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Characteristics of the Floyd and Some Related Soils in Floyd and Bremer Counties, Iowa[1]

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Abstract. This study deals with imperfectly and poorly drained soils generally considered to have developed under prairie from a parent material consisting of a sandy-silt mantle overlying Iowan glacial loam till. Three Floyd profiles, two profiles of the proposed Tripoli series (Floyd, poorly drained variant), and one Clyde profile were studied in the field and in the laboratory. Results indicate that the Tripoli soils should be separated from the Floyd and mapped as a separate series. The present concepts of the Floyd series as a minimal Brunizem and the Tripoli as a minimal Wiesenboden are substantiated by field studies and laboratory data.

Several studies have shown the need for refinement and redefinition of the older soil series, such as Floyd and Carrington, in the Iowan drift area in northeast Iowa (White, 1950; Tyler, 1957; Soileau and Riecken, 1959). The Floyd series is being re-evaluated in a re-survey of Bremer County soils (Buckner and Slusher, 1958). The present study is concerned primarily with the characteristics and definition of the Floyd series in the Iowan drift area in northeast Iowa. The original type location in Floyd County for the Floyd series (Simonson, 1956) was used as a starting point. Other sites of the Floyd series and the proposed Tripoli series, also referred to as a poorly drained variant of Floyd (Buckner and Slusher, 1958) were studied in Bremer County. A Clyde profile was included for comparison purposes. General catenary relationships of Floyd and Clyde series are given in Figure 1.

Field Studies

Preliminary field investigations consisted of careful examination of soils in Bremer and Floyd Counties, within and outside the designated range of the early Floyd series at many sites. This was done to obtain a concept of the field morphologic characteristics and range of properties represented by the Floyd and associated soils.

Six sites were selected and sampled for laboratory studies. The locations and descriptions of the profits sampled are given below.

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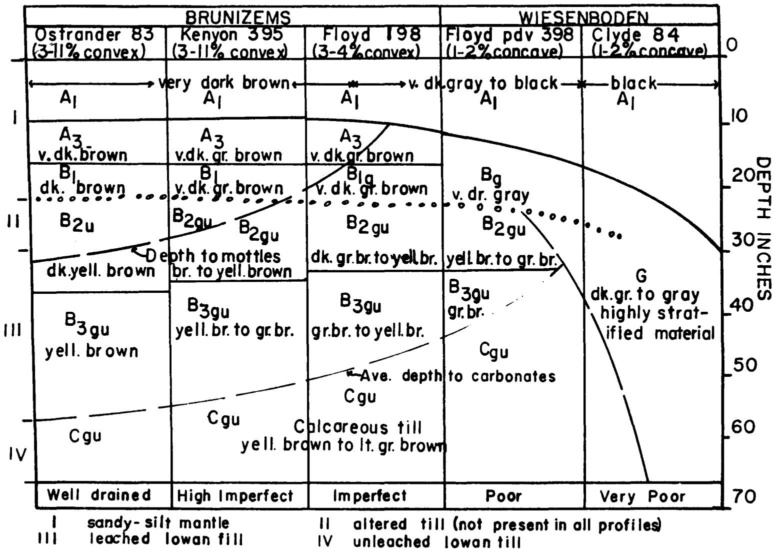

Figure 1. General catenary relationship of Floyd, Tripoli (Floyd, poorly drained variant), and Clyde soils, and some other associated soils.

Terminology used is that of the Soil Survey Manual (U.S.D.A., 1951). Moist Munsell color designations are used in the descriptions. Detailed descriptions are given elsewhere (Phillips, 1958); generalized descriptions are given below.

P-630, Floyd loam

Site and location: Sampled 0.3 mile west and about 8 yards south of NE corner of Sec. 16, T. 92 N., R. 12 W., Bremer County, Iowa; 2 percent convex slope.

A_{1p} and A_{12}	:	0- 8 in.	Black (10YR 2/1 to 3/1), granular, friable loam.
A_3	:	8-12½ in.	Very dark brown (10YR 2/2), fine subangular blocky, friable loam.
B_1 and B_{21gu}	:	18-24 in.	Very dark grayish brown (2.5Y 3/2) with mottles of light olive brown and light olive gray; moderate fine subangular blocky structure; friable loam; pebble band at 18 inches.
B_{22}	:	24-28 in.	Mottled grayish brown (2.5Y 5/2) and olive brown (2.5Y 4/4), medium subangular blocky structure; friable loam.

B_{31gu} and B_{32gu}	:	28-40 in.	Mottled yellowish brown (10YR 5/6, 5/8) and grayish brown (2.5Y 4/2, 5/2), medium subangular blocky structure; friable sandy clay loam; slight gray brown coatings on vertical peds.
C	:	40-60 in.	Mottled brownish yellow (10YR 6/8) and brown (10YR 5/3); massive; friable loam; calcareous.

P-631, Floyd loam

Site and location: Sampled ½ mile east and 160 yards north of SW corner of Sec. 18, T. 92 N., R. 12 W., Bremer County, Iowa; 2 percent convex slope.

A_{1p} and A_{12}	:	0- 8 in.	Black (10YR 2/1); granular structure; friable loam.
A_3	:	8-11 in.	Very dark gray (10YR 3/1); fine subangular blocky; friable loam.
B_{1g} and B_{2ug}	:	11-19 in.	Mottled very dark gray (10YR 3/1 to 3/2) and dark grayish brown (2.5Y 3/2) and olive brown (2.5Y 4/4); moderate fine and medium subangular blocky; friable loam to sandy clay loam; pebble band at 15 inches.
B_{22gu}	:	19-24 in.	Mottled dark grayish brown (2.5Y 4/2) and very dark gray (2.5Y 3/6) and light olive brown (2.5Y 3/6), strong subangular blocky structure; friable clay loam, conspicuous gray ped coatings when undisturbed.
B_{3gu}	:	24-31 in.	Mottled gray brown (2.5Y 5/2) and yellowish brown (10YR 5/8), medium subangular blocky, friable clay loam.
C	:	31-57 in.	Mottled grayish brown (2.5Y 5/2) and pale brown (10YR 7/3) and yellowish brown (10YR 5/6, 5/8), weak medium subangular blocky to massive; friable clay loam to loam; calcareous.

P-632, Floyd silt loam

Site and location: Sampled 937 yards north and 200 yards west from

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SE corner Sec. 36, T. 95 N., R. 16 W., Floyd County, Iowa; 2 percent convex slope.

A_{1p} and A_{12g}	:	10-14 in.	Very dark brown (10YR 2/2), granular, friable silt loam to light silty clay loam.
A_{3g}	:	10-14 in.	Dark grayish brown (10YR 4/2), weak medium subangular blocky structure; friable light silty clay loam.
B_{1g} and B_{21g}	:	14-22 in.	Mottled grayish brown (10YR 4/2) and yellowish brown (10YR 5/6); medium subangular blocky structure; friable silty clay loam.
B_{22gu}	:	22-26 in.	Yellowish brown (10YR 5/6), with yellowish brown (10YR 5/4) mottles; medium subangular blocky structure; friable loam; pebble band at 22 inches.
B_{23gu}, B_{31gu}, and B_{32gu}	:	26-43 in.	Yellowish brown (10YR 5/6, 5/8) with many coarse distinct brownish gray mottles; moderate medium subangular blocky structure; friable sandy loam.
C	:	43-60 in.	Mottled yellowish brown (10YR 5/8) and light brownish gray (10-YR 6/2); massive; friable sandy loam; calcareous at 90 inches.

P-633, Floyd loam, poorly drained variant, or Tripoli loam

Site and location: Sampled 1,144 yards east and 6 yards north from SW corner of Sec. 15, T. 92 N., R. 12 W., Bremer County, Iowa; 1 percent concave slope.

A_{1p}, A_{12}, A_{13}	:	0-15 in.	Black (10YR 2/1); granular structure; friable loam.
B_1	:	15-22 in.	Mottled dark gray (10YR 3/1 and 2/5Y 4/2) and light olive brown (2.5Y 5/6); moderate fine subangular blocky structure; friable clay loam; pebble band at 19 inches.
B_{21gu} and B_{22gu}	:	22-29 in.	Mottled brown (10YR 5/3) and yellowish brown (10YR 5/6) and light olive brown (2.5YR 5/4); fine to medium subangular blocky structure; friable clay loam.

B_{3gu}	:	29-34 in.	Mottled olive brown (2.5Y 5/6) and light brownish gray (10YR 6/2; fine subangular blocky structure; friable clay loam.
C	:	34-55 in.	Mottled light olive brown (2.5Y 5/6) and light gray (2.5Y 7/2), massive, friable loam; calcareous at 34 inches.

P-634, Floyd silty clay loam, poorly drained variant, or Tripoli silty clay loam

Site and location: Sampled 440 yards north and 5 yards west of southeast corner of Sec. 36, T. 95 N., R. 16 W., Floyd County, Iowa; 1 percent concave slope.

A_{1p}, A_{12}, A_{13}, and A_{14}	:	0-16 in.	Black to very dark gray (10YR 2/0 to 3/1), granular to fine subangular blocky structure; friable silty clay loam.
B_{1g}	:	16-20 in.	Mottled very dark gray (10YR 3/1) and dark grayish brown (2.5Y 4/2), fine subangular blocky structure; friable silty clay loam.
B_{21g}, B_{22g}, and B_{23gu}	:	20-38 in.	Mottled grayish brown (10YR 4/2) and yellowish brown (10YR 5/6, 5/8) moderate fine angular blocky structure; friable silty clay loam grading to loam with depth; diffuse pebble band at 27½ inches.
B_{3gu}	:	38-44 in.	Mottled yellowish brown (10YR 5/8) and dark grayish brown (10YR 4/2), moderate medium subangular blocky structure; friable loam.
C	:	44-60 in.	Yellowish brown (10YR 5/6, 5/8) with many light brownish gray mottles; massive; friable loam; calcareous at 44 inches.

P-635, Clyde loam

Site and location; Sampled 267 yards north and 20 yards west of southwest corner of Sec. 27, T. 92 N., R. 12 W., Bremer County; 1 percent slope.

A_{11} and A_{12}	:	0-13 in.	Black (10YR 2/0) granular, friable clay loam.
A_{13}, A_{14g},	:	13-25 in.	Black (10YR 2/0) to very dark

and A_{15g}			gray (2.5Y 3/0), moderate fine subangular blocky structure; friable sandy clay loam.
B_{1gu}, B_{2u}, and B_{3u}	:	25-43 in.	Mottled very dark gray (2.5Y 3/0, 4/0) with common medium distinct grayish brown (2.5Y 4/2) and light olive brown (2.5Y 5/6) mottles; moderate medium subangular blocky structure; friable sandy loam; pebble band at 31 inches.
C (D)	:	43-63 in.	Mottled gray (2.5Y 4/0) and light olive brown (2.5Y 5/6); subangular blocky to massive structure; friable sandy loam.

Laboratory Studies

The following analyses were made on less than 2 mm. material for each horizon sample: particle size distribution, pH, exchangeable Ca, Mg, K, and H, and total carbon and nitrogen. Free or reductant extractable iron was determined on material passed through a 40-mesh sieve. Details of the methods used are outlined elsewhere (Phillips, 1958.

Physical properties. The particle size data were obtained by the pipette method. The results are plotted in Figure 2. In profiles P-630, P-631, and P-632 (Floyd profiles), clay content is quite uniform within and between profiles, ranging between about 20 and 25 percent. P-632 has less clay in the lower layers than the other Floyd profiles. Silt content is greatest in upper layers, and conversely, sand content is highest in lower layers. These results are similar to other profiles in the Iowan till area (White, 1950; Soileau and Riecken, 1959). The higher silt contents in the upper layers (20- to 30-inch layer) represent what is called here the sandy-silt mantle overlying the pebble band and the glacial till.

Profiles P-633 and P-634, Floyd poorly drained variant or Tripoli soils, have the same general pattern of particle size distribution with depth as in the Floyd profiles. There is slightly more clay in the upper solum of the Tripoli profiles than in the Floyd profiles. Silt and sand are very similar in the two soils at all depths.

Data for the Clyde profile, P-635, are similar to those for the Tripoli profiles in the upper 6 inches of solum. Below this depth sand content increases progressively to about 45 inches in the Clyde soils. The material below 40 inches is sandy loam; possibly this material is a glacial outwash or a local alluvium. The higher sand content in the lower layers of the Clyde profile (P-635) sets it apart from the Tripoli and Floyd profiles.

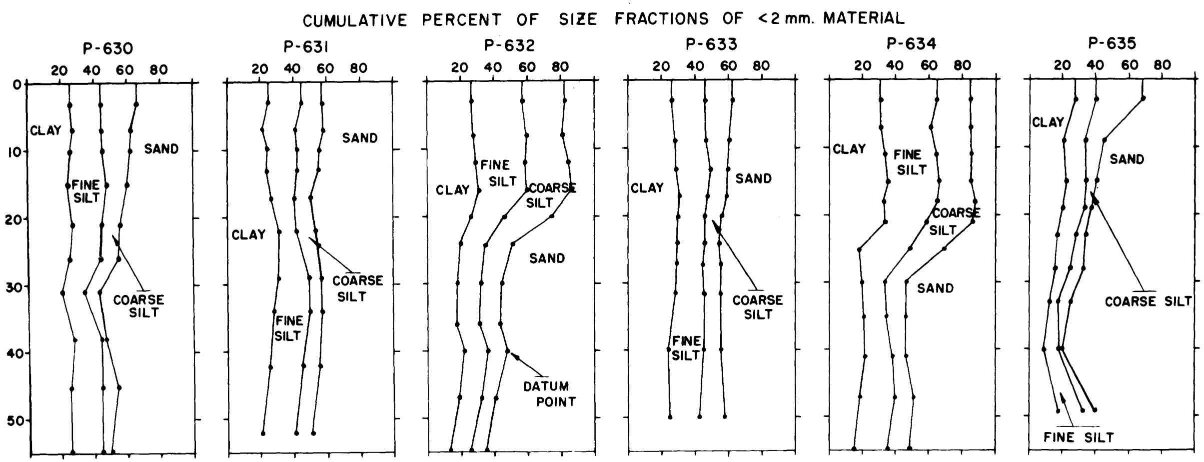

Figure 2. Depth distribution of clay, fine silt (2-20 microns), coarse silt (20-50 microns), and sand (50 microns to 2 mm.) in Floyd, Tripoli, and Clyde profiles.

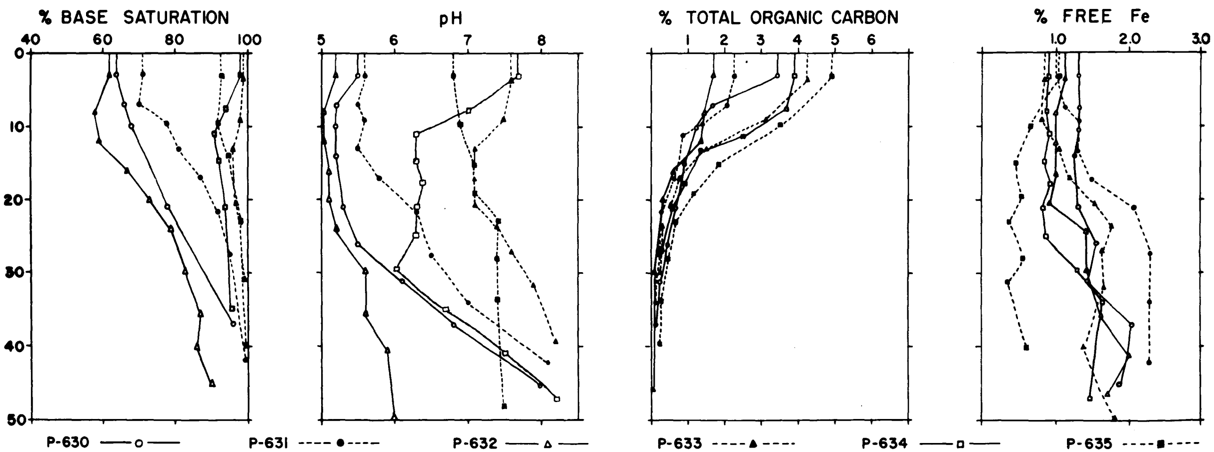

Figure 3. Depth distribution of base saturation, pH, total organic carbon, and free Fe in Floyd, Tripoli, and Clyde profiles.

It is evident from the data of all profiles that the parent material of these soils is texturally moderately heterogeneous, and is a two-story or, in some instances, a three-story parent material.

Chemical properties. Percent base saturation, pH, total organic carbon, and free Fe values for the six profiles are plotted in Figure 3. On the basis of base saturation and pH values, the three Floyd profiles (P-630, P-631, and P-632) are quite similar. Tripoli and Clyde profiles are similar but have higher pH and base saturation than Floyd profiles. A conclusion is that Floyd profiles of this study are more strongly acid and more deeply leached than are the Clyde and Tripoli profiles.

The three Floyd profiles are markedly lower in total organic carbon in the 0- to 20-inch layers than are the Tripoli and Clyde profiles (Figure 3).

Free Fe is lowest in the Clyde profile, which probably is related to the fact that it is a more poorly drained profile than the Tripoli profiles. The free Fe values for Tripoli soils are slightly lower in the upper layers than in similar layers of Floyd profiles. This may be indicative that the former soils are the more poorly drained. In the 15- to 30-inch layer free Fe values in Tripoli profiles average lower than in Floyd profiles, again indicating perhaps that Tripoli profiles are more poorly drained than are the Floyd profiles. However, there is considerable overlapping of free Fe values, and its usefulness as a differentiating criterion for Floyd and Tripoli profiles is questionable.

Definition and Characterization of Floyd Series

As was pointed out earlier in this paper, a number of the extensive older established soil series in the Iowan drift area of northeast Iowa need to be re-defined and more precisely characterized. In the resurvey of Bremer County soils it soon became apparent that the Floyd series also needed to be more precisely defined and characterized (Buckner and Slusher, 1958). It has been the primary purpose of this study to acquire additional data to aid in this task.

Preliminary field observations and soil mapping in Bremer and Floyd Counties showed that the main problem in the more precise definition of the Floyd series was that of differentiating it from the Clyde series. Further, it seemed that perhaps a new soil series should be established to include some soils intergradational between Clyde and Floyd soils. These were tentatively named Tripoli (Buckner and Slusher, 1958). This meant, of course, that not only the Floyd series needed to be more precisely characterized, but also the Clyde series and the proposed Tripoli.

The main differences between the Clyde and the suggested Tripoli series seem to be in the texture and character of the lower subsoil and substratum and in a tendency for the Clyde to be more poorly drained. As shown in Figure 1 and Figure 2, the Clyde soils have coarser textured and more evidently stratified lower subsoils and substratum and a less evident pebble band in the profile than do Tripoli soils. However, as there is some overlapping of these characteristics in the two series, further studies are needed to clarify this point. Clyde soils tend to have lower free iron and lower chromas in all layers than Tripoli soils, indicating that Clyde soils tend to have more poor natural drainage. Base saturation and pH data show Clyde and Tripoli are similar. On the basis of criteria given by Riecken (1946), Clyde and Tripoli soils can be classified with the Wiesenboden great soil group or the alternately called Humic-Gley soils (Thorp and Smith, 1949).

Data from three profiles show Floyd soils to have lower base saturation and pH values than Tripoli soils. This is the most striking difference between the two soils based on data obtained in the present study. The morphological differences used in the field separation are less striking. However, it should be pointed out that the first evidences for difference between Floyd and Tripoli soils were field criteria. The laboratory data actually have served only to support the idea that the soils are different. The field differences are not striking at first observation, but with improved skills the separation between the Floyd and Tripoli soils can be made. There apparently are several field criteria that can be used, singly or in combination. These are as follows: The Floyd soils tend to have slightly coarser textured and less thick dark colored (A_1+A_3 horizons) upper layers. The boundary from A to B is more abrupt in the Floyd than in the Tripoli soils. These differences are supported by the total organic carbon and the clay content values. The Tripoli profiles tend to have lower chromas (grayer colors) in the subsoil than the Floyd profiles, partially supported also by the lower free iron values in the Tripoli profiles. Color differences between the Floyd and Tripoli profiles are present, but more study is necessary before these can be precisely stated. Criteria suggested by Marbut (1921) and Riecken and Smith (1949) indicate that Floyd and Tripoli are different series. Above, it was concluded that the proposed Tripoli series could be classified as Wiesenboden. Previously (Riecken, 1946; Simonson *et al.,* 1952) the Floyd series has been placed with the Brunizem (Prairie) great soil group. This classification is accepted in this study, though it seems further studies are needed on the point.

Some Aspects of Genesis

In the Iowan drift area of northeast Iowa the Floyd soils are found mainly on convex 1 to 4 percent slopes, while Tripoli soils are usually on 0 to 2 percent slightly concave slopes.

The parent material is a two-story material consisting of a thin layer of sandy-silt material, 19 to 32 inches thick, overlying Iowan glacial loam till. A pebble band (Kay, 1931) commonly occurs at their contact. In places the material in and below the pebble band, ranging from 2 to about 15 inches in thickness, may be "reworked" glacial till material. In areas where the reworked material is very thick (20 to 30 inches), the Floyd and Tripoli soils might be considered to have developed from a three-story type of material consisting of a sequence from the surface to depth as follows: sandy-silt mantle, "reworked" material, and Iowan glacial loam till.

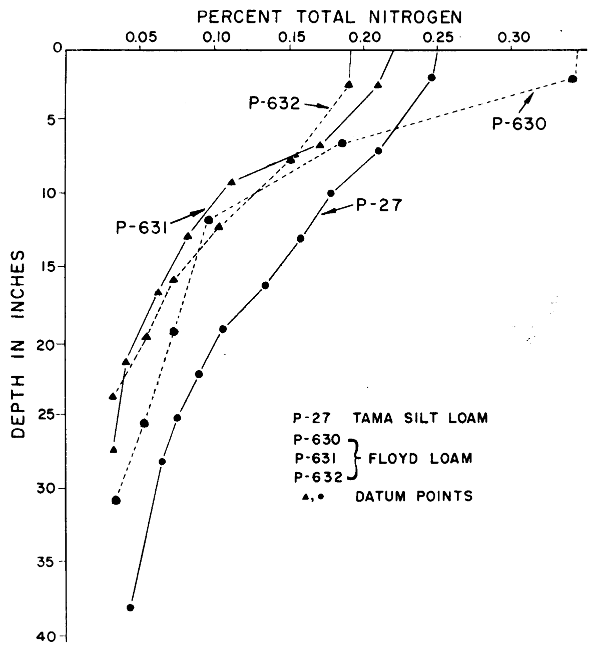

Figure 4. Depth distribution of total nitrogen in a Floyd and a Tama profile.

The absence of a textural B horizon or zone of illuvial clay accumulation in the Floyd and Tripoli profiles does not seem to be consistent with the age of Iowan till. Soileau and Riecken (1959), in studying the Coggon series, developed under trees from Iowan till, noted they lacked strong textural B horizon development, compared to the strongly developed textural B horizon found in Weller soils which developed under trees from loess in southeastern Iowa. They commented that further studies are needed to clarify the time factor in the formation of Iowan till-influenced soils. Ruhe (1956) has shown that the Kansan till-derived Shelby soils have only minimal textural B profile development. The geomorphic surfaces on which these soils occur were considered to be of Late Wisconsin to Recent age. The minimal development of the Shelby soils correlates very well with the youth of the geomorphic surfaces on which it occurs. Similar kinds of geomorphic studies in the Iowan till area may well aid in explaining lack of textural B development in the Floyd, Tripoli, and associated soils. Other factors should be explored too, such as the mineralogy of the parent material as it might affect soil formation and the effect of two-story noncalcareous parent material.

Another point of importance, and of some perplexity too, is the rather abrupt decrease with depth of the total organic carbon in the Floyd profiles. This corroborates the field observations that there is a rather abrupt change in color in going from A to B in Floyd profiles studied. This contrasts with the gradual decrease with depth characteristic for Tama silt loam, a modal Brunizem (Smith *et al.,* 1950), compared with Floyd profiles in Figure 4. This anomaly in the Floyd profile may be indicative of a former tree influence in an earlier stage of genesis of the Floyd soils. If trees did formerly occupy Floyd sites, it seems likely their occupancy was of short duration. The most recent vegetation apparently was prairie. Others (Smith *et al.,* 1950; Ruhe and Scholtes, 1956; Ryan *et al.,* 1959) have commented that in much of eastern Iowa there apparently were several advances and retreats of trees as evidenced in the soil profile morphology. Additional evidence for a former tree influence on Floyd soils may be the grainy, gray ped coatings often present in the lower B horizon. Ryan *et al.,* (1959 observed that in Muscatine County the lower B horizon of Tama soils commonly had grainy, gray ped coatings. They speculated that these were possibly due to the influence of a former occupancy by trees. Such grainy, gray ped coatings are generally considered to be characteristic of B horizons of Gray-Brown Podzolic soils but not of Brunizem soils.

Evidently the genesis of Floyd soils needs further attention. Investigations are needed that will lead to an explanation of the somewhat thin A_1 horizon, the rather abrupt decrease with depth of total nitrogen, the lack of textural B horizon, and the presence of grainy, gray ped coatings in the B horizon.

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