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Characteristics of Dewey and Fullerton soils

Roger Bruce Parsons

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To the Graduate Council:

I am submitting herewith a thesis written by Roger Bruce Parsons entitled "Characteristics of Dewey and Fullerton soils." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agronomy.

Eric Winters, Major Professor

We have read this thesis and recommend its acceptance:

Lawrence N Skold, W. L. Paulus

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

August 1, 1957

To the Graduate Council:

I am submitting herewith a thesis written by Roger Bruce Parsons entitled "Characterization of Dewey and Fullerton Soils." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agronomy.

Eric Winters
Major Professor

We have read this thesis
and recommend its acceptance:

Laurence N Skold

W. L. Parks

Accepted for the Council:

Dale Wantling
Dean of the Graduate School

CHARACTERIZATION OF DEWEY AND FULLERTON SOILS

A THESIS

Submitted to
The Graduate Council
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Master of Science

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by

Roger Bruce Parsons

August 1957

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CHAPTER I

INTRODUCTION

The Dewey and Fullerton soils are two important and extensive Red-yellow podzolic soil series in the Valley of East Tennessee. These soils are well-drained and were developed under mixed deciduous and coniferous forest vegetation. The Dewey soils have developed on residual parent materials from dolomite, dolomitic limestone, and limestone, while the Fullerton soils have developed on residual parent materials from siliceous dolomite and dolomitic limestone. Over a twenty-five year period, the area has had a mean annual rainfall of fifty inches. The mean January temperature is 40°F, while the mean July temperature is 80°F (3).[1]

Dewey soils are morphologically similar to the Fullerton soils, but have browner A horizons, redder B horizons, contain less chert gravel, and lack the pale colored A_2 horizon of the Fullerton series.

The purpose of this study was to characterize the Dewey and Fullerton soil series and to establish whether or not differences between the series do exist, other than those which may be detected by visual observation.

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[1] Figures in parenthesis refer to "Literature Cited", page 26.

CHAPTER II

METHODS AND PROCEDURES

Field Methods

The soils used in this study represent typical profiles of the Dewey and Fullerton soil series of East Tennessee. Three sites of each series were located in Loudon County at widely spaced areas mapped during the detailed progressive soil survey. All of the sites were located on five to twelve percent slopes. The soil profiles were described *in situ* from the faces of excavations according to the procedure outlined in the *Soil Survey Manual* (9). Bulk samples were taken of each horizon.

Laboratory Procedures

The soil samples were air dried, crushed to pass through a two millimeter sieve, and stored in quart glass fruit jars in the laboratory.

Organic matter content was determined by the chromate oxidation method as described by Walkley and Black (11) with slight modifications by Peech et al (5). *Soil pH* was determined with the Beckman pH meter. *Cation exchange capacity* was determined by a slight modification of the ammonium acetate method as described by Peech et al (5). *Cation exchange capacity* was also determined by a second method by saturating the soils with barium, replacing the barium with ammonium ions by leaching the soils with neutral normal ammonium acetate, and determining the concentration of barium in the leachate using flame photometry. *Exchangeable hydrogen* was determined by the triethanolamine procedure outlined by Peech et al (5). Exchangeable bases were determined with a Beckman flame photometer using a soil extract made with neutral normal ammonium acetate.

Moisture Characterization: Low moisture tensions were determined by the porous plate method as described by Richards (6); the higher moisture tensions were determined with the pressure membrane method also as described by Richards (7). Percentage sand and clay were determined by a modification of the pipette method as described by Kilmer and Alexander (4). Sedimentation times for the clay fraction were calculated using the nomograph by Tanner and Jackson (10).

Exchangeable bases, hydrogen, and exchange capacity are expressed as milliequivalents per one hundred grams of oven dry soil.

The details of each procedure used in this study are described in the Appendix, pages 28-35.

CHAPTER III

SOIL PROFILE DESCRIPTIONS

Fullerton Silt Loam, Site I

A_{oo}	1-½"	Slightly decomposed leaf litter.
A_o	½-0"	Partially decomposed organic residues.
A_1	0-1½"	Very dark greyish brown (10YR3/2)[1]; silt loam; moderate medium granular structure; friable; strongly acid.
A_2	1½-7"	Yellowish brown (10YR5/4-5/6); silt loam; moderate medium granular structure; friable; very strongly acid.
A_3	7-12"	Strong brown (7.5YR5/6); silt loam; moderate medium granular structure; friable; very strongly acid.
B_1	12-23"	Yellowish red (5YR4/6-5/6); silty clay loam; weak fine subangular blocky structure; noticeable clayskins; firm; very strongly acid.
B_2	23-40"	Red (2.5YR4/6-4/8); clay; with common reddish yellow (7.5YR6/6) variegations; moderate medium subangular blocky structure; prominent clayskins on horizontal and vertical faces of peds; very firm; very strongly acid.
B_3	40-54"	Red (2.5YR4/6); clay; with common yellowish-brown (10YR5/6) variegations; moderate medium subangular blocky structure; pronounced clayskins; very firm; strongly acid.

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[1] All Munsell soil color notations were taken on moist soil.

C 54"+ Red (2.5YR4/6); cherty silty clay, with very common strong brown (7.5YR5/6) and yellow (10YR7/6) variegations; weak medium subangular blocky structure; clayskins common only on vertical faces of peds; very firm; very strongly acid.

Small angular chert fragments throughout the soil profile.

Site location: This soil profile is located in Loudon County, Tennessee 0.4 miles northwest of Eaton's Crossroads on Tennessee Route No. 95; 0.6 miles west on a gravel road in heavy timber owned by the Bowater Company near the R. J. Jackson home.

Dewey Silt Loam, Site II

A_p	0-10"	Brown (10YR4/3) to dark yellowish brown (10YR4/4); silt loam; weak fine granular structure; very friable, strongly acid.
B_1	10-17"	Strong brown (7.5YR 5/6) to yellowish red (5YR5/6); silty clay loam; weak fine granular to subangular blocky structure; friable; strongly acid.
B_{21}	17-23"	Red (2.5YR4/6-4/8); silty clay; moderate fine to medium subangular blocky structure; some discontinuous clayskins; very firm; strongly acid.
B_{22}	23-39"	Red (2.5YR4/6-4/8); clay; with brownish yellow (10YR6/8) variegations; moderate medium angular blockly structure; very common clayskins on horizontal and vertical faces of peds; very firm; very strongly acid.
B_{23}	39-48"	Red (2.5YR4/8); clay; moderate fine to medium angular blocky structure; prominent clayskins; very firm; very strongly acid.
C_1	48-58"	Variegated red (2.5YR4/6); yellow (10YR7/6) and yellowish brown (10YR5/6); clay; moderate medium angular blocky structure; clayskins common only on vertical faces of peds; very firm; very strongly acid.
C_2	58-70"	Same as C_1 horizon.

Small chert fragments common in B and C horizons; numbers of chert fragments increase with depth.

Site location: This soil profile is located in Loudon County, Tennessee north of Lenoir City on Tennessee Route No. 95; 0.3 west northwest of the intersection of Harrison Road and Kingston Pike.

Dewey Silt Loam, Site III

A_p	0-8"	Dark brown (7.5YR4/4); silt loam; weak fine granular structure; very friable; strongly acid.
B_1	8-14"	Yellowish red (5YR4/6-4/8); silty clay loam, moderate fine to medium subangular blocky structure; a few thin clay films on peds; firm; strongly acid.
B_{21}	14-22"	Red (2.5YR3/6-4/6); silty clay to clay; moderate fine to medium subangular blocky structure; prominent clayskins; very firm; strongly acid.
B_{22}	22-38"	Red (2.5YR4/6) to dark red (2.5YR3/6); clay; moderate medium angular blocky structure; very prominent clayskins on both horizontal and vertical faces of peds; very firm; strongly acid.
B_{23}	38-50"	Red (2.5YR4/6); clay; moderate medium angular blocky structure; prominent clayskins; very firm; strongly acid.
C_1	50-62"	Variegated red (2.5YR4/6), yellow (10YR7/6), and brownish yellow (10YR6/6); clay; weak to moderate fine subangular blocky structure; discontinuous clayskins, mostly on vertical faces of peds; very firm; strongly acid.
C_2	62-70"	Same as C_1 horizon.

Some small angular chert fragments, the numbers of which increase with depth, are present in the B_{21} through C_2 horizons.

Site location: This soil profile is located in Loudon County, Tennessee 0.6 miles east of the Martel railroad underpass; north 0.6 miles in a field east of the J. E. Pepper home.

Fullerton Silt Loam, Site IV

A_{oo}	1½-½"	Slightly decomposed leaf litter.
A_o	½-0"	Partially decomposed organic residues.
A_1	0-1"	Very dark greyish brown (10YR3/2); silt loam; weak fine granular structure; very friable; very strongly acid.
A_2	1-8"	Yellowish brown (10YR5/4); silt loam; weak fine granular structure; very friable; very strongly acid.
A_3	8-13"	Strong brown (7.5YR5/6); silt loam; weak fine to medium granular structure; friable; very strongly acid.
B_1	13-22"	Strong brown (7.5YR5/6) to yellowish red (5YR5/6); silty clay loam; weak fine to medium subangular blocky structure; some thin discontinuous clayskins; firm; strongly acid.
B_2	22-38"	Yellowish red (5YR4/8) to red (2.5YR4/6); clay; moderate medium angular blocky structure; prominent clayskins on horizontal and vertical faces of peds; very firm; strongly acid.
B_3	38-51"	Red (2.5YR4/6); clay; with brownish yellow (10YR6/6) variegations; moderate medium angular blocky structure; prominent clayskins; very firm; strongly acid.
C_1	51-59"	Variegated yellow (10YR7/6) red (2.5YR4/6) and brownish yellow (10YR6/6); silty clay; weak medium subangular blocky structure; clayskins common only

		on vertical faces of peds; very firm; strongly acid.
C_2	59-68"	Same as the C_1 horizon except for increasing amounts of chert gravel.

Site location: This soil profile is located in Loudon County, Tennessee 1.1 miles west and 0.2 miles south of Reagan's store on United States Highway No. 11; 430 feet ESE in timber.

Fullerton Silt Loam, Site V

A_{oo}	1½-1"	Slightly decomposed leaf litter.
A_o	1-0"	Partially decomposed organic residues.
A_1	0-1"	Very dark greyish brown (10YR3/2); silt loam; weak fine granular structure; very friable; neutral.
A_2	1-11"	Light olive brown (2.5Y5/4) to yellowish brown (10YR5/4); silt loam; weak fine granular structure; very friable; strongly acid.
A_3	11-17"	Strong brown (7.5YR5/8); silt loam; weak fine granular to subangular blocky structure; friable; strongly acid.
B_1	17-25"	Strong brown (7.5YR5/8) to yellowish red (5YR5/8); silty clay loam, moderate medium subangular blocky structure; some thin clay films in pores; firm; strongly acid.
B_2	25-37"	Yellowish red (5YR4/8-5/8); clay; strong medium angular blocky structure; prominent clayskins; very firm; strongly acid.
B_3	37-49"	Yellowish red (5YR5/6); clay; with yellow (10YR7/8) variegations; strong medium angular blocky structure; prominent clayskins; very firm; strongly acid.
C_1	49-62"	Variegated yellow (10YR7/6), red (2.5YR4/6) and brownish yellow (10YR6/6); clay; weak to moderate medium subangular blocky structure; clayskins predominately on vertical faces of peds; very firm; strongly acid.

C_2	62-72"	Same as C_1 horizon except for increasing amounts of chert gravel.

Site location: This soil profile is located in Loudon County, Tennessee south of Loudon on State Highway 72; 0.6 miles east of Giles grocery and 1.5 miles north of the Davis Ferry Road; west of the Williams home.

CHAPTER IV

RESULTS

Organic matter contents in the A horizons of the Dewey and Fullerton soils are given in Table I. Organic matter content of the virgin Fullerton A_1 horizons varied from 10.2 percent to 11.3 percent, while the organic matter in the pale-colored A_2 horizons ranged from 1.5 percent to 2.4 percent. The A_p horizons of the cultivated Dewey soils contained from 2.1 to 2.4 percent organic matter.

pH values of each horizon sampled for this study are given in Tables II and III. pH values showed little change with depth throughout the profiles. In general, the reaction of most horizons was very strongly acid (pH 4.5-5.0). The range in pH values was from 4.6 in the A_2 horizon of Fullerton Site I to 6.8 in the A_1 horizon of Fullerton Site V.

Data on the exchange capacities, exchangeable hydrogen, exchangeable bases, percent base saturation, pH, mechanical analysis, and moisture retention for the major horizons of the Dewey soils are given in Table IV. Similar data for the Fullerton soils are given in Table V. The pH values for major horizons are repeated in Tables IV and V for convenience of comparison.

Except for Fullerton A_2 horizons, which averaged around six milliequivalents, exchange capacity values averaged around nine to ten milliequivalents per one hundred grams of oven dry soil and were somewhat higher by the barium replacement method than by the ammonium acetate method. In all major horizons studied, the values for exchangeable hydrogen were larger than the ammonium acetate exchange capacities.

TABLE I

PERCENT ORGANIC MATTER IN THE A HORIZONS OF DEWEY AND FULLERTON SOIL SERIES, LOUDON COUNTY, TENNESSEE SAMPLED AUGUST, 1956

Soil Series	Site No.	Sample No.	Horizon	Percent Organic Matter		Average
				Analysis 1	Analysis 2	
Fullerton	I	1	A_1	11.2	11.0	11.1
Fullerton	I	2	A_2	1.9	1.9	1.9
Fullerton	IV	22	A_1	10.4	10.0	10.2
Fullerton	IV	23	A_2	1.5	1.5	1.5
Fullerton	V	30	A_1	11.3	11.3	11.3
Fullerton	V	31	A_2	2.4	2.3	2.4
Dewey	II	8	A_p	2.2	2.0	2.1
Dewey	III	15	A_p	2.1	2.0	2.1
Dewey	VI	38	A_p	2.4	2.3	2.4

TABLE II

pH VALUES OF THREE FULLERTON SOILS, LOUDON COUNTY, TENNESSEE SAMPLED AUGUST 1956

Soil Series	Sample No.	Horizon	Unleached* pH	Leached* pH
Fullerton Site I	1	A_1	5.3	5.4
	2	A_2	4.7	4.6
	3	A_3	4.8	4.7
	4	B_1	4.9	4.8
	5	B_2	5.3	5.0
	6	B_3	5.2	5.1
	7	C	5.1	5.0
Fullerton Site IV	22	A_1	4.9	5.1
	23	A_2	4.9	5.0
	24	A_3	4.8	4.8
	25	B_1	5.0	4.8
	26	B_2	5.1	4.7
	27	B_3	5.3	4.9
	28	C_1	5.3	5.0
	29	C_2	5.2	5.0
Fullerton Site V	30	A_1	6.8	6.8
	31	A_2	5.4	5.4
	32	A_3	5.0	4.8
	33	B_1	5.2	5.0
	34	B_2	5.3	5.0
	35	B_3	5.3	5.1
	36	C_1	5.3	5.0
	37	C_2	5.2	4.9

* pH values represent averages of two determinations.

TABLE III

pH VALUES OF THREE DEWEY SOILS, LOUDON COUNTY, TENNESSEE SAMPLED AUGUST 1956

Soil Series	Sample No.	Horizon	Unleached* pH	Leached* pH
Dewey Site II	8	A_p	5.2	5.2
	9	B_1	5.3	5.2
	10	B_{21}	4.8	4.8
	11	B_{22}	4.9	4.9
	12	B_{23}	4.9	4.9
	13	C_1	4.8	4.7
	14	C_2	4.7	4.7
Dewey Site III	15	A_p	5.3	5.3
	16	B_1	5.1	5.0
	17	B_{21}	5.1	5.0
	18	B_{22}	5.0	5.0
	19	B_{23}	5.2	5.0
	20	C_1	5.2	5.2
	21	C_2	5.2	5.0
Dewey Site VI	38	A_p	5.0	4.9
	39	B_1	5.1	5.0
	40	B_{21}	5.3	5.2
	41	B_{22}	5.4	5.2
	42	B_{23}	5.5	5.2
	43	C_1	5.2	5.1
	44	C_2	5.2	5.0

* pH values represent averages of two determinations.

TABLE IV

LABORATORY DATA FOR MAJOR HORIZONS OF THREE DEWEY PROFILES SAMPLED AUGUST 1956

	Horizon	Site				
		II	III	VI	Average	
Exchange Capacity	A_p	8.6	8.9	6.4	8.0	± 1.4
Ammon. Acetate	B_{22}	9.2	8.4	9.7	9.1	± 0.7
M.E./100 grams	C_2	9.4	13.7	7.0	10.0	± 3.4
Exchange Capacity	A_p	9.6	9.0	9.8	9.5	± 0.4
Barium	B_{22}	10.0	9.8	10.4	10.1	± 0.3
M.E./100 grams	C_2	10.2	10.8	8.9	10.0	± 0.9
Exchangeable	A_p	8.9	11.1	12.8	10.9	± 1.9
Hydrogen	B_{22}	8.6	8.2	12.6	9.8	± 2.4
M.E./100 grams	C_2	11.0	13.9	13.0	12.6	± 1.5
Exchangeable	A_p	1.9	1.9	0.4	1.4	± 0.9
Calcium	B_{22}	2.0	0.2	0.4	0.9	± 1.0
M.E./100 grams	C_2	0.2	Trace	0.1	0.1	± 0.1
Exchangeable	A_p	0.2	0.3	0.3	0.3	± 0
Magnesium	B_{22}	1.4	0.6	1.2	1.1	± 0.4
M.E./100 grams	C_2	0.6	0.1	0.3	0.3	± 0.3
Exchangeable	A_p	0.1	0.2	0.1	0.1	± 0
Potassium	B_{22}	0.3	0.3	0.2	0.3	± 0
M.E./100 grams	C_2	0.1	0.1	0.1	0.1	± 0
Percent Base	A_p	25.6	27.0	12.5	21.7	± 7.9
Saturation	B_{22}	40.2	13.1	18.6	24.0	± 14.3
	C_2	9.6	1.5	7.1	6.1	± 4.1
pH	A_p	5.2	5.3	4.9	5.1	± 0.2
	B_{22}	4.9	5.0	5.2	5.0	± 0.2
	C_2	4.7	5.0	5.0	4.9	± 0.2
Percent Sand	A_p	32.1	28.9	32.3	31.1	± 1.9
	B_{22}	5.9	16.6	6.7	9.7	± 5.9
	C_2	7.2	5.4	10.7	7.8	± 2.7
Percent Clay	A_p	12.0	10.8	21.6	14.8	± 7.3
	B_{22}	57.2	54.0	68.8	60.0	± 7.8
	C_2	64.0	79.6	60.8	68.1	± 10.0
Percent H_2O	A_p	24.9	18.0	23.9	22.3	± 3.7
1/3 Atmosphere	B_{22}	31.8	28.2	34.4	31.5	± 3.1
Field Capacity	C_2	35.4	40.1	32.7	36.1	± 3.7
Percent H_2O	A_p	16.4	10.5	18.6	15.2	± 4.2
2 Atmospheres	B_{22}	26.5	22.1	30.3	26.3	± 4.1
	C_2	27.7	33.0	28.0	29.6	± 2.9
Percent H_2O	A_p	6.9	5.7	10.3	7.6	± 2.4
15 Atmospheres	B_{22}	20.9	18.8	26.2	22.0	± 3.8
Wilting Point	C_2	22.4	28.1	22.7	24.4	± 3.2

TABLE V

LABORATORY DATA FOR MAJOR HORIZONS
OF THREE FULLERTON PROFILES
SAMPLED AUGUST 1956

	Horizon	Site			Average	
		I	IV	V		
Exchange Capacity	A_2	6.4	6.6	6.4	6.5	± 0.1
Ammon. Acetate	B_2	8.3	10.2	8.6	9.0	± 1.0
M.E./100 grams	C_2	10.3	9.2	6.9	8.8	± 1.7
Exchange Capacity	A_2	11.3	7.8	9.0	9.4	± 1.8
Barium	B_2	9.4	10.4	10.3	10.0	± 0.5
M.E./100 grams	C_2	11.1	10.0	7.8	9.6	± 1.7
Exchangeable	A_2	13.2	11.9	9.2	11.4	± 2.0
Hydrogen	B_2	10.4	13.7	14.2	12.8	± 2.0
M.E./100 grams	C_2	12.3	15.3	13.4	13.7	± 1.5
Exchangeable	A_2	0.2	0.7	2.1	1.0	± 1.0
Calcium	B_2	1.6	0.8	0.7	1.0	± 0.5
M.E./100 grams	C_2	1.9	Trace	Trace	0.6	± 1.1
Exchangeable	A_2	Trace	Trace	Trace	—	—
Magnesium	B_2	1.3	1.3	0.9	1.2	± 0.2
M.E./100 grams	C_2	1.5	Trace	Trace	—	—
Exchangeable	A_2	0.1	0.1	0.1	0.1	± 0
Potassium	B_2	0.2	0.2	0.3	0.2	± 0
M.E./100 grams	C_2	0.2	0.1	0.1	0.1	± 0
Percent Base	A_2	4.7	12.1	34.4	17.1	± 15.5
Saturation	B_2	37.3	22.5	22.1	27.3	± 8.6
	C_2	35.0	1.1	1.4	12.5	± 19.5
pH	A_2	4.6	5.0	5.4	5.0	± 0.4
	B_2	5.0	4.7	5.0	4.9	± 0.2
	C_2	5.0	5.0	4.9	5.0	± 0.2
Percent Sand	A_2	19.4	28.6	39.4	29.1	± 10.0
	B_2	13.6	11.3	17.7	14.2	± 3.2
	C_2	10.7	8.4	13.9	11.0	± 2.7
Percent Clay	A_2	12.8	11.2	10.0	11.3	± 1.4
	B_2	42.8	56.8	58.0	52.5	± 8.4
	C_2	60.8	65.2	58.0	61.3	± 3.6
Percent H_2O	A_2	25.1	26.4	21.1	24.2	± 2.6
1/3 Atmosphere	B_2	28.4	32.0	28.4	29.6	± 2.0
Field Capacity	C_2	34.0	35.5	33.1	34.2	± 1.2
Percent H_2O	A_2	16.2	15.3	12.6	14.7	± 1.8
2 Atmospheres	B_2	21.9	26.0	24.7	24.2	± 2.0
	C_2	28.0	31.1	28.5	29.2	± 1.6
Percent H_2O	A_2	6.6	5.0	4.6	5.4	± 1.0
15 Atmospheres	B_2	16.3	20.7	20.6	19.2	± 2.4
Wilting Point	C_2	22.2	25.6	23.1	23.6	± 1.7

Exchangeable bases were consistently low and averaged one milliequivalent.

In both the Dewey and Fullerton profiles, the *clay content* of the A horizons was about ten percent. Clay contents of the B horizons were high, around sixty percent. In most cases, the clay content was greater in the C horizon than in the B horizon. The *sand content* was around thirty percent in the A horizons and ten percent in the B and C horizons.

At *one-third atmosphere tension* (field capacity) the moisture content averaged around twenty-three percent in the A horizons and thirty percent in the B horizons. In most cases, the moisture content was somewhat greater in the C horizon than in the B horizon.

Under *two atmospheres tension*, the moisture content was around fifteen percent in the A horizons, twenty-five percent in the B horizons, and twenty-nine percent in the C horizons.

At *fifteen atmospheres tension* (wilting point) the A horizons averaged around six percent moisture, while the B horizons contained about twenty percent moisture. The moisture content increased to around twenty-four percent in the C horizon in most cases.

CHAPTER V

DISCUSSION

The pronounced difference in organic matter content between the Fullerton A_1 and A_2 horizons would serve to indicate the virgin condition of the Fullerton profiles. Had these horizons been mixed by cultivation, the organic matter content would closely approximate the values determined for the cultivated Dewey A_p horizons.

An examination of the pH data shows no significant difference in pH between the Dewey and Fullerton soils. The A_1 horizon of Fullerton Site V exhibits the only high pH (6.8). This site was located in close proximity to a limestone road. It is believed that dust from this road may have settled upon the surface of the site, thereby increasing the pH of the A_1 horizon.

Exchangeable bases and pH for the A horizons are well correlated; Fullerton Site V had the greatest amount of exchangeable calcium accompanied by the highest pH value. This is evidence that the soils used in this study have similar exchange capacities and similar types of clay minerals.

In most cases, the exchangeable hydrogen determined by the triethanolamine method (pH 8.15) was greater than the exchange capacity by the ammonium acetate procedure (pH 7.0). If the exchange capacity had been determined at pH 8.15, it would be expected that the exchange capacity would have been the greater and the difference between the exchangeable hydrogen and exchange capacity would have been less. Assuming that kaolinite is the dominant type of clay mineral in these soils, the deviation may be accounted for by the greater dissociation of hydrogen ions from the hydroxyl layer of the kaolinite at a pH of 8.15 than at a pH of 7.0.

A_2 horizons of the Fullerton soils showed somewhat lower exchange capacities than the A_p horizons of the Dewey soils. In general, the horizons with the greatest exchange capacities also contained the greatest amount of clay. It should be noted that the C_2 horizon of Dewey Site III showed the greatest exchange capacity (13.7 milliequivalents) and the highest content of clay (79.6 percent).

The results of the mechanical analysis which are given in Tables IV and V are similar to those reported for these soils by Alexander et al (1, 2). In most cases, the clay contents were greater in the C horizons than in the B horizons as suggested by Simonson (8). It is proposed that the clay distribution in these profiles is due in part to illuviation, but due predominately to the formation and inheritance of clay minerals from the weathering of the parent material. Simonson has reported that the formation of clay minerals in the C horizon is greater than the destruction for Red-yellow podzolic soils (8). In the A horizon, destruction and eluviation greatly exceed formation (8). The clay eluviated from the A horizon is translocated predominately to the B horizon as evidenced by the prominence of clayskins on both the horizontal and vertical faces of the aggregates in the B horizon. The few clayskins observed in the C horizon, most of which occur on the vertical faces of the aggregates, indicate the lack of eluviation from the overlying horizons.

The very high clay content (79.6 percent) of the Dewey Site III C_2 horizon may be due to a layer of shale or argillaceous limestone in the parent rock.

It is probable that the high clay content of the A_p horizon of Dewey Site VI is due to some mixing by cultivation with the B_1 horizon. The redder color of this horizon is indicated in the profile description of Site VI.

An examination of the data clearly indicates that the sand content varies inversely with the content of clay. The higher percentage sand in the surface layers is thought to be due to the eluviation of the colloidal material from the surface horizons. Much of the sand fraction in the soil profiles is fine chert fragments.

Moisture tension data very closely correspond to the clay distribution. Horizons having the greatest amounts of clay hold the greatest amount of moisture at each tension. The fine textured B and C horizons hold more moisture than the coarse textured A horizons.

At field capacity (one-third atmosphere), the amount of water held by the A horizons approaches the amount of moisture held by the B and C horizons. However, at the wilting point, the A horizons contain a relatively small amount of water when compared with the amount held by the fine textured B and C horizons.

In view of the similarity in properties noted in this study between the Dewey and Fullerton soils, it becomes apparent that in many instances these soils have been poorly utilized. It has been observed during the soil survey of Loudon County that the Fullerton soils have been neglected and inefficiently utilized for crop production. This may be due in part to the leached, infertile appearance of the surface horizons. On the other hand, the Dewey soils have been exploited and severely eroded. With fertilization, it would seem the Fullerton soils, providing chert gravel was not too prevalent, would be satisfactory for the production of pasture and small grains as well as timber.

The data obtained in this study indicate that little difference exists between these soils except for characteristics, such as color and chert content, which may be readily distinguished by visual methods.

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APPENDIX

APPENDIX

Details of Procedure

(1) Organic Matter

Reagents.

A. Potassium dichromate, 1.0 N.—dissolve 49.04 grams of $K_2Cr_2O_7$ in distilled water and dilute to 1 liter.

B. Ferrous sulfate, 0.5N.—dissolve 140 grams of ($FeSO_4 \cdot 7H_2O$) in water, add 15 ml. of conc. H_2SO_4, cool and dilute to 1 liter. (196.1 gms. of $Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$/liter may be used instead of $FeSO_4 \cdot 7H_2O$). Standardize this solution daily against 10 ml. of reagent A.

C. Conc. H_2SO_4, not less than 96 percent acid.

D. Ortho-phenanthroline ferrous complex indicator. Dissolve 1.5 grams of ortho-phenanthroline monohydrate in 100 ml. of freshly prepared 0.025 M. ferrous sulfate solution.

Procedure.

Grind soil to pass an 80 mesh sieve, avoiding contact with iron or steel. Weigh a 1.00 gram sample and transfer to a 500 ml. Erlenmeyer flask. Add 10 ml. of $K_2Cr_2O_7$ followed by 20 ml. of conc. H_2SO_4. Swirl gently to mix. Avoid throwing soil up onto the flask out of contact with the reagents. Stand on an asbestos pad for 30 minutes. Add 200 ml. of distilled water, four drops of indicator solution and titrate with $FeSO_4$. The color change is from green to red.

If more than 8 ml. of the available 10 ml. of $K_2Cr_2O_7$ are reduced by the organic matter, the determination should be repeated with less soil.

Percentage of organic matter is equal to:

$$\frac{(\text{ml. } K_2Cr_2O_7 \times N) - (\text{ml. } FeSO_4 \times N)\ (0.69)}{\text{weight of sample in grams}}$$

(2) Soil pH

Several increments of distilled water were allowed to leach the soil producing a soil-water ratio of about 1:1. This has a paste like consistance. A Beckman pH meter equipped with a glass electrode was used to make the determination. During the series of determinations, the instrument was periodically re-checked using the buffer solutions of known pH. The pH of unleached samples was also determined in a similar manner.

(3) Exchange Capacity

Reagents.

A. Ammonium acetate, 1.0 N, pH 7.0--prepare a sufficient volume, preferably in a Pyrex bottle, by mixing 70 ml. of ammonium hydroxide, specific gravity 0.90, and 58 ml. of 99.5 percent acetic acid per liter of solution desired. After cooling, adjust exactly to pH 7.0 and dilute to volume with water.

B. Acidified sodium chloride solution, 10 percent. -- Prepare an aqueous 10 percent solution of NaCl, U.S.P. grade (ammonia-free), and acidify with HCl to render the solution approximately 0.005 N with respect to acidity.

C. 1.0 N NaOH

D. Standard 0.20 N H_2SO_4

E. Standard 0.10 N NaOH

Procedure.

Weigh out 50 gm. of air-dry 2-mm. soil into a 250 ml. Erlenmeyer flask and add 100 ml. of ammonium acetate solution. Stopper, shake the flask for several minutes, and allow to stand overnight. Transfer the contents of the flask to a small Buckner funnel (Coors No. 1) fitted with moist 5.5-cm. Whatman No. 42 filter paper and filter, applying gentle suction. Leach the soil with an additional 400 ml. of ammonium acetate, adding small portions of ammonium acetate at a time and using gentle suction, so that the leaching process will require not less than one hour.

After washing the soil with alcohol to remove the excess of ammonium acetate, extract the absorbed ammonium by leaching the soil with 450 ml. of acidified 10 percent NaCl solution, adding small portions at a time, and draining well between each addition. Transfer the sodium chloride extract to a Kjeldahl flask, add 25 ml. of 1 N NaOH, and distill 200 ml. into 60 ml. of standard 0.2 N H_2SO_4. Titrate the excess of acid with standard 0.1 N NaOH, using methyl red as the indicator.

(4) Exchangeable Hydrogen by the Triethanolamine Method

Reagents.

A. Buffer solution.— Barium chloride (0.5 N), triethanolamine (0.2 N). Dilute 100 ml. of commercial triethanolamine (specific gravity 1.126 about 8 N) with 1,000 ml. of water and partially neutralize with HCl to adjust to pH 8.1 to 8.2 (this requires approximately 360 ml. of 1 N HCl). Make up to 2 liters with water and mix with 2 liters of a solution containing 250 gm. of $BaCl_2.2H_2O$. Protect from CO_2 of the air.

B. Replacement solution.— Barium chloride. Dissolve 250 gm. of $BaCl_2.2H_2O$ in 4 liters of distilled water, add 10 ml. of buffer solution, and mix.

C. Standard hydrochloric acid.— 0.100 N; standardize according to accepted procedures.

Procedure.

Place 10 gm. of soil in a 125-ml. Erlenmeyer flask, add 25 ml. of buffer solution, and allow the flask to stand for one-half hour, mixing the contents occasionally by swirling. Transfer to a Gooch crucible containing a moist paper disk (Whatman No. 42) and filter into a 250 ml. flask. Use an additional 25 ml. of buffer solution to aid in the transfer of all the soil to the crucible. The rate of filtration should be such that not less than 30 minutes is required to complete this filtration and leaching. Now, by adding small increments, leach the soil with 100 ml. of the replacement solution.

To the leachate add 10 drops of bromcresol green and 2 drops of methyl red. Titrate with 0.100 N.HCl. The end point can be chosen as any point during the progressive color change from a bluish green through violet to pink. This end point should be checked against a blank containing 50 ml. of buffer solution and 100 ml. of replacement solution and titrated to the same end point with the 0.100 N hydrochloric acid. This end point should be reached when titrating the soil extracts. All calculations are made with this blank determination as a reference.

(5) Mechanical Analysis by the Pipette Method

Reagents.

A. Hydrogen Peroxide (30%)

B. Hydrochloric Acid 0.1N

C. Ethyl alcohol 95%

D. Sodium Hydroxide 0.1N

Procedure.

Weigh 10.00 grams of air dry soil into a beaker. Weigh another 10 gram sample and determine moisture content to calculate exact amount of soil used. Add 10 cc H_2O and stir. Place on a hot plate at low heat. Add 10 ml. H_2O_2 stir and continue low heat. Repeat treatments until there is no further oxidation of organic matter after the addition of the H_2O_2. Add water as necessary to keep soil in suspension. Add 50 ml. H_2O and mix. Transfer the soil to a Buckner funnel fitted with a Whatman No. 42 filter paper. Use more water to complete transfer. Leach soil with 400 ml. 0.1 N HCl. Wash out excess HCl with 50 ml. H_2O and then 150 ml. ethyl alcohol. Allow soil to dry and then transfer to nursing bottles. Add 200 ml. H_2O, and sufficient NaOH to satisfy the exchange capacity (6 ml. to sands and silts, 10 ml. to loams, 14 ml. to clays, silty clays). Shake in a reciprocating shaker overnight. The pH should be between 8 and 9. Transfer soil to a 300 mesh sieve, catching the filtrate in a 1,000 ml. graduate. Wash the sieve until all the silt and clay has entered the graduate.

The sand will remain on the screen and should be transferred to a tared beaker, dried at 105° C for 24 hours, cooled and weighed.

$$\frac{\text{(wt. of beaker + sand) - wt. of beaker}}{\text{wt. of soil sample}} \text{ X } 100 = \%\text{ sand}$$

Determine the sedimentation time from the nomograph. Pipette a 25 ml. aliquot at 10 cm. depth using an aspirator bottle so as to take approximately 10-12 seconds in obtaining the sample. Transfer the aliquot to a tared weighing bottle, evaporate to dryness at 105° C, cool and weigh.

$$\frac{\text{(wt. of bottle + clay - wt. of bottle)}}{\text{wt. of soil sample}}\ 4000 = \%\text{ clay}$$

(6) Exchangeable Bases

Reagents. - Neutral normal ammonium acetate

Procedure.

Ten grams of soil are placed on a Buckner funnel fitted with Whatman No. 42 filter paper. The soil is leached with increments of neutral normal ammonium acetate. The content of exchangeable bases contained in the leachate is then determined by flame photometry. The reading in parts per million of each base is converted to milliequivalents by the following calculation:

$$\text{milliequivalents per 100 grams of oven dry soil} = \frac{\text{parts per million}}{\text{10 X milligrams per milliequivalent}}$$

The sum of the bases represents exchangeable bases.

(7) Cation Exchange Capacity Using Barium Chloride as the Replacing Solution

Reagents.

A. Barium chloride - dissolve 250 grams of $BaCl_2.2H_2O$ in 4 liters of distilled water.

B. Neutral normal ammonium acetate.

Procedure.

Ten grams of soil are placed on a Buckner funnel fitted with Whatman No. 42 filter paper. The soil is then leached with 150 milliliters of barium chloride. The leachate is discarded. The soil is then washed by adding small increments of distilled water. Ammonium acetate is then used as a replacing solution by adding 400 milliliters in small increments. The concentration of barium in the leachate is determined by flame photometry. The method of converting parts per million to milliequivalents is calculated in the same manner as were the exchangeable bases.

(8) Low Moisture Tensions - Porous Plate Method

Materials.

A. Source of compressed air

B. Porous Plate

C. Rubber rings

D. Pressure cooker

E. Pressure regulator and gauges

F. Torsion balances and aluminum dishes

G. Oven

Procedure.

Wet the porous plate thoroughly, place the small rubber rings on the plate, and fill with air-dry two mm. soil. Pack soil slightly when dry. Add water to plate to wet soil from the bottom up. Allow to stand overnight with free water to complete saturation. Place plate in cooker and properly seal all openings. Adjust air pressure to five pounds and allow twenty-four hours for the soil to reach equilibrium. Remove samples, weigh, dry in oven at 110° C, cool and weigh.

To calculate moisture content on an oven dry basis:

$$\frac{(\text{wt. wet soil}) - (\text{wt. dry soil})}{\text{weight dry soil}} = \%\ \text{soil moisture}$$

Moisture content at 5 lbs. = 1/3 atmosphere = Field capacity.

(9) Higher Moisture Tensions - Pressure Membrane Method

Materials.

A. Tank of compressed nitrogen

B. Pressure membrane apparatus

C. Rubber rings

D. Pressure regulator and gauges

E. Torsion balance and aluminum dishes

F. Oven

Procedure.

Soak the sausage casing membrane twelve hours before use. Place the membrane over a copper screen extractor plate. Place small rubber rings on the membrane and fill them with soil. Add water to wet from bottom up, allowing 12-24 hours to complete hydration. Remove excess H_2O from plate with a pipette and fit top of apparatus correctly. Apply air pressure slowly (nitrogen here) to thirty pounds, and allow twenty-four hours for equilibrium. Remove apparatus top, transfer soil samples to aluminum dishes and weigh. Dry at 110° C and weigh. To calculate moisture content on oven dry basis:

$$\frac{(\text{wt. wet soil}) - (\text{wt. dry soil})}{\text{wt. dry soil}} = \%\ \text{soil moisture}$$

Repeat using 220# pressure (15 atmospheres, wilting point).