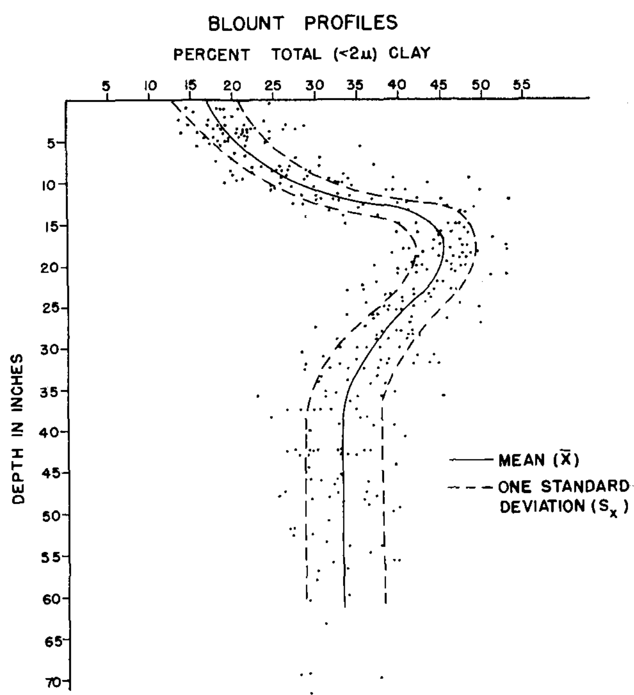

Fig. 3—Scatter diagram of total clay distribution in 38 Blount soil profiles.

Little significance is attached to the slightly greater depths to mottling in Morley, as compared to Blount, soils because of the considerable overlap and high degree of variability in this parameter. Mean depth to mottling, its range, and standard deviation for Morley soils are 10, 6 to 22, and 4 inches, respectively. Similar statistics for Blount soils are 7, 2 to 16, and 3 inches. Possibly, the dominant mottling color(s) would be a more meaningful criterion of drainage, and hence, should be included in future studies of this kind. However, either consciously or unconsciously, the investigators may have placed greater weight on the color of ped coatings than on depth to mottling in assessing the drainage class of these soils.

Blount soils are leached of free carbonates to somewhat greater depths than Morley soils. For example, 68% of the time the former would be expected to be leached 28 ± 4 inches and the latter 24 ± 3 inches. Calcium carbonate equivalent for both soils varies from about 13 $\pm 7\%$ in BC horizons, 20 $\pm 6\%$ in C1 horizons, and 23 $\pm 6\%$ in C2 horizons 68% of the time. Variation in calcium carbonate equivalent of BC horizons is attributed to the high degree of variability in leaching of ped exteriors while ped interiors are calcareous or partially leached (13).

Both Morley and Blount soils have argillic horizons (9, pages 35-45) which exhibit clay films on vertical and horizontal ped surfaces; have ratios of clay in B1 and B2 horizons to that in A horizons of about 1.4 and 2.0 respectively; and have greater fine clay ($< .2\mu$) content in argillic horizons than in C horizons. In addition, the total clay content of argillic B2 horizons exceeds that of C horizons (Fig. 2 and 3). The mean B/C clay ratio is 1.5 for Morley and 1.4 for Blount soils. Morley soils have mean clay contents about 3% higher in A2 and B horizons than Blount soils, but in C1 and C2 horizons mean clay contents and corresponding standard deviations are almost identical. In 68% of the cases, clay contents range from 35 $\pm 5\%$ in C1 and 33 $\pm 5\%$ in C2 horizons of both soils. Fine clay content, although more highly variable than total clay content (Table 3), follows a similar type of clay distribution pattern and contributes on the average 40 to 45% of the total clay content in the B2 horizon of both soils.

A portion of the variation in sand content may be explained by the variable thickness of a thin loess mantle over the Morley-Blount landscape. The remainder is attributed to stratification and textural heterogeneity in the parent till deposits.

The mean pH profile of Morley and Blount soils is characteristic of Gray-Brown Podzolic soils; it decreases from the surface to a minimum in upper B horizons and then increases with depth. Since pH is a logarithmic function it is a relatively variable property in spite of its relatively low coefficient of variability (V) in Table 3. The few number of profiles necessary to estimate the pH mean within $\pm$ 10% is understandable since this is a low level of accuracy in terms of hydrogen ion concentration. A much more accurate estimate of pH would be obtained by decreasing the confidence interval to $\pm$ 2% about the population mean which would result in a consequent increase in number of profiles necessary to estimate the mean to this level of accuracy (81 for $\pm 2\%$ vs. 3 for $\pm 10\%$).

The morphological, physical, and chemical properties of the Blount soils as reported in northeastern Illinois (12) (the western margin of their occurrence) compare favorably with mean values of these properties in Ohio. It is encouraging from the standpoint of soil classification that soils separated by this geographical distance (some 300 miles) are indeed so similar.

CONCLUSIONS

Certain morphological, physical, and chemical properties of Morley and Blount soils are more variable than others (Table 3). These include grade of structure, the chroma variable of color, depth to mottling, sand content, fine clay content, organic matter content, calcium carbonate equivalent, and pH. Those properties which are less variable include composite horizon thicknesses, hue and value variables of color, depth of leaching of free carbonates, silt content, and total clay content.

For the more variable properties of Morley and Blount soils, as classified in Ohio, field or laboratory observations from at least 20 to 50 profiles are necessary to estimate the mean with a relatively high degree of accuracy. For the less variable properties, 15 or fewer profiles would be sufficient to estimate the mean with the same degree of accuracy. In characterizing a soil series or in attempting to define the modal concept of a series based on field or laboratory data of only a few profiles, general inferences must be restricted to those properties that are known to be relatively uniform.

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