RELATIONSHIP OF THE NEW SOIL CLASSIFICATION SYSTEM TO THE MINERAL SOILS IN INGHAM COUNTY MICHIGAN

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ABSTRACT

RELATIONSHIP OF THE NEW SOIL CLASSIFICATION SYSTEM TO THE MINERAL SOILS IN INGHAM COUNTY MICHIGAN

by Ramez Mahjoory

Relationship of the new classification system to the mineral soils with two or more profile descriptions available in Ingham County was investigated using the official series descriptions, and the most recent field and laboratory data, as follows:

First, the proposed placements of the established soil series into the new soil classification system were tested according to the seventh approximation, plus its October 1966 supplement and the official descriptions of these series. Some changes in the family names of the Bronson, Celina, Hillsdale and Lapeer series resulted.

Second, the most recent profile descriptions of twenty-five mineral soils with the aid of the laboratory data available for those series in Ingham County were placed into the new system.

Third, the official description of each soil series was compared with the field descriptions of the profiles of the same series in Ingham County. The possible deviations from

the modal profile description and the cited range of properties in the official series description were described. Any inclusions of other series or variants in the description of these series were noted.

Fourth, the suitability of the names of the mapping units were examined according to the guidelines in the January 11, 1966 memo on the application of the new soil classification system.

Finally, the resulting suggestions for each soil series and mapping unit were checked against the revised descriptive legend for the county. The general suitability of the new soil classification was discussed in the light of these data and comparisons as follows:

(1) Ten mineral series not in the legend have been described in Ingham County; two, Matherton and Wasepi, in the legend have not been found. These mineral soils are from seven different families in the New Soil Classification System. They probably represent about one-quarter of the number of mineral series and about one-sixth of the area of the county.

(2) The names of the mapping units agree with 56% of the profile descriptions from the County but the other 44%

are mapping inclusions. If the names of the mapping units are adjusted as indicated herein, they would then agree with over 90% of the profile descriptions.

(3) There is a place in the New Soil Classification System for over 96% of the mineral profiles described to date.

(4) Thus the application of the system to date in Ingham County leaves much room for improvement by more adequate characterization and naming of the mapping units. However, not many of these inadequacies are inherent in the classification system.

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By

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To my wife, Shirin,

for her sacrifice and encouragement

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I. INTRODUCTION

On the basis of soil morphology and genesis, two divisions of soils, minerals and organic, are represented in Ingham County, Michigan.

The mineral soil series have recently been re-grouped in a new soil classification system (Soil Survey Staff, 1960 and 1966 supplement).

The purposes of this particular investigation are:

(a) To examine the changes needed in the series definitions, according to recent field studies, to bring the ranges permitted within each series into conformity with limits of the taxa in the higher categories of the new classification;

(b) To determine, what proportion of the existing field descriptions of each series are representative of that series;

(c) To test whether all deviations from the official series descriptions are provided for in the new classification system.

(d) Emphasis will also be placed on what portion of the series in Ingham County need further investigation to be certain of their placement in the new classification system.

In placement of the series in the new soil classification system special consideration will be given to the orders of Alfisols, Mollisols, Inceptisols and Entisols, since they include most of the mineral soils in Ingham County.

II. LITERATURE REVIEW

A. Some Definitions

Pedon - According to the 7th approximation (Soil Survey Staff, 1960), a pedon is a three dimensional body of soil with lateral dimensions large enough to study its shape, the properties of the horizons, their relationships to each other and their relationships to the roots of the common grain plants. It is the smallest volume that can be called a soil. The pedons are what are being classified in natural soil classifications.

A soil or the soil individual, as used herein, consists of one or many contiguous pedons and other similar pedons which are the predominant component of the areas delineated on detailed soil maps and identified by a soil name. These individuals are phases of types of the series. They are necessary units in order to make the most precise statements about a soil's management or behavior. Therefore, contrary to the 7th approximation, a natural soil system cannot logically exclude this lower category from the system.

Epipedon - The horizons that forms at the soil surface are called epipedons.

Soil series - Is a group of phases of types, or soil individuals, similar in differentiating characteristics at the series categorical level in the classification system. It is relatively uniform in the range of all soil properties diagnostic for series and developed from a particular type of parent material.

B. Differentiating Among Soils

The usefulness of the soil series (Soil Survey Manual of U.S.D.A.) is as a means for summarizing most of the significant subsurface profile properties of soils and communicating that information to individuals familiar with their characteristics.

The short descriptive designations that accompany the series names, complete the identification of the major component of the mapping units commonly used in medium intensity or detailed soil surveys of the United States.

Each soil series is identified by the name of a geographic feature in the area where the soil was first described. Thus, the Hillsdale series was first recognized in Hillsdale County, Michigan.

Soil series are differentiated mainly on the basis of significant morphological variations of the soil profile below

the plow layer (usually about 18 cm or 7 inches) such as the kind, thickness, and arrangement of the horizons and their structure, color, texture, reaction, consistence, content of humus, mineralogical compositions, salt content and other properties.

A significant difference in one or more of these properties in one or more subsurface horizons may be the basis for recognizing a different series. Some variations in each of the properties of the individual soil horizons must be allowed, however in each series.

From the point of view of applied soil science, the mappable difference of importance to the growth of the native or crop plants should be recognized. For example, significant differences in depth of leaching of calcium carbonate in two profiles should be considered as a possible separation of two soils. However, the separations made in mapping should also be those that can be made consistently with the time and facilities available. The resulting map units should be described as to their component soils pertinent to the objectives of the survey.

Generally, those profile properties which have significance in soil genesis, in the growth of crop plants, in soil management and in soil engineering are to be considered

in the separation of soil series. The properties or ranges in properties not selected as series differences, but significant to these objectives, are considered in their subdivisions into phases or types.

The mineralogical composition of soil materials is perhaps their most important characteristics, but in addition, such features as porosity, permeability, texture and degree of assortment must be considered in the differentiation of soil series. Differences in natural drainage, mineralogy and other qualities are often associated with variations in subsurface textures and so texture is commonly important in series separations. However, traditionally differences in surface texture are recognized as type differences within the series. Short descriptive terms indicating the ranges in properties of the phases or types within the soil series are added to the series name to form the names of the individual kinds of soils.

C. Diagnostic Horizons

(a) Diagnostic surface horizons.

Two diagnostic epidedons are recognized in Ingham County soils, according to the 7th approximation (Soil Survey Staff, 1960), and are defined as follows:

(1) A mollic epipedon is a soft, usually moist, dark colored (value less than 3.5), surface, mineral layer which contains more than 50% base saturation and at least one percent organic matter.

The thickness of this horizon should be more than 18 centimeters (7 inches) and more than 1/3 the thickness of the solum or more than 25 centimeters (10 inches) where the thickness of the solum exceeds 75 centimeters (30 inches).

(2) An ochric epipedon is too light in color, too low in organic carbon, too acid or too thin to be a mollic epipedon.

(b) Diagnostic subsurface horizons.

The most important diagnostic subsurface horizons, common in Ingham County soils are defined as:

(1) An argillic horizon - is an illuvial B horizon with coatings of clay on the peds and pore surfaces. The ratio of clay content in the illuvial compared to the overlying eluvial horizon is 1.2 or larger. This clay increase must occur within 12 inches vertically or less. Exchangeable sodium is less than 15% in this diagnostic horizon.

(2) A cambic horizon is mildly weathered, and contains little original rock structure. It shows evidence of leaching, gleying or soil structure formation. Cambic horizons may contain more clay than the parent material, without having clay skins, because of weathering in place or by removal of more soluble coarser materials.

(3) An albic horizon is the light colored (albus = white) horizon from which clay and/or free iron oxides have been removed. An albic horizon usually lies above an illuvial horizon or a fragipan or an equally impervious horizon or layer.

(c) High categories

According to Guy D. Smith (1965) and the 7th Approximation (Soil Survey Staff, 1960) there are ten orders in the new system. Some of them apply to the classification of Ingham County soils as indicated below.

(1) Alfisols: The concept of Alfisols is centered on a group of soils that are usually moist, have ochric epipedons, and have argillic horizons

with medium or high base status. Water movement through the solum has been adequate to remove free carbonates from the fine earth in the epipedon and from most of the argillic horizon, but inadequate to remove a substantial part of the exchangeable bases held by the soil.

Total analyses show accumulations of sesquioxides in the B horizons, but this is largely the results of accumulations of layer lattice clays. Free iron is low in the albic horizon relative to the clay fraction, but it seems to be equally low in the argillic horizons.

Exchange capacities are unaffected by heat or they increase instead of decreasing on heating.

Aqualfs, Boralfs, Udalfs, and Ustalfs are listed as suborders of Alfisols. Only the Aqualfs and Udalfs are represented in Ingham County.

(2) Mollisols: These are soils in which decomposition and accumulation of relatively large amounts of organic matter have taken place in the presence of calcium, producing Ca-rich forms of humus.

This requires decomposition in the soil, not on the soil. They have high base saturation with calcium and a mollic epipedon.

Mollisols are found where moisture is adequate for relatively large annual additions of organic matter. There are a few soils that have more than 4% organic matter and more than 40% calcium carbonate throughout the epipedon, which have been grouped as Mollisols.

Albolls, Aquolls, Borolls, Rendolls, Udolls, Ustolls and Xerolls are the suborders listed for the order of Mollisols. Only the Aquolls and Udolls are represented in Ingham County.

(3) Entisols: These are mineral soils that lack diagnostic horizons other than an ochric epipedon or an albic horizon. They may be found in any climate, on very recent surfaces, either on steep slopes or on flood plains.

The Entisols include most of the alluvial soils or the very sandy upland soils in Ingham County, Michigan.

Four suborders have been listed as: Arents, Fluvents, Orthents and Psamments.

(4) Inceptisols: Are soils without spodic, argillic, or oxic horizons, unless in a lower sequum. We may say they are primarily eluvial soils.

Inceptisols also lack a calcic, salic or gypsic horizon within 100 cms. (40 inches) of the surface.

Andepts, Aquepts, Plaggepts, Tropepts, Ochrepts, and Umbrepts, are the suborders of Inceptisols. Only a few Aquepts are represented in Ingham County.

(5) Histosols: The Histosols include the soils previously called bog soils, or organic soils, and some half-bog soils. While a number of these occur in Ingham County their description and the properties proposed for their classification are not yet adequate for testing their classification in the new system.

III. FIELD INVESTIGATIONS

A soil survey of medium intensity is currently in progress in Ingham County, Michigan. In this survey the mapping units are generally phases of types of soil series. In the field work being done cooperatively by the Michigan Agricultural Experiment Station and the U.S. Department of Agriculture examinations of the soils generally take place to a depth of forty to sixty-six inches which is considered adequate for most farmlands.

The mapping of the areas was done using aerial photographs of about 1:12,000 scale as base maps. Delineations are made according to differences in the landscape, such as changes in topography or variation in surface color and other diagnostic surface features. Test holes were dug (about 1 hole for 5 acres) to define the boundaries between the mapping units that are based on subsurface soil profile characteristics. A number of descriptions of typical profiles were made in the field for each soil series. Topography or slope of the land and other features were also observed and recorded in the field notes at the points where those profile descriptions were made. Texture, structure, consistence,

color, and thickness of each horizon also were noted accurately for each soil profile. The acidity of the material in each horizon was measured by means of field pH kit and recorded.

The location of natural land features such as streams, lakes, ponds, and marshes; and of man made features such as levees, churches, cemeteries, gravel pits, roads and homes were also marked on the field sheets to assist in relating the soil boundaries to the landscapes. Since the maps will be published on an aerial photo background and woodlots, field boundaries and surface colors of the areas also help in delineating the areas of the different soils and relating these differences to ownership units such as farms, or management units such as fields.

IV. METHODS OF STUDY

A. Placement of Soil Series in New Classification, based on Official Series Descriptions.

The placement of the established soil series identified in Ingham County into the new soil classification system was first tested. This was done according to the latest information available, the 7th Approximation (Soil Survey Staff, 1960) and its October, 1966 supplement.

The established soil series descriptions were used to place each of them into the new classification system, including the range in characteristics cited. Cases of deviations from a class in the higher categories are noted and discussed in the sections of comparison and suggestions for each series in alphabetical order.

In order to illustrate the method of procedure, one of the soil series "Miami" is cited here as an example.

Miami Series:

According to the official series description of Miami, 1/17/58, it belongs in the following taxa of the new classification system for the reasons cited.

Order: Alfisols

Because:

a. The Ap horizon is an ochric epipedon;

b. The Bt horizon is an argillic horizon, 16 inches thick;

c. The Miami soils are usually moist in some part of the soil between 25 cm and 1.m (10 and 40 inches);

d. Base saturation (by sum of cations) is 35% or more at a depth of 1.25 .m (50 inches) below the top of the argillic horizon.

Suborder: Udalf

Because:

a. The Miami soils are not saturated with water at any season;

b. The Miami soils are usually moist, not dry in most years for more than three months.

Great Group: Hapludalfs

a. There is no irregular upper boundary of the argillic horizon in the Miami series;

b. There is no fragipan or natric or argic horizon present.

Subgroup: Typic Hapludalfs

a. Miami series lack a lithic contact within 20" of the surface;

b. Have an argillic horizon that is free of mottles with chromas of 2 or less in the upper 25 cm (10 inches);

c. There is an Ap horizon with a moist value of more than 3;

d. Chroma of the argillic horizon is less than 6;

e. Miami soils do not have over 35% clay in all horizons between 10 and 40 inches.

Family: fine-loamy, mixed, mesic

Because:

a. The argillic horizon contains more than 18% clay but less than 35% clay;

b. There is no special kind of minerals dominant in the Miami profile between the Ap horizon and the top of the C horizon;

c. The range of mean annual temperature at 50 centimeters depth (20 inches) is between 8.3-15°C (47 and 59°F.).

In summary, the Miami series is thus in the fine loamy, mixed, mesic family of Typic Hapludalfs.

B. Comparing Field and Laboratory Studies in Ingham County with the Official Series Descriptions

The official description of each series was next compared with the field descriptions of the profiles of the same series in Ingham County to find out the possible deviations in these soils from the modal profile description and the cited range of properties in the official series description cited above.

Seventeen field descriptions and twenty field notes on the Miami series had been prepared in the course of the Ingham County survey thru the 1966 field season. This series is again taken as an example of the procedure followed in this study. In addition to the field descriptions, laboratory analyses of two profiles of Miami were available from Ingham County. All this available information was studied as follows:

> The properties cited in the official description are shown at the top of Table 1, and various sets of properties of the horizons at sites described in the field are shown below it in Table 1.

Considering the modal properties (line 0 of Table 1) and the range in characteristics of the Miami series (silt loam, sandy loam, loam surface texture; clay loam textural B;

slightly acid reaction of sola; 10YR 5/3, 5/4-7.5YR 4/4 color of sola; none to 18 inches depth of loess capping; and 20-42 inches of depth to the calcareous material); the deviations of various profile descriptions from these standards are noted below.

Profiles Nos. 4, 6, and 9 have an A_1 horizon which is less than 15 cm (6 inches) thick but their moist color value is lower than 3.5;

Profiles Nos. 2, 3, 5, 8, 11, and 12 have an Ap horizon with a moist value of 3.

In addition:

Profile No. 2

(a) The depth of leaching (64") is greater than the range of this characteristic in the official series description.

(b) It also lacks a B_1 horizon.

Profile No. 6

(a) The texture of the B_{21t} and B_{22t} horizons are finer (clay).

(b) The depth of leaching is 54 inches.

Profile No. 9

(a) This profile has a coarser surface texture (l.s)

(b) It lacks a B_1 horizon

(c) The color of the B_{22t} horizon is reddish (5YR 4/4)

(d) The thickness of solum is 50 inches.

Profile No. 12

Thickness of the solum is 45 inches.

Profile No. 13

The depth of leaching is 50 inches.

Profile No. 15

(a) Depth of leaching in this profile is 46 inches.

(b) The color of B_2t horizon is reddish brown (5YR 4/4)

(c) This profile lacks the B_1 and A_2 horizons.

C. Discussion of Results and Suggestions on Miami Series

The following conclusions and proposed changes in the classification and description of the Miami series, or its mapping units, in Ingham County are based on the above data.

(a) Changes in classification at the family level and above:

1. Recognize another series in the fine-loamy, mixed, mesic family of Mollic Hapludalfs for the 35% of the soil descriptions which have

moist Ap color values of 3 or less. This is probably the same soil as the Octagon series in Indiana, Table 2.

2. Recognize the profiles with clay to fine clay loam B_2 horizons as members of the Morley series in the fine, illitic, family of Typic Hapludalfs.

(b) Changes in the description of the Miami series in Ingham County:

1. Extend the depth of leaching from 42 inches (described officially) to 50 inches according to 30% of the Miami profiles described in Ingham County.
2. Mention the absence of the B_1 horizon from the modal description as observed in 30% of the Miami profiles studied.
3. Mention the occasional reddish color of the B horizon and the loamy sand surface textures.

(c) Changes needed in the name and/or description of the mapping units:

1. Mention the new series in the fine-loamy mixed, mesic family of Mollic Hapludalfs in the name and description of the Miami mapping units.

2. Mention the fine-textured B_{21t} and B_{22t} (clay to fine clay loam) Morley series inclusions in the range of characteristics of mapping units.
3. The mapping unit Miami loams, 0-2% slopes should apparently be Miami-Octagon loams, 0-2% slopes and Miami loams, 2-6% slopes should be Miami-Octagon loams, 2-6% slopes.

(d) Comparisons with the current, April 1967, descriptive legend:

1. Series description:

   The above mentioned characteristics are not shown, but, the absence of the B_1 horizon is mentioned in the descriptive legend of Ingham County.

2. Mapping unit description:

   The moist Ap color value of 3 have been mentioned in the descriptive legend. In addition, small areas of Celina, Metea, Spinks on the lesser slopes and Conover, Brookston in the depressions, have been mentioned as included soils of Miami units in Ingham County survey area.

Table 1A. Summary of Observed Properties of the Ap or A_1 Horizons of the Miami Profiles Described (The Official Series Description is Shown on Line 0)

Profile No.	Horizon	Depth (in.)	Color (mo.)	Tex.	Str.	Cons.	Reac.	Remarks
0	Ap	0-8"	10YR 4/2	L	2 C Gr	Fr	S. to M. Acid	
1	Ap	0-10"	10YR 4/3	S.L.	F Gr	Fr	6.0	
2	Ap	0-10"	10YR 3/3	L	1F Gr	Fr	7.0	
3	Ap	0-10"	10YR 3/3	L	1F gr	Fr	7.0	
4	A_1	0-4"	10YR 2/2	L	2F Gr	Fr	6.9	
5	Ap	0-9"	10YR 3/3	L	2M Gr	Fr	7.0	
6	A_1	0-6"	10YR 2/2	L	-		6.0	
7	Ap	0-8"	10YR 4/1	S.L	1F Gr	Fr	6.0	
8	Ap	0-7"	10YR 3/3	S.L	1F Gr	Fr	7.0	
9	A_1	0-5"	7.5YR 3/2	L.S	1F Gr	V.Ft	7.0	inclusion in Miami
10	Ap	0-8"	10YR 4/2	S.L	1L Gr	Fr	5.5	
11	Ap	0-8"	10YR 3/2	L	1L Gr	Fr	7.0	some reddish s. stone in cal. till with pink color
12	Ap	0-10"	10YR 3/2, 2/2	L	1M Sub-Gr	Fr	5.3	
13	Ap	0-8"	10YR 4/2, 6/4	S.L	1L Gr	Fr	6.0	
14	Ap	0-9"	10YR 4/2	L	2M Gr	Fr	6.8	few stones
15	Ap	0-7"	10YR 4/4	L	2M Gr	Fr	6.0	few stones
16	Ap	0-11"	10YR 4/3	S.L	1F Gr	Fr	6.5	the surface is covered by gravel
17	Ap	0-8"	10YR 4/3	L	1M Gr	Fr	6.5	

Table 1B. Summary of Observed Properties of the A_2 Horizon of the Miami Profiles Described (The Official Series Description is Shown on Line 0)

Profile No.	Horizon	Depth (in.)	Color (mo.)	Tex.	Str.	Cons.	Reac.	Remarks
0	A_2	8-12.	10YR 5/4 10YR 5/3	Si.L or L	1M Pl 1C Gr	Fr	M. to Str. Acid	
1	A_2	10-14	10YR 6/4	L	2M Sub ang. bk	Fr	6.5	
2	A_2	10-13	10YR 5/4	L	1F Gr	Fr	6.8	
3	A_2	10-14	10YR 5/4	L	2M sub ang. bk	Fr	6.0	
4	A_2	4-7	10YR 5/4	L	2F Gr	Fr	6.5	
5	A_2	9-18	10YR 5/3	Gl	1F Gr	Fr	7.5	
6	A_2	6-18	10YR 5/4	F.S.L.	W.F.S.b	V.Fr	5.5	
7	A_2	8-18	10YR 5/3, 6/3	S.L.	1F Gr	Fr	6.0	
8	A_2	7-10	10YR 2/3, 4/2	S.L.	Ang. bK	Fr	7.0	
9	A_2	5-12	10YR 4/4	L.S	1VF Gr	V Fr	6.8	
10	A_2	8-12	7.5YR 4/4	S.C.L	2M S bk	Fr	4.0	
11	A_2	8-14	10YR 5/3, 6/3	L	1F S bk	Fr	7.5	
12	A_2	10-13	10YR 7/2, 5/4	F.S. L	1 F sub	V. Fr	6.0	
13	A_2	8-16	10YR 6/3	L	1L S bk	Fr	6.0	Few small pebbles
14	A_2	8-13	10YR 6/3	L	2M Gr	Fr	6.5	
15	-	-	-	-	-	-	-	
16	-	-	-	-	-	-	-	
17	-	-	-	-	-	-	-	

Table 1C. Summary of Observed Properties of the B_1 Horizon of the Miami Profiles Described (The Official Series Description is Shown on Line 0)

Profile No.	Horizon	Depth (in.)	Color (mo.)	Tex.	Str.	Cons.	Reac.	Remarks
0	B_1	12-15"	10YR 5/4	Si.Lm or Si.C.L	M to F Sb A.bk	Fr to Fi	M to S acid	C coatings
1	B_1	14-18	10YR 5/3	C.L	2.M.Sub A bk	Fr	6.7	
2	-	-	-	-	-	-	-	
3	B_1	14-18	10YR 5/4	L	2.F.m bk	Fr	5.5	
4	B_1	7-9	10YR 4/4	C.L	2M.Sb	Fr	6.5	
5	B_1	18-22	10YR 3/2	C.L	2M.S bk	V.fi	7.8	
6	B_1	18-24	10YR 4/4	L	W.M.Sb	Fr	5.0	
7	B_1	18-22	10YR 4/3	L	V.F.Sb bk	Fi	6.5	
8	B_1	10-15	10YR 4/3	L	M.Sb. bk	Fr	7.2	
9	B_1	12-16	10YR 5/3	L.S.	Massive to platy	-	7.0	
10	B_1	12-15	10YR 4/4	S.C.L	1MSbk	Fr	5.5	
11	B_1	14-23	7.5YR 4/4	C.L	1MSbk	Fr	7.5	
12	B_1	13-19	10YR 6/3, 5/4	L	1MSbk	Fr	5.5	
13	B_1	16-25	10YR 5/4	L	1LSbk	Fr	6.0	
14	-	-	-	-	-	-	-	
15	-	-	-	-	-	-	-	
16	-	-	-	-	-	-	-	
17	B_1	8-16	10YR 4/4	L	2MSbk	Fr	6.5	

Table 1D. Summary Observed Properties of the B_2 Horizon of the Miami Profiles Described (The Official Series Description is Shown on Line 0)

Profile No.	Horizon	Depth (in.)	Color (mo.)	Tex.	Str.	Cons.	Reac.	Remarks
0	B_{21t}	12-24	10YR 4/4 5/4, 5/6 7.5YR 4/4	C.L to Si.C.L	M to St Sb.A.bk	Fi	Mid to Str.Acid	Clay coatings
1	B_{21t}	18-30	10YR 5/6	C.L.	2M.sb bi	Fi	7.0	
2	B_{21t}	13-34	10YR 4/4	C.L.	2.F.M. SB.bk	Fr	6.2	
3	B_{21t}	18-24	10YR 4/3	C.L.	2.F.m bk	Fi	5.5	
4	B_{21t}	9-32	10YR 3/4	C.L	2.M.Sb	Fi	6.8	
5	B_{21t}		10YR 4/4	C.L	2.M.S. bk	Fi	7.9	
6	B_{21t}	24-36	10YR 4/4, 5/6	C	3M.Sb	Fi	7.0	Some bright spots
7	B_{21t}	22-36	7.5YR 4/4	L to C.L	M.M.Sb bk	Fi	7	
8	B_{21t}	15-30	10YR 4/4, 4/3	C.L	M.Sb. bk	Fi	7.5	clay skins
9	B_{21t}	16-25	7.5YR 4/4	C.L	2M.S.bk	-	6.0	
10	B_{21t}	15-22	7.5YR 4/4	C.L	2M.S.bk	Fi	6.0	
11	B_2	23-30	7.5YR 5/4	C.L	2M.S.bk	Fi	7.0	
12	B_{21t}	19-27	7.5YR 4/4, 4/4	C.L	3C sub	V.fi	5.2	
13	B_{21t}	25-33	10YR 4/4	C.L	1LSbk	Fi	6.0	
14	-	-	-	-	-	-	-	
15	B_{2t}	17-25	5YR 4/4	C.L	2MSbk	V.Fi	6.0	
16	-	-	-	-	-	-	-	
17	-	-	-	-	-	-	-	

Table 1E. Summary Observed Properties of the Lower B_2 Horizons of the Miami Profiles Described (The Official Description is Shown on Line 0)

Profile No.	Horizon	Depth (in.)	Color (mo.)	Tex.	Str.	Cons.	Reac.	Remarks
0	B_{22t}	24-28	7.5YR 9/6 10YR 4/3	C.L	F to sub K	Fi	S.Acid to nuetral	Coatings
1	B_{22t}	30-40	10YR 4/3	C.L	Sub K	Fi	7.0	
2	B_{22t}	34-64	10YR 5/3	C.L	2MSub K	Fi	6.0	
3	B_{22t}	24-30	10YR 5/4	C.L	2F.ang bk	Fi	6.5	
4	-	-	-	-	-	-	-	
5	-	-	-	-	-	-	-	
6	-	-	-	-	-	-	-	
7	B_{22t}	36-42	10YR 4/3	C.L	2.M sub ag Bk	Fi	8	
8	-	-	-	-	-	-	-	
9	B_{22t}	25-50	5YR 4/4	C.L	2Msub ag.Bk	-	6.3	
10	B_{22t}	22-29	10YR 4/4	C.L	2M sbK	Fi	6.5	
11	B_3	30-35	10YR 5/4	C.L	2M sbK	Fi	7.5	
12	B_3	27-45	10YR 4/3	C.L	2M sub	Fi	6.2-7.5	Clay skins
13	-	33-50	10YR 5/4	C.L	2M Sbk	Fi	7.0	Some mottled 10YR 5/8
14	B_3	13-28	10YR 5/4	C.L	2M Sbk	Fi	6.5	
15								
16	B_3	11-30	10YR 5/8	C.L	2M Sbk	Fi	6.5	
17	B_3	16-35	10YR 5/4	L	M	V.Fi	6.5	

Table 1F. Summary Observed Properties of the C Horizon of the Miami Profiles Described (The Official Description is Shown on Line 0)

Profile No.	Horizon	Depth (in.)	Color (mo.)	Tex.	Str.	Cons.	Reac.	Remarks
0	C	28+	10YR 6/4 2/3 10YR 5/3	L Si.L. C.L. or coarse	Massive to W.Sub A.bk	Fi	Calcar-eous	
1	C	40+	10YR 5/4	L	massive	Fi	8	
2	C	64+	10YR 5/3	L	massive	Fi	8	
3	C	30+	10YR 4/4, 5/4	L	Gr.	Fr	8.0	
4	C	32+	10YR 5/3	L	massive	Fi	8.0	
5	C	30+	10YR 4/4	L	2M.S.a	Fi	8.0	
6	C	54+	10YR 5/4	C.L	S.F.Sb	Fi	8.0	
7	C	42+	10YR 5/3	C.L	M.M.sub ag.bk	Fi	8.0	
8	C	30+	10YR 5/4	H.L	massive	Fr	8.0	
9	C	50+	10YR 4/4	L.	massive	-	Calc.	
10	C	29-60+	10YR 5/3	L	1MSbk	Fi	Calc.	Area mapped as Owosso
11	C	35+	10YR 5/3-6/3	L	1LSbk	Fi	Calc.	Some reddish sandstone with pink color
12	C	45+	10YR 4/3	L	massive	Fi	Calc.	
13	C	50-60+	10YR 5/3	L	1FSbk	Fi	Calc.	
14	C	28-108+	10YR 5/3	L	2MSbk	Fi	Calc.	
15	C	46-64+	10YR 5/6	L	1FSbk	Fr	Calc.	
16	C	30+	10YR 6/4	L	2MSbk	Fr	Calc.	
17	C	35+	10YR 5/6	L	1MSbk	Fi	Calc.	

V. PLACEMENT OF MINERAL SOILS IN THE NEW SYSTEM, COMPARISONS WITH AVAILABLE DATA IN INGHAM COUNTY AND RESULTING SUGGESTIONS

In order to classify the mineral soils in Ingham County according to the new soil classification system, the following steps were followed. First, the current proposed placements of all series were tested. This revealed a few changes in the tentative placements. Secondly, the field descriptions and the profiles on which laboratory data were available for each of those series were placed in the new system. Thirdly, the field descriptions and notes from Ingham County were compared to the official series description. Fourth, assuming that the descriptions and notes were representative of the mapping units, the suitability of the names of the mapping units were examined according to the guidelines in the January 11, 1966 memo on the application of the new soil classification system. Finally, these suggestions were checked against the revised descriptive legend for the county.

The resulting suggestions for each soil series are given below in alphabetical order. However, it was found there are no estimates of the proportions of the various soils in each mapping unit in the descriptive legend.

It should be born in mind that the correlations of the mapping units for this area have not yet been completed and the descriptive legend is now in the process of being compiled. Where changes are suggested on the basis of the currently available information these will need to be checked in the field to see if the profile descriptions now available are truly representative of the soil units as mapped in Ingham County. Failure to describe grey mottles if present in the profile, for example, may greatly alter the following suggestions. The small number of profile descriptions and notes on these soils is insufficient to be adequately representative of the composition of the units and this has no doubt been corrected in part by the personal experiences of the surveyors in the recently revised descriptive legend. Further checking and observations as the survey progresses may result in deviations from these suggestions.

A. Boyer Series

Seven profile descriptions, eight field notes and one profile analysis were available from the Boyer series. The following conclusions and proposed changes are based on the above mentioned data.

(a) Classification at the family level and above:

(1) 70% of the profile descriptions fit into the coarse-loamy, mixed, mesic family of Typic Hapludalfs into which the Boyer series has been placed.

(2) The remaining 30% are inclusions of the Fox and Casco series which will be mentioned under descriptions of the mapping units of Boyer.

(b) Proposed changes in the description of the Boyer series for this survey area are:

(1) A B_1 horizon was not noted in 2/3 of the studied profiles. However, further field studies are needed to clarify this observation. The B_1 horizon may not always be detected in auger borings on which most of the descriptions are based.

(2) No difference was noted between the sandy clay loam B_{21t} and B_{22t} horizons, so only a B_{2t} horizon is needed, as shown by 60% of the Boyer series descriptions.

(3) A moderately coarse texture layer between the B_{2t} and the IIC should be mentioned as a B_3 horizon according to 40% of the Boyer descriptions.

(c) Changes needed in the description and naming of the Boyer mapping units:

(1) 15% of the profile descriptions are in the fine-loamy over sandy or sandy skeletal, mixed, mesic family of Typic Hapludalfs represented by the Fox series.

(2) 15% of the profile descriptions are in the fine-loamy, over sandy or sandy skeletal, mixed, mesic, shallow, family of the Typic Hapludalfs represented by the Casco series.

(d) Comparisons with the current, April 1967, descriptive legend:

(1) Series description: The above mentioned characteristics of the Boyer have been shown in its description in Ingham County, but, the surface color mentioned is darker than usual for this series.

(2) Mapping unit description: The Fox is mentioned as an inclusion in the mapping unit but the Casco is not. However, the one Casco profile description is in the F1 mapping unit that is described as being shallower than the Boyer described on gentler slopes. This raises the question of whether the F1 units should be Casco instead of Boyer.

B. Brady Series

Three profile descriptions and three field notes were available from the Brady series. The following conclusions and suggestions are based on the above data:

(a) Classification at the family level and above:

(1) None of the profile descriptions fit into the coarse-loamy, mixed, mesic Aquollic Hapludalfs into which the official Brady series description has been placed.

(2) 33% of the soil descriptions fit into the Coarse-loamy, mixed, mesic family of Typic Hapludalfs represented by the Boyer series.

(3) 33% of the soil description fit into the coarse-loamy, mixed, mesic family of Mollic Hapludalfs. The Constantine series has been proposed for a soil in this family in Michigan.

(4) 33% of the soil descriptions fit into an imperfectly drained variant of Spinks which is in the sandy, mixed, mesic family of Aquic Hapludalfs.

(b) Proposed changes in the description of the Brady series for this area:

Since no Brady profiles have yet been described in these units, it seems their names should be changed.

(c) Changes needed in the description and naming of the mapping units:

The mapping unit Brady loamy sand, 2-6% slopes, apparently is Spinks loamy sand imperfectly drained variant, 2-6% slopes; and the Brady sandy loams, 0-2% slopes should apparently be Boyer-Constantine sandy loams, 0-2% slopes. They are each represented in about equal proportions in the profile descriptions from these mapping units.

(d) Comparisons with the current, April 1967, descriptive legend:

(1) Series description

No Brady profiles have yet been studied in Ingham County according to this investigation.

(2) Mapping unit description:

No mapping units descriptions are shown yet in the descriptive legend of Ingham County.

C. Bronson Series

Three profile descriptions and one field note were available from the Bronson series.

The following conclusions and suggestions are based on those field studies.

(a) Classification at the family level and above:

(1) None of the profile descriptions fit into the coarse-loamy, mixed, mesic family of Aquic Hapludalfs into which the Bronson series has been placed.

(2) 35% of the soil descriptions fit into the coarse-loamy, mixed, mesic family of Mollic Hapludalfs. The Constantine series has been proposed for a soil in that family, as mentioned under the Brady series.

(3) 65% of the soil descriptions are the well drained Spinks series which is in the sandy, mixed, mesic family of Psammentic Hapludalfs.

(b) Changes in the description of the Bronson series in this area:

No Bronson profiles have yet been described in these units.

(c) Changes needed in the description and naming of the Bronson sandy loam mapping units:

The name of these mapping units on B slopes should apparently be Spinks-Constantine sandy loams. They are represented by 65% and 35%, respectively, of the profile descriptions from the mapping units to date.

(d) Bronson does not yet appear in the descriptive legend for Ingham County.

D. Brookston Series

Six profile descriptions, seven field notes and one profile analysis were available from the Brookston series.

The following conclusions and suggestions are based on those data.

(a) Classification at the family level and above:

(1) 50% of the profile descriptions fit into the fine-loamy, mixed, mesic family of Typic Argiaquolls which includes the Brookston series.

(2) The remaining 50% of the soil descriptions fit into the poorly drained Pewamo series which is in the fine, illitic, non-calcareous, mesic family of Typic Argiaquolls.

(b) Proposed changes in the description of the Brookston series for this area:

The occurrence of thin (4 to 10 inches) gravel, gravelly loam, sandy or loamy sand strata within 18 inches of the surface, according to field notes, should be mentioned in the range of characteristics of the Brookston series in Ingham County.

(c) Changes needed in the description and naming of the mapping units of Brookston:

Because of the fine textured (CL to C) B_{22t} horizon as indicated by 50% of the profile description, the inclusion of the Pewamo series should be mentioned in the name and the descriptions of the mapping units of the Brookston series. The name of this mapping unit would thus be Brookston-Pewamo loams.

(d) Comparisons with the current, April 1967, descriptive legend:

(1) Series description:

The above mentioned characteristics have been shown in the descriptive legend for Ingham County.

(2) Mapping unit description:

The Pewamo is not mentioned as an inclusion in the mapping unit. But small areas of Conover and some small areas of Colwood are mentioned in the descriptive legend of Ingham County.

E. Celina Series

Four profile descriptions and ten field notes were available for the Celina series. The following conclusions and proposed changes are based on those data.

(a) Classification at the family level and above:

(1) 50% of the soil descriptions fit into the fine-loamy, mixed, mesic family of Aquic Hapludalfs which includes the Celina series.

(2) The remaining 50% are inclusions of Conover series which will be discussed under descriptions of the mapping units of Celina.

(b) Proposed changes in the descriptions of the Celina series for this area:

(1) There is no B_{23t} horizon present according to 100% of the Celina profile descriptions.

(2) The minimum depth of mottlings from the surface should be mentioned as 13" instead of 16" according to the soil profile descriptions.

(3) The presence of loamy sand or sand lenses within the upper 18" of the profile, according to occasional field notes, should be mentioned.

(c) Changes needed in the description and naming of the Celina loam mapping units:

(1) 50% of the profile descriptions are in the fine-loamy mixed, mesic family of Aquollic Hapludalfs, represented by the Conover series.

(2) The name of these mapping units on B slopes should therefore be Celina-Conover loams.

(d) Comparison with the current, April 1967, descriptive legend:

(1) Series description:

The above mentioned characteristics are not shown in the descriptive legend of Ingham County.

(2) Mapping unit description:

The inclusion of Conover is mentioned in the descriptive legend.

F. Colwood Series

Two profile descriptions and three field notes were available from the Colwood series. The following conclusions and suggestions are based on those data.

(a) Classification at the family level and above:

(1) 100% of the profile descriptions fit into the fine-loamy, mixed, mesic family of Aquollic Hapludalfs which include the Conover series.

(b) Proposed changes in the description of the Conover series in Ingham County:

(1) The occurrence of (9 to 12 inches) sandy loam to loamy sand layers within 18 inches of the surface, should be mentioned in the range of characteristics of this series according to 40% of the soil profile descriptions.

(c) Comparison with the current, April 1967, descriptive legend:

(1) Soil description:

The above mentioned characteristics of the Conover has been shown in the descriptive legend.

(2) Mapping unit description:

No mapping unit inclusions have been indicated in this study. But, small inclusions of Celina, Kibbie, Locke, Brookston, and Miami have been mentioned in the descriptive legend.

I. Fox Series

The following conclusions and suggestions are based on six profile descriptions and seven field notes from the Fox series in Ingham County.

(a) Classification at the family level and above:

(1) 66% of the soil descriptions fit into the fine-loamy over sandy or sandy skeletal, mixed, mesic family of Typic Hapludalfs which include the Fox series.

(2) The remaining 34% are inclusions of Boyer and Oshtemo series which will be mentioned under descriptions of the mapping units of Fox.

(b) Proposed changes in the description of the Fox series in this survey area:

(1) Mention the coarse textured A_2 horizon (SL to LS) as indicated by 75% of the Fox descriptions.

(2) Omit the B_1 horizon as indicated by 50% of the soil descriptions, unless this has been missed in auger descriptions.

(3) Combine the B_{21} and B_{22t} horizons into one B_{2t} horizon as indicated by 50% of the soil descriptions.

(4) Mention the existence of a transitional B_3 horizon (6 to 10 inches) between the B_{2t} and IIC horizons, according to 75% of the soil descriptions.

(c) Changes needed in the description of the Fox mapping units.

(1) In addition to 66% of Fox, 17% of the profile descriptions are in the coarse-loamy, mixed, mesic family of Typic Hapludalfs, represented by the Boyer series.

(2) The remaining 17% of the soil descriptions are in the coarse-loamy, mixed, mesic family of Typic Hapludalfs, represented by the Oshtemo series.

(3) No changes are proposed in the names of these mapping units.

(d) Comparisons with the current, April 1967, descriptive legend:

(1) Series description:

The above mentioned characteristics of the Fox have been shown in the descriptive legend of Ingham County.

(2) Mapping unit description:

The Boyer and Oshtemo soils, described as mapping unit inclusions in this study, have been mentioned also in the descriptive legend.

J. Gilford Series

Eight profile descriptions and three field notes were available from the Gilford series. The following conclusions and proposed changes are based on those data.

(a) Classification at the family level and above:

(1) 40% of the soil descriptions fit into the coarse-loamy, mixed, mesic, non-calcareous family of Typic Haplaquolls which include the Gilford series.

(2) The remaining 60% of the profile descriptions are inclusions of the Sebewa, Wasepi and "poorly drained Spinks" series which will be mentioned under descriptions of the mapping units of Gilford.

(b) Proposed changes in the description of the Gilford series for this survey area are:

(1) Mention the common absence of an A_2 horizon, as indicated by 60% of the soil descriptions.

(2) Combine B_{1g} and B_{21g} horizons as B_{2g} horizon as indicated by 60% of the soil descriptions.

(3) Consider the existence of a B_{3g} transitional horizon, with LS and SL texture, as indicated by 60% of the profile descriptions.

(c) Changes needed in the descriptions and names of the Gilford mapping units.

(1) 25% of the soil descriptions are in the fine-loamy over sandy or sandy skeletal, mixed, mesic, family of Typic Argiaquolls represented by the Sebewa series.

(2) 25% of the profile descriptions are in the coarse-loamy, mixed, mesic family of Aquollic Hapludalfs represented by the Wasepi series.

(3) 10% of the soil descriptions include the poorly drained variant of the Spink series.

(4) In view of the large proportions of other series in these mapping units, Gilford-Wasepi sandy loams seems a more appropriate name for these mapping units.

(d) Comparisons with the current, April 1967, descriptive legend:

(1) Series description:

The above mentioned characteristics of the Gilford have been mentioned in the descriptive legend.

(2) Mapping unit description:

There are no definite proportions of mapping inclusions in the descriptive legend. But, it is mentioned that small areas of organic soils occur in low spots and that loamy sand, sandy loam and loam surface textures are included.

K. Granby Series

Five profile descriptions, one profile analysis, and one field note were available from the Granby series. The following conclusions and suggestions are based on those data.

(a) Classification at the family level and above:

(1) 80% of the soil profile descriptions fit into the sandy, mixed, non-acid, mesic, family of Typic Haplaquolls into which the Granby series has been placed.

(2) The remaining 20% are inclusions of the Maumee series which is in the same family.

(b) Changes in the description of the Granby series in Ingham County:

(1) The thickness of Ap plus A_{12} horizons should be extended from 8 to 15 inches to 10 to 18 inches according to 75% of the descriptions of Granby.

(2) The occurrence of a stratified Bg horizon (LS and S) according to 50% of the descriptions should be mentioned in the range of characteristics of the Granby series in Ingham County.

(3) Extend the depth of leaching from 30 inches to 50 inches according to 75% of the Granby profile descriptions.

(4) There is muck, about 8 inches thick, on the surface of the Granby series in scattered areas according to 25% of the descriptions.

(c) Changes needed in the description and naming of the Granby mapping units:

(1) No change in the name of the mapping unit is proposed.

(2) The 20% inclusion of the Maumee series should be mentioned in the description of the mapping unit.

(d) Comparisons with the current, April 1967, descriptive legend:

(1) Series description:

The above mentioned characteristics of the Granby have been mentioned in its description in Ingham County.

(2) Mapping unit description:

Small areas of Berrien, Tedrow and some inclusions of organic soils (Tawas, Carlisle) have been mentioned as mapping inclusions in the descriptive legend of Ingham County.

L. Hillsdale Series

The following conclusions and suggestions are based on the three profile descriptions, four field notes and four profile analyses from the Hillsdale series in Ingham County.

(a) Classification at the family level and above:

(1) 35% of the soil profile descriptions fit into the coarse-loamy, mixed, mesic family of Typic Hapludalfs which include the Hillsdale series.

(2) The remaining 65% are inclusions of fine-loamy, mixed, mesic family of Mollic Hapludalfs which will be discussed under descriptions of the mapping units of Hillsdale.

(b) Proposed changes in the description of the Hillsdale series in this survey area:

(1) No difference was noted between the B_{21t} and B_{22t} horizons, so only a B_{2t} horizon is needed as shown by 100% of the Hillsdale profile description.

(c) Changes needed in the description and naming of the Hillsdale sandy loam mapping units:

(1) 65% of the profile descriptions are in the fine-loamy, mixed, mesic family of Mollic Hapludalfs, No soil has yet been recognized in this family in this survey area.

Apparently a new soil series, X_1, should be recognized under the above mentioned family category. This is probably the same soil as the Nippersink series (BWR 2-22-56) in Illinois.

(2) The name of these mapping units should therefore probably be Nippersink-Hillsdale sandy loams.

(d) Comparisons with the current, April 1967, descriptive legend:

(1) Series description:

The above mentioned characteristics of the Hillsdale series have been shown in its description in Ingham County.

(2) Mapping unit description:

No mapping unit descriptions are shown yet in the descriptive legend for Ingham County.

M. Kibbie Series

Three profile descriptions and six field notes were available for the Kibbie series. The following conclusions and suggestions are based on those data.

(a) Classification at the family level and above:

(1) 33% of the soil descriptions fit into the fine-loamy, mixed, mesic family of Aquollic Hapludalfs which include the Kibbie series.

(2) 33% of the soil descriptions fit into the fine-loamy, mixed, mesic family of Mollic Hapludalfs. A new soil series, X_2, should be recognized. This is probably the same soil as the Argyle series in Illinois.

(3) 33% of the soil profile descriptions fit into the fine-loamy, mixed, mesic Aquic Hapludalfs represented by the Celina series.

(b) Proposed changes in the description of the Kibbie series for this area:

Since only one of the profile descriptions fits the family into which the Kibbie series has been placed, no change is proposed in the description of this series.

(c) Changes needed in the description and naming of the Kibbie mapping unit:

(1) The mapping unit Kibbie loamy fine sands, 0-2% slopes, should probably be Argyle loamy fine sand, 0-2% slopes, and the Kibbie loams, 2-6% slopes should apparently be Kibbie-Celina loams, 2-6%, slopes.

(2) These three soils are represented in equal proportions in the profile descriptions from these mapping units.

(d) Comparisons with the current, April 1967, descriptive legend:

(1) Series description:

The above mentioned characteristics of the Kibbie have not been shown in the descriptive legend.

(2) Mapping unit description:

There are no mapping unit descriptions shown in the descriptive legend of Ingham County.

N. Lapeer Series

Two profile descriptions, two field notes, and one profile analysis were available for the Lapeer series (Mokma 1966). The following suggestions and conclusions are based on those data:

(a) Classification at the family level and above:

(1) 100% of the profile descriptions fit into the coarse-loamy, mixed, mesic family of Typic Hapludalfs which includes the Lapeer series.

(b) Proposed changes in the description of the Lapeer series in Ingham County:

(1) The occurrence of some gravels and pebbles in the B_1 and B_{21} horizons should be mentioned in the range of characteristics of this series in this area.

(c) Comparisons with the current, April 1967, descriptive legend:

(1) The above mentioned characteristics of the Lapeer have not been shown in the descriptive legend.

(2) Mapping unit description:

There are no mapping unit descriptions yet in the descriptive legend of Ingham County.

O. Matherton Series

Four profile descriptions and four field notes were available for the Matherton series. The following conclusions and proposed changes are based on those data.

(a) Classification at the family level and above:

(1) None of the profile descriptions fit into the fine-loamy over sandy or sandy skeletal, mixed, mesic family of Mollic Ochraqualfs into which the official Matherton series description has been placed.

(2) 50% of the soil profile descriptions fit into the fine-loamy over sandy or sandy skeletal, mixed, mesic family of Mollic Hapludalfs represented by the Dresden series.

(3) 25% of the soil descriptions fit into the fine-loamy over sandy or sandy skeletal, mixed, mesic family of Typic Hapludalfs represented by the Ionia series.

(4) 25% of the soil descriptions probably fit into an imperfectly drained variant of Dresden which is in the fine-loamy over sandy or sandy skeletal, mixed, mesic family of Aquollic Hapludalfs. This soil, X_3, has not yet been recognized in Michigan.

(b) Proposed changes in the description of the Matherton series in Ingham County:

Since no Matherton profiles have yet been described in these units, it seems their names should be changed.

(c) Changes needed in the description and naming of the mapping units:

The mapping unit, Matherton sandy loams, 0-2% slopes, should apparently be Dresden sandy loam, 0-2% slopes. The Matherton loams, 0-2% slopes should be Ionia-X_3 loams, 0-2% slopes.

(d) Comparisons with the current, April 1967, descriptive legend:

(1) Series description:

There were no Matherton series description according to this study to be compared with the descriptive legend.

(2) Mapping unit description:

No mapping unit descriptions have been shown yet in the descriptive legend of Ingham County.

P. Metamora Series

The following conclusions and suggestions are based on four profile descriptions and seven field notes from the Metamora series in Ingham County.

(a) Classification at the family level and above:

(1) 50% of the soil profile descriptions fit into the fine-loamy, mixed, mesic family of Aquollic Hapludalfs which include the Metamora series.

(2) The remaining 50% of the soil descriptions are inclusions of the Celina series which will be discussed under descriptions of the mapping units of Metamora.

(b) Proposed changes in the description of the Metamora series for this area:

(1) The depth to the IIB_{22tg} horizon varies from 24 to 42 inches instead of 18 to 42 inches, according 100% of the soil descriptions of Metamora.

(2) The texture of the IIC horizon is silty clay loam instead of clay loam according to 100% of the soil profile descriptions. This change in texture of IIC horizon should be mentioned in the range of characteristics of the Metamora series for this area.

(3) The depth of leaching is more than 42 inches according to two field notes.

(c) Changes needed in the description and naming of the Metamora sandy loam mapping units:

(1) 50% of the profile descriptions are in the fine-loamy, mixed, mesic family of Aquic Hapludalfs, represented by the Celina series.

(2) The name of these mapping units on A slopes should therefore be, Metamora-Celina sandy loams.

(d) Comparisons with the current, April 1967, descriptive legend:

(1) Series description:

The first two characteristics of the Metamora series mentioned above have not been shown in the descriptive legend. But the depth of leaching is indicated as more than 42 inches.

(2) Mapping unit description:

The inclusions of Celina have not been mentioned, but inclusions of Conover and some Brookston have been indicated in the descriptive legend.

Q. Metea Series

Four profile descriptions and ten field notes were available from the Metea series. The following conclusions and suggestions are based on those data.

(a) Classification at the family level and above:

(1) 25% of the profile descriptions fit into the sandy over fine-loamy, mixed, mesic family of Arenic Hapludalfs which includes the Metea series.

(2) 25% of the profile descriptions fit into the sandy over fine-loamy, mixed, mesic family of Arenic Aquollic Hapludalfs which is not listed under the new classification system. This soil, X_4, has not yet been recognized as a separate series in Michigan.

(3) 50% of the profile descriptions fit into the sandy over fine-loamy, mixed, mesic family of Arenic Mollic Hapludalfs. This soil, X_5, has not yet been recognized as a separate series in Michigan.

(b) Proposed changes in the description of the Metea series in Ingham County:

(1) The range of thickness of the upper story is 24 to 34 inches according to 100% of the soil profile descriptions. This should be mentioned in the range of characteristics of the Metea series for this area.

(c) Changes needed in the description and naming of the mapping units of Metea:

(1) The name of these mapping units should be "X_5-X_4-Metea" loamy sands. They are present in proportions of 50, 25, and 25%, respectively.

(2) 25% of the profile descriptions, "X_4", are in the sandy over fine-loamy, mixed, mesic family of Arenic Aquollic Hapludalfs which has not yet been recognized in this area.

(3) Recognize new soil "X_5" according to 50% of the soil profile descriptions. This new soil should meet the requirements for a sandy over fine loamy, mixed mesic family of Arenic Mollic Hapludalfs.

(d) Comparisons with the current, April 1967, descriptive legend:

The above mentioned range in thickness of the upper story of the Metea has been mentioned in the descriptive legend. But the inclusion and descriptions of the new soils have not been indicated. However, the inclusion of small scattered areas of Spinks and Ottawa soils have been mentioned in the descriptive legend.

R. Miami Series

The Miami series has been discussed in Section IV (Methods of Study).

It should be re-emphasized, 35% of the profile descriptions are in the fine-loamy, mixed, mesic family of Mollic Hapludalfs. No soil has yet been recognized in this family in this survey area. The Octagon series, X6, in Illinois should probably be recognized here under the above mentioned family category. It is listed as "X6" in this study.

S. Oshtemo Series

Four profile descriptions and five field notes were available from the Oshtemo series. The following conclusions and suggestions are based on those data.

(a) Classification at the family level and above: 100% of the soil profile descriptions fit into the coarse-loamy, mixed, mesic family of Typic Hapludalfs which include the Oshtemo series.

(b) Proposed changes in the description of the Oshtemo series for this survey area:

(1) The depth to the C horizon ranges from 56 to 66 inches according to 100% of the soil profile descriptions.

(2) The color of the B_{21} horizon is 10YR 5/4-5/6 instead of 5YR 3/4 according to 75% of the profile descriptions. This should be mentioned in the range of characteristics of the Oshtemo series in this area.

(c) Comparisons with the current, April 1967, descriptive legend:

(1) Series description:

The above mentioned characteristics of the Oshtemo have been shown in the descriptive legend.

(2) Mapping unit description:

Small areas of Brady, Spinks and Boyer soils have been mentioned as mapping unit inclusions in the descriptive legend.

T. Owosso Series

The following conclusions and suggestions are based on eight profile descriptions and fourteen field notes from the Owosso series.

(a) Classification at the family level and above.

(1) 50% of the soil profile descriptions fit into the fine-loamy, mixed, mesic family of Typic Hapludalfs that include the Owosso series.

(2) 25% of the soil descriptions are in the fine-loamy, mixed, mesic family of Typic Hapludalfs represented by the Miami series.

(3) The remaining 25% of the soil profile descriptions fit into the fine-loamy, mixed, mesic family of Aquollic Hapludalfs represented by the Metamora series.

(b) Changes in the description of the Owosso series in Ingham County:

(1) The depth of the $11B_t$ horizon ranges from 23 to 43 inches according to 100% of the Owosso profile descriptions.

(2) The depth of leaching starts from 42 inches or more instead of 30 inches according to 75% of the soil profile descriptions.

(c) Changes needed in the description and naming of the mapping units:

(1) 50% of the soil profile descriptions are inclusions of Miami and Metamora series in about equal proportions which should be mentioned in the name and the descriptions of the mapping units of the Owosso series.

(2) The name of this mapping unit should therefore be Owosso-Metamora-Miami sandy loams.

(d) Comparisons with the current, April 1967, descriptive legend:

(1) Series description:

The above mentioned characteristics of the Owosso have not been shown in the descriptive legend.

(2) Mapping unit description:

There are no mapping unit descriptions yet shown in the descriptive legend of Ingham County.

U. Perrin Series

Two profile descriptions, one profile analysis and four field notes were available from the Perrin Series. The following conclusions and suggestions are based on those data.

(a) Classification at the family level and above:

100% of the profile descriptions fit into the coarse-loamy, mixed, mesic family of Typic Hapludalfs which include the Perrin series.

(b) Proposed changes in the description of the Perrin series:

The depth to bright colored mottling ranges from 10 to 30 inches according to the soil profile descriptions. However, this range has been noted as 16-30 inches in the official series description.

(c) Comparisons with the current, April 1967, descriptive legend:

The depth to mottling have been mentioned as 20 to 24 inches. This should be in agreement with the above mentioned series description for this area. Small spots of Wasepi and Boyer have been indicated as mapping unit inclusions in the descriptive legend of Ingham County.

V. Sebewa Series

The following conclusions and suggestions are based on eight profile descriptions and three field notes from the Sebewa series.

(a) Classification at the family level and above:

(1) 75% of the soil profile descriptions fit into the fine-loamy over sandy or sandy skeletal, mixed, mesic non-calcareous family of Typic Argiaquolls which include the Sebewa series.

(2) The remaining 25% are inclusions of Brookston series which will be discussed under descriptions of the mapping units of Sebewa.

(b) Proposed changes in the descriptions of the Sebewa series in Ingham County:

(1) Occurrence of an A_2 horizon should be mentioned, according to 33% of the Sebewa soil profile descriptions, but this may be a Blg.

(2) The Blg horizon is absent according to 50% of the Sebewa soil profile descriptions.

(3) The B_{21t} and B_{22t} horizons could be combined as only one B_{2tg} horizon as indicated by 66% of the Sebewa profile descriptions.

(c) Changes needed in the description and naming of the Sebewa mapping units:

(1) 25% of the profile descriptions are in the fine-loamy mixed, mesic family of Typic Argiaquolls, represented by the Brookston series. This should be mentioned in the description of the mapping units.

(2) No change is proposed in the names of these mapping units.

(d) Comparisons with the current, April 1967, descriptive legend:

(1) Series description:

Only the absence of a Blg horizon have been indicated in the descriptive legend.

(2) Mapping unit description:

The Brookston is mentioned as an inclusion in the mapping unit. In addition, the Carlisle, Matherton, and Conover series are also indicated as mapping unit inclusions.

W. Sisson Series

Two profile descriptions, one profile analysis and nine field notes were available from the Sisson series. The following conclusions and suggestions are based on those data.

(a) Classification at the family level and above:

100% of the profile descriptions fit into the fine-loamy, mixed, mesic family of Typic Hapludalfs which include the Sisson series.

(b) Proposed changes in the description of the Sisson series:

Extend the depth of leaching from 42 to 52 inches according to 50% of the soil profile descriptions.

(c) Comparisons with the current, April 1967, descriptive legend:

(1) Series description:

The above mentioned depth of leaching is not the same as in the descriptive legend. There it has been mentioned as 24 to 42 inches from the surface. A correction is apparently needed.

(2) Mapping unit description:

There are no mapping unit descriptions yet shown in the descriptive legend.

X. Spinks Series

Nine profile descriptions, two profile analyses and sixteen field notes were available from the Spinks series. The following conclusions and suggestions are based on those data.

(a) Classification at the family level and above:

(1) 33% of the profile descriptions fit into the sandy, mixed, mesic family of Mollic Psammentic Hapludalfs which is not listed under the new classification system. This soil "X7" has not yet been recognized as a separate series

in Michigan. This soil is probably the same as the Stroh series (OCR, 6/29/55) in Indiana.

(2) 22% of the profile descriptions fit into the sandy, mixed, mesic family of Psammentic Hapludalfs which include the Spinks series.

(3) 22% of the soil profile descriptions fit into an imperfectly drained variant of Spinks which is in the sandy, mixed, mesic family of Aquic Hapludalfs.

(4) 11% of the soil descriptions fit into the coarse-loamy, mixed, mesic family of Typic Hapludalfs represented by the Oshtemo series.

(5) 11% of the profile descriptions fit into the fine-loamy, mixed, mesic, family of the Typic Hapludalfs represented by the Sisson series.

(b) Proposed changes in the description of the Spinks series for this survey area:

(1) Omit the B_{2t} horizon as indicated by 100% of the Spinks descriptions. But, mention thin discontinuous layers of brown sandy loam. These layers are 1/8 to 1 inch thick.

(2) The C_1 horizon is not calcareous to a depth of 66 inches from the surface, according 50% of the soil descriptions.

(c) Changes needed in the descriptions and names of the Spinks mapping units:

(1) 22% of the soil profile descriptions fit into an imperfectly drained variant of Spinks.

(2) 33% of the profile descriptions are in the sandy, mixed, mesic family of Mollic Psammentic Hapludalfs.

(3) The mapping unit Spinks loamy sands, 2-6% slopes should therefore be Stroh-Spinks loamy sands, 2-6% slopes and Spinks sandy loams, 0-2% slopes should be Spinks imperfectly drained variant, sandy loams, 0-2% slopes.

(4) The inclusions of Sisson and Oshtemo series should also be mentioned in the descriptions of the mapping units.

(d) Comparisons with the current, April 1967, descriptive legend:

(1) Series description:

The above mentioned characteristics of Spinks have been mentioned in its description.

(2) Mapping unit description:

The above mentioned imperfectly drained Spinks variant has been indicated in the mapping unit, but the other mapping inclusions have not been mentioned.

The inclusions of some Oakville, Berrien, Metea, Metamora and scattered areas of Hillsdale or Lapeer have been shown in the descriptive legend of Ingham County. Apparently this is a complex mapping unit that may need further study.

Y. Wasepi Series

The following conclusions and suggestions are based on two profile descriptions and three field notes from the Wasepi Series in Ingham County.

(a) Classification at the family level and above:

(1) 50% of the profile descriptions fit into the coarse-loamy, mixed, mesic family of Aquollic Hapludalfs into which the official Wasepi series description has been placed, but they are representative of the Brady instead of the Wasepi series.

(2) 50% of the soil descriptions fit into the coarse-loamy, mixed, mesic family of Aquic Hapludalfs represented by the Bronson series.

(b) Proposed changes in the description of the Wasepi series in Ingham County:

(1) Since no Wasepi profiles have yet been described in these units, because of the depth to calcareous material which is more than 40 inches, the name of these units should be changed.

(c) Changes needed in the description and naming of the Wasepi mapping units:

(1) The mapping unit Wasepi sandy loam, 0-2% slopes should apparently be, Brady sandy loam, 0-2% slopes and the Wasepi sandy loam, 2-6% slopes should be Bronson sandy loams, 2-6% slopes, or

(2) The mapping units should be named Brady-Bronson sandy loams. They are apparently represented in about equal proportions in these mapping units.

(d) Comparisons with the current, April 1967, descriptive legend:

(1) Series description: There was no Wasepi series description in the descriptive legend.

(2) Mapping unit description:

No mapping unit descriptions have been shown yet in the descriptive legend of Ingham County.

VI. SUMMARY AND CONCLUSIONS

The relationship of the new soil classification system to the mineral soils in Ingham County was investigated as follows:

(1) The established series with two or more profile descriptions available in Ingham County were classified according to the October 1966 supplement and the 7th approximation.

(2) All the profile descriptions of these mineral soils from Ingham County were placed into the new classification system.

(3) Then, comparisons of field and laboratory data in Ingham County with the official series descriptions were made.

(4) Changes needed in the modal descriptions of the series for Ingham County were noted and any new soil series or variants were also noted.

(5) The mapping unit descriptions, and the naming of the mapping units were also reviewed and these were then checked with the current descriptive legend for the County.

The results of these studies are summarzied as follows:

1. Changes in the proposed placement of the established series in Ingham County:
   (a) The Bronson series was changed from coarse loamy, mixed, mesic, Typic Hapludalfs to - coarse loamy, mixed, mesic, Aquic Hapludalfs
   (b) The Celina series was changed from fine-loamy, mixed, mesic, Typic Hapludalfs to - fine loamy, mixed, mesic, Aquic Hapludalfs
   (c) The Hillsdale series was changed from fine-loamy, mixed, mesic, Typic Hapludalfs to - coarse loamy, mixed, mesic Typic Hapludalfs.
   (d) The Lapeer series was changed from fine-loamy, mixed, mesic Typic Hapludalfs to - coarse-loamy, mixed, mesic, Typic Hapludalfs.

2. Soils found that had not previously been correlated in Michigan:

   Seven new mineral soils have been identified in Ingham County during this study. These soils, X_1 through X_7 (in Table 2) should be recognized and their significance should be evaluated in the future survey activities of the National Cooperative Soil Survey in the Tri-County Area (Ingham, Eaton and Clinton counties).

3. From the NCR-3 Regional Publication 76 and studies of the most recent placements of Indiana and Illinois soil series into the new soil classification system, four soil series similar to four of the above mentioned seven mineral soils have been recognized and listed in Table 2.

4. Mapping inclusions:

As shown in Table 3, 125 profile descriptions were available for the 25 series studied in Ingham County. Fifty-five of these, or 44 percent of the studied soils, have beem indicated as mapping unit inclusions in Ingham County survey area. Where the amount of a mapping inclusion in a series was non-contrasting in properties and exceeded 25%, or where the amount of a mapping inclusion was contrasting in properties and exceeded 10% of the mapping unit, names of these units were changed to indicate their variable nature. The proposed names leave only 9% of the profiles as mapping inclusions.

The present names of those units and their proposed names are shown in Table 4.

5. Applicability of the new system in Ingham County:
According to this study, only four profiles out of one hundred and twenty-five studied soils did not fit into

Table 2. New mineral soils recognized according to this study of the Ingham County Soil Survey, up to April 1, 1967

No.	Soils as mapped in Ingham Co.	New soils that should be recognized	Family or families of new soils	Possible Correlations		No. of profile descriptions
				Series	State	
1	Hillsdale	X_1	Fine loamy, mixed mesic family of Mollic Hapludalfs	Nippersink	Ill.	2
2	Kibbie	X_2	Fine loamy, mixed mesic family of Mollic Hapludalfs	Argyle	Ill.	1
3	Matherton	X_3	Fine loamy over sandy or sandy skeletal, mixed, mesic family of Aquollic Hapludalfs	-	-	1
4	Metea	X_4	Sandy over fine loamy, mixed, mesic family of Arenic Aquollic Hapludalfs	-	-	1
5		X_5	Sandy over fine loamy, mixed, mesic family of Arenic Mollic Hapludalfs	-	-	2

Table 2, cont.

No.	Soils as mapped in Ingham Co.	New soils that should be recognized	Family or families of new soils	Possible Correlations		No. of profile descriptions
				Series	State	
6	Miami	X_6	Fine loamy, mixed mesic family of Mollic Hapludalfs	Octagon	Ind.	6
7	Spinks	X_7	Sandy, mixed, mesic family of Mollic Psammentic Hapludalfs	Stroh	Ind.	2

Table 3. Summary and applicability of the new system in Ingham County

No.	Named soil series	Total No. of desc.	Mapping incl.		New soil families		
			Soil series	No. of desc.	Not defined families	No. of desc.	Soils not in Ingham County legend
1	Boyer	7	Casco Fox	1	-	1	Casco
2	Brady	3	Boyer Constan-tine Spinks-imperfectly drained variant	1 1 1	- - -	1	Constantine
3	Bronson	3	Constantine Spinks	1 2	-	1	Constantine
4	Brookston	6	Pewamo	3	-		
5	Celina	4	Conover	2	-		
6	Colwood	2	-	-	-		
7	Conover	7	-	-	-		
8	Corunna	2	-	-	-		

Table 3, cont.

No.	Named soil series	Total no. of desc.	Mapping incl.		New soil families		
			Soil series	No. of desc.	Not defined families	No. of desc.	Soils not in Ingham County legend
9	Fox	6	Boyer	2			
10	Gilford	8	Sebewa	5			
11	Granby	5	Maumee	1			
12	Hillsdale	3	X_1	2	(a)		Nippersink
13	Kibbie	3	X_2	1	(b)	1	Argyle
14	Lapeer	2	-	-	-	-	-
15	Matherton	4	Dresden Ionia X_3	2 1 1	- - (c)	2 - 1	Dresden X_3
16	Metamora	4	Celina	2	-	-	-

Table 3, cont.

No.	Named soil series	Total no. of desc.	Mapping inc.		New soil families		
			Soil series	No. of desc.	Not defined families	No. of desc.	Soils not in Ingham County legend
17	Metea	X_4 4	1 X_5	1 2	(d) (e)	1 2	X_4 X_5
18	Miami	17	X_6	6	(f)	6	Octagon
19	Oshtemo	4	-	-	-	-	-
20	Owosso	8	Miami Metamora	2 2	- -	- -	
21	Perrin	2	-	-	-	-	
22	Sebewa	8	Brookston	2	-	-	
23	Sisson	2	-	-	-	-	-

Table 3, cont.

No.	Named soils series	Total no. of desc.	Mapping inc.		New soil families		
			Soil series	No. of desc.	Not defined families	No. of desc.	Soils not in Ingham County legend
24	Spinks	9	X7 Imperfectly dr.Spinks	3 2	(g)	3	Stroh
			Oshtemo	1	-	-	-
			Sisson	1	-	-	-
25	Wasepi	2	Brady	1	-	-	-
			Bronson	1	-	-	-
	Total	125		55	7 fam.	21	10 series

(a) fine-loamy, mixed, mesic family of Mollic Hapludalfs
(b) fine-loamy, mixed, mesic family of Mollic Hapludalfs
(c) fine-loamy, over sandy or sandy skeletal, mixed, mesic family of Aquollic Hapludalfs
(d) sandy over fine loamy, mixed, mesic family of Arenic Aquollic Hapludalfs
(e) sandy over fine loamy, mixed, mesic family of Arenic Mollic Hapludalfs
(f) fine loamy, mixed, mesic family of Mollic Hapludalfs
(g) sandy, mixed, mesic family of Mollic Psammentic Hapludalfs

Table 4. Mapping Units

No.	Present Name	Proposed Name
1	Boyer sandy loam, over 25% slopes	Casco sandy loam, over 25% slopes
2	Brady loamy sand, 2-6% slopes	Spinks loamy sand, imperfectly drained variant, 2-6% slope
3	Brady sandy loams, 0-2% slopes	Boyer-Constantine sandy loams, 0-2% slopes
4	Bronson sandy loams, 2-6% slopes	Spinks-Constantine sandy loams 2-6% slopes
5	Brookston loams, 0-2% slopes	Brookston-Pewamo loams, 0-2% slopes
6	Celina loams, 2-6% slopes	Celina-Conover loams, 2-6% slopes
7	Gilford sandy loams, 0-2% slopes	Gilford-Wasepi sandy loams, 0-2% slopes
8	Hillsdale sandy loams, 2-6% slopes	Nippersink-Hillsdale sandy loams, 2-6% slopes
9	Kibbie loamy fine sand, 0-2% slopes	Argyle loamy fine sand 0-2% slopes
10	Kibbie loams, 2-6% slopes	Kibbie-Celina loams, 2-6% slopes
11	Matherton loams, 0-2% slopes	Ionia-X3 loams, 0-2% slopes
12	Matherton sandy loams, 0-2% slopes	Dresden sandy loams, 0-2% slopes
13	Metamora sandy loams, 0-2% slopes	Metamora-Celina sandy loams 0-2% slopes
14	Metea loamy sands, 0-2% slopes	"X5-X4-Metea" loamy sands 0-2% slopes

Table 4, cont.

No.	Present Name	Proposed Name
15	Miami loams, 0-2% slopes	Miami-Octagon loams, 0-2% slopes
16	Miami loams, 2-6% slopes	Miami-Octagon loams, 2-6% slopes
17	Owosso sandy loams, 2-6% slopes	Owosso-Metamora-Miami sandy loams, 2-6% slopes
18	Spinks loamy sands, 2-6% slopes	Stroh-Spinks loamy sands, 2-6% slopes
19	Spinks sandy loams, 0-2% slopes	Spinks imperfectly drained variant sandy loams, 0-2% slopes
20	Wasepi sandy loams, 0-2% slopes	Brady sandy loams, 0-2% slopes
21	Wasepi sandy loams, 2-6% slopes	Bronson sandy loams, 2-6% slopes

the new system in this survey area. That portion will cover less than four percent of the total number of soil profiles studied.

As a result:

(a) Over 96% of the Ingham County soils studied fit into the new soil classification system. Thus, the new classification certainly appears to be applicable to nearly all of the soils in this survey area.

(b) Ten series described (as shown in Table 3) have not yet been identified in the County. This means that from thirty-five soils described (all series studied) in Ingham County, about 28% of those composing the mapping units have not yet been recognized in this survey area.

(c) The above mentioned ten series are defined by means of twenty-one soil profiles (sixteen percent of the total profiles) not yet recognized by series in Ingham County. If the profile descriptions are representative of the proportional areas of the soils this means that about one-sixth of the soils are not being classified in the survey to date. However, this is due largely to the mode of application of the system and is not inherent to the system.

(d) Three, out of ten series (unknown in Ingham County) did not fit into the new classification as shown on Table 3. This covers only 8.5% of the total number of series and 3.2% of the area (if the descriptions are representative of the areal proportions present).

(e) Problems dealing with new system:

According to this study the composition of the mapping units is the greatest difficulty in applying the new system in this survey area. The separations below the series level, soil types and phases, in the new system are among the most significant separations in detailed soil mapping.

The effects of soil moisture and temperature as distinguishing criteria in separation of soils do not seem to be quantitative, because measurement of those factors are under the influence of seasonal and short term or cyclical fluctuations.

6. Utility of this study:

It is hoped that this work will be utilized in applying the new classification system to Ingham County and that it will stimulate further work on related problems.

Perhaps one of the important uses of this study will be to emphasize the needs for using the new system. An active research program is needed in the field and in the laboratory to insure the more precise and complete applicability and usefulness of the new soil classification system. This applies to this survey area and to other areas.

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