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Canada Soil Survey Committee

Second Regional Meeting of the Eastern Section

Fredericton, New Brunswick, September 24, 1971

D. B. Cann, Chairman

The chairman called the meeting to order and extended to John Nowland the thanks and appreciation of the participants for his organization and direction of the organic soil tour in eastern Canada. Dr. A. A. MacLean, acting Director of the Fredericton Research Station, welcomed the group and outlined the work being undertaken at the Station. He affirmed his interest in soil survey based on a long association with the work. Dr. MacLean mentioned his particular interest in the paper to be presented on fragipans, recalling his encounters with fragipans while working in the United States. He wished the group a successful and productive meeting.

Following Dr. MacLean's remarks, the chairman turned the meeting over to J. H. Day who conducted a discussion on various problems of organic soil classification. A preliminary discussion on this topic was held the previous evening, September 23, following the conclusion of a tour of the organic soils in eastern Canada. Some of the pertinent discussion at this preliminary meeting is recorded here to provide a background for the report of the regional meeting.

Preliminary discussion on organic soils, September 23. Leader: J.H. Day

After a brief discussion of some of the sites seen on the tour, J.H. Day asked Dr. Warren Lynn to present his concepts or organic soils. Dr. Lynn mentioned three main points:

(1) We should regard organic soils as a skeletal framework of organic materials with numerous voids between them, somewhat similar to the skeletal mineral soils. The volume we are dealing with here is the organic volume.

(2) The concept of bulk density in organic soils is different than that in mineral soils. In mineral soils the solid particles, for practical purposes, have no pore space - they do not contain water. Organic soils, on the other hand, have particles that permit water to enter. Hence, using the dry weight of organic material to compute pore space does not mean the same thing as in mineral soils.

(3) Adding mineral matter to organic soils does not change the bulk density very much until the mineral content is about 70 per cent.

Dr. Lynn suggested using specific volume (cc/gm) instead of bulk density in that it gives a wider spread of values and this is helpful where the range of densities is narrow.

Smith: questioned the definition of an organic soil. Should it be based on 30% organic matter by volume or by weight?

Farnham: disagreed with Lynn, pointing out that specific volume is just another way of stating a value which adds nothing to our knowledge. If we consider Lynn's figures, we could say that a bulk density of 0.1 g/cc is the same as 100 g per liter and 0.2 g/cc is 200 g per liter or 100 per cent increase in bulk density. Mineral soils never show this increase. Consequently, it is wrong to say that organic soils have a narrow range in density. We create problems by comparing organic to mineral soils.

He suggested that layers in the profile are important and composite sampling should be avoided. If contrasting layers are present, the most humified and least humified should be sampled separately, and not mixed to give a composite sample. It is necessary to know what the extremes are and how they affect the use of the soil.

Day: presented four topics in the classification scheme which required adjustments in definition or limits:

(1) Definition of the surface tier to permit the presence of an Ap horizon on the fibric surface.

(2) The effect of the presence of sulfur on reaction classes.

(3) Revision of the definition of clastic families.

(4) Revision of textural classes for underlying mineral soil.

Day pointed out that the present definition of the surface tier (p. 1, SSCC Manual) does not make provision for the presence of an Ap (mesic or humic) horizon on the surface. Some adjustment must be made to ensure the inclusion of thick mesic or humic layers in the 24-inch surface tier. The discussion of this proposal follows.

Smith: How do we interpret the statement "75% or more of the volume derived from sphagnum" - as 75% of the depth or 75% of the volume by composition?

Farnham: There has been some confusion. Some people take 24 inches and multiply it by 75%. This is not the way it was intended. It should be taken as 75% of the existing fibre being derived from sphagnum. Think of it as sphagnum versus all other types of fibre amounting to 75% of the total fibre in the tier. We do need some revision of the definition along the lines proposed. I had never thought about an Ap on sphagnum, but now we have seen it, and I do not know what to do about it. Perhaps anything that is being farmed should not be regarded as sphagnum in the surface tier.

Smith: Would like to have a simplified approach whereby the surface tier is the same depth for all soils. Very few soils would be affected by adopting such an approach. Suggested that too much arithmetic is involved. Most of the soils we are dealing with are going to be left undisturbed; therefore, changes of volume will not be significant for these and we must deal with these volumes in their natural state.

Day: This would be a retrograde step going back four or five years. One big difference between organic and mineral soils is the farmer's liability to change in volume. This is the reason for the present arrangement. More soils are affected than Smith suggested, for example, developments in the MacKenzie Valley.

Farnham: All fibrisols by definition and regardless of surface cover and conditions, are going to be thicker soils.

Day: Right now we are looking for a way to handle the Ap layer with a view to a recommendation. We should not be concerned so much with the existing control section depths.

Farnham: Our definition of surface tier is bad. It allows mosses other than sphagnum in a 24-inch surface tier, and we should clear this up.

Day: Perhaps we could use bulk density as diagnostic in the field and eliminate completely all reference to the vegetative composition.

Day: Outlined a draft definition for the surface tier for consideration. (See below).

Cann: The Ap should be included in the surface tier, but the control section should be kept at 64 inches.

Veer: Soils compressed by machinery may have a bulk density greater than 0.1 in the surface, even though they are composed of fibric sphagnum.

Smith: Suggested that so long as this raised the bulk density from say, 0.05 to 0.08, the classification would be unaffected.

Meeting adjourned with the draft definition still under consideration.

Discussion on Organic Soils - September 24. Leader: J.H. Day

I. The discussion of a revised definition for the surface tier continued. The definition in final form is stated below:

Ehrlich: Accepted the definition as proposed on the understanding that there would be ample time for its study and evaluation.

Smith: Would like to see one depth of surface tier and perhaps one depth of control section, as a means of overcoming difficulties of interpreting a complex system.

Hoffman, Langmaid, Cann and others supported this suggestion in principle.

Ehrlich: Opposed the suggestion as being too simple a solution.

Farnham: Pointed out that formerly there had been three depths of control section, and the existing two represent a simplification.

McKinzie: If the suggestion for a uniform depth of surface tier were adopted, the whole U.S. system of organic soil classification would need to be changed. If the surface tier was 24 inches deep on all soils, important suborder determining layers would be too deep.

Ehrlich: Using the shallower control section, the classification of a soil could be out of date overnight as a result of fire. We should, however, give Smith's suggestions some thought over the next year.

Day: Opposed the suggestions at present on the grounds that we lack information to make such a radical change.

McKinzie: If we adopt a uniform 64-inch control section, the 12-inch surface tier should be retained and 12 inches added to the middle tier.

The following definition was proposed by Day:

"The surface tier, exclusive of loose litter or living mosses, is 24 inches (60 cm) thick if there is on the surface:

(1) 24 inches (60 cm) or more of fibric organic material that has a bulk density of less than 0.1, or

(2) a mesic or humic Ap horizon thinner than 6 inches (15 cm) underlain by 18 inches (45 cm) or more of fibric organic material that has a bulk density of less than 0.1, or

(3) it is 12 inches (30 cm) thick if there is on the surface 16 inches (40 cm) or more of any material that has a bulk density greater than 0.1, or, it extends to a lithic contact if deeper than 4 inches (10 cm) but shallower than 12 inches (30 cm) or 24 inches (60 cm)."

<u>Motion 1</u>: It was moved by Nowland, seconded by Cann that the revised definition of the surface tier be recommended for adoption. <u>Motion carried</u>, none opposed.

Motion 2: It was moved by Hoffman, seconded by Ehrlich, that in the definition of the organic order (p. 8, SSCC Manual) paragraphs (a) and (b) be rewritten as follows:

(a) if the surface layer consists of fibric organic material having a bulk density of less than 0.1 (with or without a mesic or humic Ap thinner than 6 inches (15 cm), the organic material must extend to a depth of at least 24 inches (60 cm).

(b) if the surface layer consists of organic material having a bulk density of 0.1 or more, the organic material must extend to a depth of at least 16 inches (40 cm).

Motion carried; none opposing.

II. Reaction classes in organic soils.

Day: When sulfur is present in quantities sufficient to cause the pH to drop markedly on drying, as exemplified at N.S. Site No. 5, the soil should not be in the euic reaction class. Suggested adding a paragraph under "Reaction Classes" (p. 14, SSCC Manual) - "Soils that qualify as a sulfurous family will not be assigned to a reaction family."

McKinzie: Sulfurous characteristics should be dealt with at higher taxonomic levels.

Day: There is difficulty in recognizing sulfurous conditions in the field.

Nowland, Baril: Suggested that field pH is important and that the designation "sulfurous" itself indicates what is likely to happen when these soils are drained. Suggested dropping the proposed modification.

Day: Agreed that the modification could be dropped.

Acton: Queried the discrepancy between the pH 5.5 break for mineral soil families and the pH 4.5 limit used for organic soil families.

Day: Much work in the U.S.A. has indicated that pH 4.5 is a significant limit in organic soils.

Farnham: Referred to work in Finland and at Michigan State which supported this limit. Noted that pH in salt solution is much superior because of buffering capacity. In organic soils the exchangeable H is very important. pH in water is far too variable.

McKinzie: Recommended the publication - "Tidal Marshes of Connecticut and Rhode Island". D.E. Hill and A.E. Shearin, Bull. 709, Conn. Agr. Expt. Sta. New Haven, 1970.

Day: Referring to mineralogy classes for organic soil families, noted that work is needed on the levels of Ca CO_3 and S, which may be significant.

III. Discussion of clastic families.

Day: Is it necessary to recognize clastic families where there is mineral material present in peat? If so, are the present limits too high or too low?

McKinzie: Recommended that the limit be lowered from 55% mineral material to 35 or 40% designation as a clastic family.

Nowland, Ehrlich: Agreed with this suggestion.

McKinzie: Intends to propose modification of American definitions in order to allow coprogenic earth into the Histosol Order, perhaps using a 20% organic matter limit in this case. Suggested that marl be treated as mineral soil in the Entisol Order. Even if the organic content is less than 20 or 30%, some level of organic matter must be selected to allow coprogenous earth into the Histosols.

Farnham: Have folisols been seen in the Maritimes?

Langmaid: Observed something like folisols, but not resting on rock or fragmental material. These were on till.

Marcoux: Observed folisols in the Laurentians.

Nowland: Only a few scattered occurrences in Nova Scotia; not mappable.

Day: They are common in British Columbia, and mapped in two series.

McKinzie: Folisols occur in Connecticut.

Nowland: Would like to see a clastic layer described and adopted under "Other layers" (p. 3, SSCC Manual). This would be purely for profile description purposes. A motion to this effect was withdrawn due to such a layer being non-diagnostic at the subgroup level, unlike the other types of layers.

Day: This is taken care of at the family level, but we do need a way of describing and designating clastic and other layers. The U.S. system uses the following designations.

L co - coprogenous layer	Oi - fibric layer
L ca - marl layer	Oe - mesic layer
L di - dietomaceous layer	Oa - humic layer

Hoffman: Sees some confusion in the use of f, h and m, as horizon designations with different meanings for mineral and organic soils.

Motion 3: Moved by Cann, seconded by Langmaid, that the Subcommittee for Horizon Nomenclature be charged with amending the horizon designations for organic soils. Motion carried.

IV. Revision of textural classes for underlying mineral soils.

Day: Should the present family textural classes (p. 15, SSCC Manual) be changed: The inclusion of fragmental was a mistake and skeletal should have been used instead. The classes might well be limited to coarse-skeletal; coarse, medium-skeletal, medium, fine-skeletal, fine and fragmental.

Smith: In Manitoba only two textures of underlying mineral soil were recognized - coarse and fine, thus deliberately playing down the significance of this material. It is recognized that additional textural ranges may be useful in other provinces.

Acton: Coarse, medium and fine was used in Ontario; skeletal condition not encountered.

Veer: It is important to define what is underneath the peat. Agreed with proposal of Day.

Day: The nature of underlying paleosols is treated at series level.

Ehrlich: Agreed with Day's proposal.

Baril: Favored six textural groups.

Motion 4: Moved by Acton, seconded by Hoffman, that the textural classes which have been recognized at the family level for mineral soils be adopted for mineral material underlying organic soils, namely, coarse-skeletal, coarse, medium-skeletal, medium, fine-skeletal, fine and fragmental. Motion carried, none opposed.

Farnham: Would like to know if woody peats can be handled properly.

Day: Handled at the family level.

Smith: As presently used, "silvo" has a broader meaning than woody; it refers to dominant peat formers. Would like to see limnic characteristics used in great group separation instead of at subgroup level as at present. Perhaps it is too soon to look into this. Day agreed. Noted some confusion with folisols in that they are defined as not saturated for more than a few days. This is not true; they can be saturated beyond water holding capacity for longer periods.

Day: In British Columbia, the lack of prolonged saturation has been confirmed.

Lynn: Why not write the definition more positively, e.g., saturated for a few days after rain.

Langmaid: Snowmelt would keep folisols saturated for some time.

Hoffman: Objects to the folisol great group and wonders if these soils cannot be kept in the Regosols.

Smith: Are folisols designed to take care of boreal areas?

Day: No

Day: Stated that the discussions will be useful for the western regional meeting and expressed appreciation for the participation from the U.S. in this meeting.

This concluded the discussion on organic soils.

Proposals for Changes in the Podzolic Order. Leader: D. B. Cann

The original purpose in discussing the Podzolic Order at this meeting was limited to correcting some of the inconsistencies in the definitions given in the S.S.C.C. Manual. Some of these were discussed at our last national meeting (October, 1970) and a further list was circulated to the participants in this meeting. Further study has made it obvious that a more critical look at the Order as a whole is necessary.

Therefore, the main purpose today is to ask you to consider (1) a revised definition of the Podzolic Order, (2) combining the Ferro-Humic and Humo-Ferric great groups, and (3) dropping the Mini-Podzol subgroup. The fundamental purpose of the revised definition is to provide, at the Order level, a means of identifying Podzols in the field without reference to chemical criteria. It seems to me that one should be able, from a description of the Order, to examine a soil in the field and to say positively that it does or does not belong to the Podzolic Order. If we cannot do this at the Order level, our classification scheme is weak and not very useful.

We know from experience that some soils with podzolic characteristics have been classified in other Orders because they did not meet certain chemical requirements. In particular, there has always been controversy about those soils bordering on the Brunisols on the one hand and Regosols on the other. For example, if one examines some of the soils classified as Dystric Brunisols, it is obvious that they were so classified not because they had a Bm horizon as defined, but because Δ(Fe + Al) did not meet the requirements of a Bf horizon. These soils look like Podzols yet they are excluded from the Podzolic Order because they do not meet certain chemical criteria. I suggest that our choice of Δ(Fe + Al) values was arbitrary. Although it seemed a good choice as a separation criterion, it should be pointed out that the profiles of the various kinds of soils used in testing the value were "representative" or "modal" profiles for the type, and we have no figures for the submodal profiles. I suggest that, since we are classifying natural objects and we recognize these by what we can see or feel, it might be a better choice to put things that look alike together and then determine the range of chemical properties. One might argue that we would still have difficulty in separating weakly developed soils, but at the Order level, if properly defined, there should be recognizable characteristics that place a soil definitely in one Order or another.

Fortunately, the means for doing this is already embodied in our definition of the Order, but the definition as written does not fully develop the use of visual characteristics to identify the soils at the Order level. The separation of Podzol soils at this level is based on the presence of a podzolic B. horizon. We have accepted (p. 97, S.S.C.C. Manual) that this horizon is similar to the spodic B horizon in the American system. If the full implications of the spodic B horizon had been incorporated into our definition, we would have had field criteria for separating Podzols from other soils at the Order level and the great groups and subgroups would have been adjusted accordingly. So, what is being proposed is not new, but rather a more complete definition at the Order level. As we make more observations some of the chemical criteria may have to be adjusted.

In the American system Spodosols (Podzols) are separated at the Order level by recognition of a spodic B horizon. Any soil having this horizon belongs to the Spodosol Order regardless of the presence of an albic, argillic or other kinds of horizons. The proposed new definition of the Podzolic Order places more emphasis on the characteristics of the podzolic B (spodic) horizon and embodies recent improvements made in the definition of the spodic horizon. It will enable us to recognize Podzols in the field at the Order level both by the appearance and the sequence of horizons not found in other Orders. Application of the definition would place some Dystric Brunisols in the Podzolic Order (possibly as a weakly developed great group) but it would also simplify field recognition and leave the "Brown" soils in the Brunisolic Order. Adjustments in chemical criteria might be necessary and we may have to examine our thinking on this matter. The following definition is proposed for the Podzolic Order.

4. Podzolic Order

The Podzolic Order consists of well and imperfectly drained soils that have developed mostly in cold to temperate climates under coniferous and mixed forest vegetation or heath. They are formed mostly in coarse, moderately coarse, and medium-textured parent materials. Some may form in finer textured materials.

These soils are characterized by podzolic B (spodic) horizons in which the main accumulation products are organic matter (dominantly fulvic acid) combined with various proportions of iron, aluminum and clay. These amorphous materials occur as coatings on mineral grains and commonly as silt-sized pellets. The podzolic B (spodic) horizon has an abrupt upper boundary and may be cemented. Hues and chromas of this horizon may remain constant with depth, if the horizon is thin and overlies bedrock, or the subhorizon with the reddest hue or highest chroma is near the top of the horizon or below a thin black horizon with values of 2 or less. Hues become yellower or chromas mainly become lower, or both, within 20 inches (50 cm) of the top of the horizon. Colors of the podzolic B (spodic) horizon are mostly redder than 10YR in hue, with moist values and chromas of 5/6, 4/4, 3/2, and 2/1, or with these values in higher chromas.

Under undisturbed conditions the soils have organic surface horizons (L-H) dominantly of a mor or moder type. They may have an Ah horizon below the L-H horizons. Generally they have an eluviated, light-colored horizon (Ae) overlying the podzolic B (spodic) horizon, but this may be indistinct or absent.

Under cultivation, the Ap horizon may be underlain by remnants of an Ah, Ae, or a podzolic B (spodic) horizon. The Ap may meet the requirements of an ochric or umbric epipedon. The sola are acid (usually $<$pH 5.5) and have a high pH dependent cation exchange capacity in the B horizon. Commonly there is a second maximum of organic carbon in the podzolic B horizon.

The Podzolic Order is divided into the Humic and Podzol great groups based on the presence or absence of a B subhorizon that lacks sufficient iron to turn redder on ignition.

The second item for consideration is the combining of the Ferro-Humic and Humo-Ferric great groups.

Throughout the development of our system we have generally recognized two major great groups of Podzols, based mainly on the color and the amount of organic matter in the upper B horizon — the Humic Podzol and Podzol great groups. Until 1965, the Humic Podzol great group was divided into Humic (or Orthic) and Humus Podzol subgroups, depending on whether the Bh subhorizon had sufficient iron to turn redder on ignition or lacked this property, respectively. The Bh subhorizon contained more than 10% organic matter and was required to be 2 or more inches thick.

In 1965, the Bh subhorizon was confined to the Humus Podzol subgroup, restricted to a thickness of 4 inches with more than 2% organic matter and an O.M./Fe ratio of more than 20. A new subhorizon (Bhf) having more than 10% organic matter and an O.M./Fe ratio of less than 20 was introduced as the diagnostic horizon of the Humic Podzol subgroup.

In 1968 the Humus Podzol subgroup became the Orthic Humic Podzol in the Humic Podzol great group, and the original Humic Podzol was separated in the Ferro-Humic great group.

One of the main difficulties in using the present system results from the requirements of thickness, color and organic matter content of the B horizon. Apart from color and thickness, the requirements for the Bh and Bhf (also Bfh) subhorizons are chemical (O.M./Fe ratio, Δ(Fe + Al); % O.M., % $Fe_{(ox)}$, etc.) and not visual. In other words, they are properties and not characteristics. In examination of a profile one can sometimes make an approximate guess as to whether or not a B horizon contains more or less than 10% organic matter, but color is not a reliable indication. The checking of the range in color of Bh, Bhf and Bfh subhorizons of some 200 Podzol profiles has shown that for a given color a subhorizon may be a Bh, Bhf or Bfh. Thus it is not always certain in the field whether one is looking at a Ferro-Humic, Humo-Ferric or Humic Podzol.

The Humic Podzol, I believe, has recognizable characteristics of its own which justify separation from the Ferro-Humic and Humo-Ferric Podzols. I base this on very limited experience and on the fact that there are very few analyses or descriptions of these soils in Canada. In searching the literature I have yet to find analyses showing a Bh and Bhf in the same profile (except in B.C. where a Bh occurred under a Bhf at 44 inches). If anyone has examples of this, it would be useful to record it. Most of the literature supports the presence of a Bh subhorizon in hydromorphic Podzols and occasionally in well-drained, low iron parent materials.

It might be argued that it would be difficult to separate the Bh from the Bhf subhorizon if both were present. I think the Bh would have physical characteristics (color, texture, consistency) that would make this possible. Again, I base this on limited experience, but if we cannot separate these subhorizons by field examination, we are in difficulties. It seems to me that the presence of a Bh subhorizon indicates a different environment, parent material or soil forming process which separates the Humic from the other Podzols. This is partly the basis for the separation of Humods in the 7th Approximation.

In our classification we require the Bh to have a thickness of 4 inches before we recognize a Humic Podzol. Evidently we are emphasizing <u>degree</u> rather than <u>kind</u> of development. Horizon thickness is a series criterion and should not be used at this level.

The Ferro-Humic and Humo-Ferric Podzols are separated mainly on the organic matter content of the upper B horizon. The only visual characteristics stated in our definitions are that the Ferro-Humic Podzols have B horizons with values and chromas usually 3.0 or less, and the Humo-Ferric Podzols generally a chroma of 4.0 or more. Separation on this basis alone would be made at the series level along with other observable criteria, but color would not necessarily be an indication of organic matter content. It would appear that we are using organic matter content at a too high categorical level (one might note in passing that our definitions of Bhf and Bfh horizons do not provide us with any means of recognizing these horizons except by content of organic matter).

It is possible to have light-colored as well as dark-colored B horizons containing more than 10% organic matter. In any mapping program, soils with similar characteristics will be placed in the same series. Thus, soils with dark-colored B horizons will be separated from those with light-colored B horizons. If we insist on applying the organic matter content at the great group or subgroup level, then single series might contain soils belonging to different great groups. Briefly, the separation of these two groups on the basis of organic matter content cannot be done in the field. By combining these groups we do away with the restrictions on color, thickness, and organic matter content of the B horizon at this level. It does not seem desirable to retain the two names at the subgroup level, since the same difficulties would arise. Dropping the names simplifies the classification without altering its effectiveness. It seems logical that separation on an organic matter basis, if desired, should take place at a much lower level - at the family or series level. We need more information on the significance of the organic matter content of the B horizon.

The third point to be considered is the dropping of the Mini-Podzol subgroup. At present, this subgroup is classified on the thickness or lack of an Ae horizon, and not on weakly developed B horizons. Undoubtedly, this could be handled at the series level. Soils with weakly developed podzolic B horizons could be classified at a subgroup level.

I would like to mention something about subgroups and some problems that have arisen since our last meeting. Until recently very little data was available on Podzol soils in Newfoundland. As a result of soil surveys in the Avalon Peninsula, the Gander area and on the west coast of Newfoundland, we now have considerable information on the physical and chemical properties of these soils. One of the striking characteristics is the clay content of the Ae horizons, which frequently is as much as 10 to 40 per cent higher than any underlying horizon. At the moment no suitable explanation has been proposed and there is need for some research on these soils. If this is a common property, we probably need a new subgroup for these soils. Other soils have clay as well as organic matter and free Fe. accumulation in the B horizon and qualify for both Bfh and Bt horizons. Other horizons with high values and low chromas (Ae?) have considerable organic matter as well as free iron. The presence of placic horizons or thin iron pans has been a criterion for separating subgroups. Recent observations show that the thin iron pan may expand into an ortstein layer within the pedon. This poses a problem in defining ortstein and placic subgroups and requires further study.

Another source of controversy is the classification of the Bisequa Podzol subgroup. In the American system these soils would have to be placed in the Spodosol Order. At our last national meeting it was suggested that soils with an argillic (Bt) horizon underlying the podzolic B horizon should be classified in the Podzolic Order as Luvic Podzols. There has been some objections to this. Another suggestion is that we adopt the former definition that we used in 1965. This is a problem that has not received enough attention and needs discussion. Other problems that need discussion are the presence of placic horizons in Luvisols and Gleysols.

If the proposed changes are acceptable to the majority of the members, after discussion by the western section, then revised definitions will have to be written for the great groups and subgroups for presentation at the next national meeting. Some adjustments may have to be made also in the Brunisolic Order - particularly in the Dystric Brunisols.

If the proposed changes are not acceptable then we must consider revisions to the present definitions as outlined below.

The following items in the definitions of the Podzolic Order require clarification and changes. Some of these were discussed at the 1970 national meeting. Page numbers refer to pages in the System of Soil Classification for Canada.

Item 1, p.97 <u>Podzolic Order</u>

"These amorphous materials form coatings on sand, silt-sized particles, or fine pellets."

Suggest - "These amorphous materials form silt-sized pellets and also coat sand grains."

Item 2, p.97 Delete last sentence on the page. This is not now included in the definition of a spodic horizon. (It means that the Ap horizon qualifies as a Bfh or Bf horizon and there is no underlying podzolic B (spodic) horizon.

Item 3, p.98 "The Podzolic Order is divided into the Humic, Ferro-Humic and Humo-Ferric great groups based on the dominance of the Bh, Bhf, or Bfh (or Bf) horizons as defined."

Change to: "The Podzolic Order is divided into the Humic, Ferro-Humic, and Humo-Ferric great groups based on the organic matter content and OM/Fe ratio of the upper part of the B horizon.

Item 4, p.98 <u>Humic Podzol</u>

"These soils have dark colored (value and chroma usually < 3.0 moist) illuvial Bh horizons at least 4 inches (10 cm) thick --"

What about soils with a Bh horizon only 3 inches thick? Under present definitions such soils would be classified with the Ferro-Humic Podzols. See discussion under Item 6 below.

Item 5, p.99 <u>Placic Humic Podzol</u>

"Orthic Humic Podzols and Gleyed Humic Podzols occur on the lower slopes and troughs (of the pan)."

We have already stated under 4.11 that the Orthic Humic Podzol lacks a placic horizon. Perhaps this statement should be deleted because a Placic Humic Podzol is an Orthic Humic with a placic horizon <u>or</u> delete Orthic Humic Podzols from the above statement.

Item 6, p.99 <u>Ferro-Humic Podzol</u>

"A Bh horizon less than 4 inches (10 cm) thick may overlie the Bhf horizon or the Bhf may directly underlie the Ah or Ae horizon."

This statement creates an anomalous situation. If the Bh horizon is 3 inches thick, the upper 4 inches of the B horizon might have either less than 10% organic matter as required, or the OM/Fe ratio might be more than 20. As presently written, the requirements for the Ferro-Humic Podzol would exclude a 3 inch Bh horizon.

In order to simplify the requirements of the B horizon and avoid confusion in the classification of the Humic, Ferro-Humic and Humo-Ferric Podzols, it is suggested that the requirements for the B horizon should be based on the average content of the upper 4 inches (10 cm). Thus, if the upper 4 inches (10 cm) of the B horizon has an average

(1) OM/Fe ratio of more than 20, the soil is classified as a Humic Podzol.

(2) OM/Fe ratio of less than 20, and more than 10% organic matter, the soil is classified as a Ferro-Humic Podzol.

(3) OM/Fe ratio of less than 20, and less than 10% organic matter, the soil is classified as a Humo-Ferric Podzol.

Thus, a Podzol soil might have a Bh, Bhf, Bfh or Bf horizon of any thickness, but the classification would be based on the average organic matter content and OM/Fe ratio of the upper 4 inches (10 cm) of the B horizon. The sequence and thickness of the various horizons would be criteria for separation at the series level. This would not alter the definitions of the Bh, Bhf, Bfh or Bf horizons.

Item 7, p.103 <u>Orthic Ferro-Humic Podzol</u>

"These soils have podzolic B horizons that are dark colored (moist values and chromas usually 3.0 or less) in the upper part --"

Investigation of approximately 200 podzol profile descriptions indicates that values and chromas of 4 or less would be more suitable.

"- and contain more than 10% organic matter;"

Add: in the upper 4 inches (10 cm). As presently written, the whole B horizon must contain more than 10% organic matter.

"They may have a Bh horizon less than 4 inches (10 cm) thick-"

See discussion under Item 6.

Item 8, p.103 <u>Mini Ferro-Humic Podzol</u>

Do we really need this subgroup or could it be taken out at the series level?

Item 9, p.104 Sombric Ferro-Humic Podzol

"-and the upper 4 inches (10 cm) of the B horizon (Bhf) contains more than 10% organic matter."

Delete (Bhf) since this implies that the Bhf must be 4 inches thick.

Item 10, p.105 Humo-Ferric Podzol

"-- and they may have an Ah horizon."

Delete this part of the sentence as it is already stated in the previous sentence.

Item 11, p.105 Orthic Humo-Ferric Podzol

Delete the first sentence, as it is repeated in the second sentence.

"In the Bfh and Bf horizons Δ (Fe + Al) is greater than 0.8%, except for some soils with textures of loamy sand or coarser."

This statement is ambiguous in that it implies that soils with textures of loamy sand or coarser are included in this group, but do not meet the requirements for a Bfh or Bf horizon or that such soils are excluded from the group. If excluded, it should be so stated.

Item 12, p.109 Mini Humo-Ferric Podzol

There needs to be some discussion as to whether or not we need this subgroup. Perhaps this should be 4.3-/2.

"Under cultivated conditions, the Ap horizon (6 inches [15 cm]) thick generally contains substantial amounts of Bfh or Bh horizons or both."

Change to: Bf.

Delete the last sentence in the subgroup description. In the great group description, it states that the Ap is underlain by a podzolic B horizon.

Item 13, p.109 Sombric Humo-Ferric Podzol

Note that the Ah horizon in the Sombric Ferro-Humic Podzol is developed by accumulation whereas in the Sombric Humo-Ferric Podzol it is the result of mixing by earthworms.

Item 14, p.110 Bisequa Humo-Ferric Podzol

Delete second paragraph. It does not belong to this section.

It has been suggested that the term "bisequa" should be dropped and that all soils having Podzol development in the upper part of the profile (podzolic B horizon) should be classified in the Podzolic Order. This would include the Bisequa Gray Luvisols. They could be called Luvic Podzols.

Discussion of Proposed Changes. Chairman: John L. Nowland.

Baril: At the second paragraph, fifth line, where it says "commonly as silt-sized pellets" it should be noted that many of these amorphous materials are colloidal. The second point is that where it mentions "high pH-dependent cation exchange capacity" it should state "organic and inorganic pH-dependent" since Clark has shown that the organic accounts for 6 meq. My third point is that in the last paragraph where it states "B subhorizon that lacks sufficient iron to turn redder on ignition", that this refers to only a few areas, including Newfoundland, because in most cases the Bh horizon does turn redder on ignition, even with a high ratio of organic matter to iron. I find this suggestion in the text a little bit strong.

Cann: I think that at the order level this is all we can say. Unless we do that we are out of step with other people who separate what we now call Humic Podzols. The idea is to get those podzols which have very low iron in the B separated from the other podzols. The Americans separate their Humods from their Orthods on the basis of this low iron condition. So far as your first point is concerned we could insert "silt and clay sized pellets".

Wang: Actually most of the pellets are silt-sized, and this can be seen in thin sections. The presence of other sizes is adequately covered by use of the word "commonly".

Day: I would take exception to the statement that they occur as coatings on "sand grains". They also occur as coatings on other particles, besides sand-sized fractions. It's a little too specific".

Cann: You don't see the clay size particles. Perhaps mineral particles would be better.

Chairman: I suggest we let it stand as it is.

Day: In the literature I believe that when one speaks of the pH dependent charge it is assumed that you mean the "organic" plus "inorganic"; there is no need therefore to insert the word "total".

Cann: On the subject of the Bh horizon, we have very few of the humic podzols which we are trying to define. Many that I have seen do not in fact turn redder on ignition. I think the split we are trying to make, which is made by other people, represents a different environment and kind of process and deposition.

Baril: What I mean is that we can have humic podzols which do turn redder on ignition and I think these must remain humic podzols. We could not make the distinction in the way you are suggesting.

Day: I would question this on the same basis because my understanding of this group of soils is that there may be a sub-horizon which will fail to turn redder. What is your intention? - to say that humic podzols lack <u>any</u> sub-horizon which will turn redder on ignition?

Cann: No, because when we come down to the great group definition we say that it has to occur in at least 50% of the pedon.

Day: Well perhaps instead of saying "B sub-horizon" it would be wiser to specify exactly which horizon you mean, for example Bh.

Cann: Then we would have to specify its position which would create problems, that is why I put it in this form.

Day: That is the reason why I think this form may run into problems.

Ehrlich: With all due respect for what Bruce has been suggesting and I know we shall all be faced with this, there remains the question of what to do with our sandy soils that look like podzols and do not meet the criteria. The Americans have used the Entisols to take care of some of them, those that are coarser than loamy sands. I feel that if we try to throw these things together we might as well throw the criteria we have been using, delta Fe plus Al, out of the window. If we set a lower level, our Gray Wooded soils will come into this, and also many Brunisols. If that is the case we might as well discard this criterion completely. I think we shall have to look for some alternative. I have seen these sandy soils in Manitoba, Saskatchewan and Alberta and they do look like Podzols. I do not think that throwing these soils together is the answer. I have a suggestion that they be placed in the Regosols or remain in the Brunisols but given a different name, e.g., Albic Regosols or Albic Brunisols. This is because it is the thick Ae, possibly 18 inches thick, which worries most of us. If we do not like this type of soil in the Regosols then perhaps Brunisol is the best place for them, but call them Albic, a separate Great Group.

Smith: Are you saying that you favour the retention of these chemical criteria within the definition of podzols.

Ehrlich: Yes. Maybe we can make some small adjustments, but not enough to accommodate our sandy soils. As it is set up now, we exclude Gray Wooded soils and our Brunisols. We have to rely upon chemical criteria to some extent because we can't see everything. Texture can be used for some of them, but there are loamy soils which present the same problems.

Cann: This is my argument. Perhaps our criteria are wrong. We set up certain criteria but refuse to recognize natural characteristics. I know we have trouble with these sandy brunisols that look like podzols. Let us recognize things that look alike and put them together, and then accept a range of characteristics and not make unnatural splits. We have been saying that a red barn is not a red barn because there is not enough iron in the paint. It would be much simpler if we accepted what nature shows us, and soils which have these kinds of profiles are lumped.

Ehrlich: You would have soils in the same group with base saturations ranging from 100 down to 35 per cent.

Day: I would ask you to review our classifications in 1965, when we had soils that had a lot of iron in the Brunisolic order, soils in the Podzolic order that did not have a lot of iron, and we had soils in the Regosolic order that had a lot of iron plus aluminum. We ended up with soils now called Podzols split between the Podzolic order and Regosols.

To take up the argument about omitting chemical criteria because you cannot see them in the field, then it would be equally logical to say all solonetzic soils that have what looks like solonetzic structure are solonetz regardless of their chemistry. I think we had an awful lot of trouble making significant separations between soils prior to 1965, because we had soils that had a lot of Fe plus Al plus organic matter in the solum and had high pH-dependent charges, split off from other kinds of soils with Ae horizons in the podzolic order. To me this is going back about five years, and to do the same thing over again we might just as well pick up the 1965 book and go along like that. In my experience that was fraught with difficulties.

Ehrlich: The solonetzic order is a good case in point, where chemical criteria are essential; otherwise, the Red River Valley would be all solonetz soils, with no Na in them at all.

Hoffman: There is a parallel situation with the Gray Brown Luvisols, the sandy ones in S. Ontario. We have a number of series there that have Bt horizons that do not make the criteria by a long shot, and they have now been classed as Brunisols. We make this split, and it does not seem to be upsetting.

Day: If you throw away the criteria we use, they could become podzols.

Smith: Can you not use an analogy, and draw upon the experience of the histosols, You say it is difficult to recognize chemistry in soils in the field, yet we expect people to recognize fibre content. Maybe I oversimplify this, but I don't think so. We have had the same kind of problems although not to the same degree, in terms of differentiating between brunisols and podzols. In Manitoba we have a pretty wide range of podzol-like soils that do not come anywhere close to the chemistry that is suggested in the definition of the podzolic order. That does not disturb me, but I feel very confidently that we can go into the field and say these are all brunisolic soils, there are no podzols here. If everybody accepts this, that's fine so far as I am concerned.

Your situation in the Maritimes is quite different. What amazed me was some of the morphology related to the chemistry, especially in the first two soils we looked at in New Brunswick. The Bf horizons in those had yellowish-brown and not reddish-brown colours and did not seem strongly developed. The amazing thing to me was that these did have a lot of Fe and Al. So you cannot go on the basis of morphology that well either. It would seem to me that, just like trying to work with fibre in organic soil, if you do pay more attention to morphology, maybe these difficulties associated with recognizing podzolic soil types would fall by the way.

Day: I think we need to differentiate a little bit between the morphological criteria that you see in the field, coupled with simple chemical tests that can be done in the field, and those which must be done in the lab. We do have a test that works in the field for oxalate extractable Al; we can use this test in the field and decide if the soil meets the criteria. In my experience it works. I am aware that there is a very serious problem in assessing the content of organic matter, the lack of relationship between colour and organic content; to me that is the most serious problem of all. I would hope that we could come up with a field test that would help to discriminate between these soils.

Farnham: How about a pyrophosphate test for organic matter in the podzol?

Day: Yes, something like that. I think it will work, although I haven't had the opportunity to evaluate it. I think it needs a good deal of sharpening up to quantify the amount of soil you use in relation to the amount of extractant and perhaps more work needs to be done on the kind of colour response that you would measure. I wonder if there is a relationship between the Munsell hue of the extract and the organic matter content. I would like to test that.

Farnham: We have a very large area, and I know Western Ontario does, of these "neither" soils. You have to rely on laboratory analysis, which we have done, since they do not seem to fit anywhere. They did not look like podzols, but they turned out to be by the iron analysis. So we are now calling them podzols, but you cannot go out there with soil auger and identify them. We saw one like them yesterday; we called them brown podzolic soils.

Chairman: If I may pull this together, the discussion started with Dr. Ehrlich saying what can we do with the sandy podzols that lack the chemical criteria. To get back to this point, quite a bit has been said both last year and this on these soils on the West that lack these criteria, and have these characteristics. We looked for these in Nova Scotia in extremely sandy soils and chose a site to visit near Annapolis Royal, which we subsequently missed when behind schedule, Site 4, Round Hill. But we found a well developed spodic B and no problem; we do not appear to have this phenomenon down east. However, my inclination is to go on the visual criteria and put those soils into the podzols. I don't regard this as being a fundamental problem in our scheme. I think we are dealing here with one of these extreme variants to which Dr. Cann was referring, which we are not yet in a position to understand. In the meantime, it seems folly to put soil with such deep bleached horizons into the Brunisols. I can't see them in the Regosols, even less so, and until we can resolve this problem, I think these soils have to go in the podzols provisionally.

Wang: The sandy podzols in the United States, if coarser than loamy sand, have a cambic horizon rather than a spodic horizon and go into the psamments. Enough Fe and Al are released to coat the sand grains giving the morphological appearance of a podzol; therefore, we have to make a decision whether we are to go along with the morphological appearance, or whether we go along with the chemical tests. I would say that we can handle this by adding colour contrast criteria for the soils coarser than loamy sand, or whatever texture we decide upon. If the podzol B is redder than a certain hue, then the soil is a podzol, in other words, we go along with the morphological feature for the sandy soils. For the medium-textured podzols, we would use the chemical tests. This is a compromise solution.

McKinzie: In the U.S. system it states that a spodic horizon has a particle-size distribution that is sandy or coarse loamy.

Chairman: Would anyone here disagree that what goes on in the leaching dynamics, if you like, of these sandy soils in Saskatchewan and Alberta, is any different from other podzols. If this happens, are we not dealing with essentially the same leaching situation, but the soils just do not happen to have the materials there in the original parent material to be mobilized? Should we not give weight to the very process that is going on in these soils and allow for it in the way we treat them taxonomically?

Ehrlich: There is only one difference. Those that look like podzols, but are not podzols, are in most cases developed on calcareous materials. It seems that when they are developed on acid materials they may make the criteria; they often have Bf horizons. One more point. If we go to this extent now and accept these as podzols, we are going to be in trouble on calcareous materials. Other soils which are now in the Brunisols are equally deeply leached, with a foot and a half of Ae, but they do not quite make a Bt. Under present definition these will have to stay in the Brunisolic Order, even though they have an Ae. This is just as bad a departure as the ones we now want to call podzols; both are equally leached, but both will have to go in the Brunisols unless we discard the criteria.

Cann: Having said all this, I think that looking at this definition we have just discussed, there is nothing in this that is not in our original one, except that it is written a little more explicitly. It does not force you to put in the sandy soils if you do not want to. It does not force you to put them in the dystric brunisols. All we have done here is to expand the definition of the podzolic order, to include those parts of the spodic B as described in the American system, to simply round out the definition of the podzolic order. There is nothing here that would commit you to accept those very sandy soils at the order level. If we decided to accept them, they would have to come out as some kind of a weakly developed subgroup.

Day: I would agree with that. There is one small point dealing with the definition as you have written it. At line 10 in the second paragraph, it says that "hues become yellower or chromas become lower, or both, within 20 inches of the top of the horizon". I think that 20 inches is a little restrictive. I think I could find soils in which hues do not become yellower or chromas lower within 20 inches.

Chairman: What figure would you suggest? I take it you are thinking mainly of British Columbia soils?

Day: Perhaps 30 inches.

Cann: I tried this out this summer on a large number of soils, and those soils that did not make the change in chroma or hue, almost invariably would be classified as Brunisols, even though they looked like good podzols. It seems to work fairly well.

MacDougall: Would you place any minimum depth on the B horizon?

Cann: I do not think so.

Chairman: This is at the order level.

MacDougall: How would you handle these at lower levels? You would have to use chemical criteria.

Cann: If there are no other comments on this, would you be prepared to recommend this for consideration? It will certainly have to be considered by the western people. If not, then we have to go back and accept the definition we already have, and go on to the question of subgroups. I think this definition as I have rewritten it is simply an elaboration of the one we have in the book; it does not commit us to make other decisions, but simply defines the kind of soil that we are looking for more accurately.

Hoffman: At line 4, it states "acid parent material". Extending from Kapuskasing to the border we have podzol soils, with good spodic B and albic horizons, covering millions of acres, developed both on medium textured tills and sands. The materials are highly calcareous, running 20-25%, $CaCo_3$, so I would like to see the "acid" dropped.

Cann: That is why I put "mostly" in there.

Hoffman: In our case the "mostly" does not really fit. A question. Would it be possible to have a Bft or a Bfht horizon?

Cann: I think it is possible, but we have to make provision for it.

Hoffman: I was asking from the horizon designation point of view. We have also discovered in the same areas horizons that we would like to qualify as Bft or something of this kind. They meet all the qualifications of clay accumulation and they occur in the logical position of a spodic horizon. The only difference is that they have clay in them, under calcareous conditions, and they are not bisequa.

Ehrlich: They would go as luvisols, to me. This would outweigh your Bf, because of the clay accumulation.

Wang: Soils like these with sufficient clay accumulation may qualify as luvisols, even without apparent clay skins, because the clay skins do not show very well when the structure is granular. We have to decide whether they are podzols or luvisols.

Ehrlich: They are luvisols; otherwise, we do not have Gray Wooded. We saw one the other day which went in as a Gray Wooded soil; initially it was a textural podzol.

Chairman: We shall have to come to some consensus on this proposed podzolic order revision.

Day: On SSCC p. 87, in the definition of Gray Luvisols, it states "but there are no significant increases in oxalate-extractable Fe and Al". So the soils in question are not luvisols, but podzols.

Hoffman: What is most upsetting is that I defy you to tell the difference morphologically between these soils and the ones that are standard orthic podzols.

Ehrlich: You can tell the difference in texture between the Ae and Bt. You are going to have podzols on calcareous materials and also podzols on acid materials. From a management standpoint, they are entirely different soils. The textural B is important because it influences the water regime, for one thing.

Hoffman: Looking ahead, there is a suggestion in here for a subgroup of "luvic podzols". Would these soils be luvic podzols?

Chairman: Do we have sufficient agreement on the fundamentals embodied in this redefinition of the podzolic order?

Smith: You have omitted all reference to chemical criteria in this definition. Is this the intention of the redefinition of this order?

Cann: It contains all chemical criteria that are written up in the original. The chemical criteria are included in the great group definitions.

Motion: It was moved by P.K. Heringa, seconded by J.H. Day, that the new definition of the Podzolic Order prepared by D.B. Cann, be adopted. Motion carried, one vote against (Ehrlich).

Discussion of the Proposal to Combine the Ferro-Humic and Humo-Ferric Subgroups

Cann: We have talked about the difficulty of identifying these in the field. It is very difficult to identify a Bhf from a Bfh. I worked over two or three hundred soils over the past winter and I .... (remainder of Cann's presentation not recorded).

Day: I would like to observe that in the last two years, quite a considerable number of Ferro-Humic Podzols have been established in British Columbia. I do not know whether they are having similar problems to yours or not. Apparently they are much more widespread at least in British Columbia than we thought before.

Langmaid: We have them here. They were not very apparent in the field, but after analysis they turned out to be Ferro-Humic. We may just have happened to choose 3 sites on three different series that happened to be Ferro-Humic. I feel that if we had more manpower and had taken more samples, some would have been Ferro-Humic and some Humo-Ferric.

Day: I do not think there is any reason to leave the sampling program until the end of the mapping program. How many technicians do you have?

Langmaid: None.

Day: Let's hope the future will take care of that. If you have a technician you should be feeding samples in to him all the time.

I would ask also that we should give some considerable importance to the project of discovering what is the importance of organic matter in these soils. Is it useful to nutrition of trees; is it a source of energy for conversion of weathering products by bacteria? I do not know what the importance of organic matter is.

Maybe it is worthwhile separating. Admittedly, you can separate these things at many different levels, and perhaps the series is as good as any other place.

Chairman: The very statement John makes on the lack of this knowledge indicates that this distinction should be treated at the family or series level, rather than great group. Would this not be logical? The information is largely lacking. Foresters have been largely concerned with diseases in trees and there are some excellent research papers on the subject in their bi-monthly Research Notes, but still the forestry department in Nova Scotia cannot tell me what trees prefer what characteristics in soils, with the exception of very basic differences. I suspect that the Ferro-Humic Podzol as we define it now, and such as we saw at Site 14,Nova Scotia, provides a great rooting medium for trees compared with other soils in the area. But it is a very subtle ecological difference, that I would not hope to be able to correlate exactly with the soil map, and the forest species distribution.

Day: I think this relationship has been established in British Columbia. The distribution of the Humo-Ferric Podzols is generally at a lower elevation and the Ferro-Humic Podzols, by and large, at a higher elevation. There is a relationship to the forest capability areas, just by virtue of the additional rainfall. I think the chaps out there would be distressed at the proposal to lump these two things together, because it would make the capability groupings for forestry a little bit more difficult to arrive at.

Chairman: But their capability groupings, like ours in the east, are based on the soil series, in fact the soil phase.

Day: Their Ferro-Humic podzols are, by and large, dark coloured. There is a geographical distribution which helps them explain the relationship between soil subgroups and forest capability groupings.

Chairman: Naturally, sites 13 and 14, Nova Scotia, were chosen to exemplify this problem, and the range of hills where the second site was located, rising from 600 to over 1000 ft above sea level, is all covered by Ferro-Humic Podzols. We ran tests on the Bhf and Bfh horizons of these soils, all along the hills, thinking there was an altitudinal limit somewhere between the Humo-Ferric and Ferro-Humic. In fact, the Ferro-Humic came down to 150 ft above sea level, where it was certainly indistinguishable visually from the Humo-Ferric. Likewise in other areas, the Humo-Ferric rose to 700 ft above sea level. There was no exact correlation, and visually they were almost impossible to map on this basis; we would have needed a laboratory sample from every hole.

Day: If there was a suitable field test method for the presence of organic matter in these horizons, would you be more inclined to leave things as they now are?

Chairman: No, I would not, because right now I am spending a lot of time at each hole doing field tests, and this materially slows down the mapping.

Cann: We are still going to put the dark ones together and the light ones together at the series level, regardless of how much organic matter we have.

Chairman: We have enough problems getting these out as series, you see, but when it comes to making a family map, we are making irrational family separations, simply because we have these soils in different subgroups and therefore cannot be in the same family. The whole family classification is shot to pieces.

Cann: The separation might work at the family level.

Smith: How could it, because families exist under subgroups and you are having trouble with great groups?

Cann: At the family level, they would all be podzols and they could be split into Ferro-Humic and Humo-Ferric, those that have more than 10% organic matter and those that have less, regardless of colour. The colour separation at family level would not matter.

Langmaid: Why was 10% chosen?

Ehrlich: No specific reason.

Chairman: It's a good figure too, but at the series level, or family. Is there a view from the U.S. on this decision?

Langmaid: They are having exactly the same trouble in Maine, with light and dark coloured horizons, and the light having as much organic matter as the dark.

Chairman: Does anyone remain opposed in principle to the amalgamation of these two groups into one great group of Podzols?

Day: I think I am opposed to the amalgamation of them right now; I am certainly in favour of studying the problem.

Chairman: It follows that they will be studied because we have at least a year while these ideas go to the western meeting, thereafter more time until the next national meeting. So, I think there is time for study. I put it to you that we should have a motion for the adoption of this proposal, without even putting in a reference to the effect that it is to be studied, which is assumed.

Baril: When lumping things together we must recognize that they integrade; are we doing the right thing to lump them together in this way? I think we should have the split on a Canada-wide basis between Humo-Ferric and Ferro-Humic. Of course, this would be reflected in the horizon designations Bf, Bfh, Bhf. Then when we look at the total description usually we have the analysis, and when we see Bfh or Bhf, we know the content of organic matter. Laboratory data are essential. I am not saying that it would not be simpler to have just two great groups but we may find more Ferro-Humic Podzols, as we are doing in Quebec. Are we doing the right thing in lumping them together? There is a difference in degree, but not in kind; this is a very important point. At the great group, we prefer difference in kind.

Does this mean that the Humic Podzol will be confined to Newfoundland? Do you have enough data?

Cann: I am sure we have some in British Columbia.

Baril: If we have soil series established on Ferro-Humic Podzols this is a case for keeping the distinction.

Langmaid: The main problem with these is the 4 inches in which the organic matter averages 10%. Those horizons are rarely uniform, and widen and pinch out within one pit.

<u>Motion</u>: It was moved by K. K. Langmaid, seconded by J.I. MacDougall "that the Ferro-Humic and Humo-Ferric great groups of the Podzolic Order be combined into a Podzol great group, the emphasis on organic matter being considered at a lower taxonomic level". <u>Motion carried</u>, no opposing votes.

<u>Proposal to eliminate the Mini Podzol Subgroups</u>

Cann: The only other point I would like to deal with today is this question of the mini podzols. I suggest we eliminate them. I think we can deal with them quite adequately at the series level. I see no need for having them as such a high category as subgroup.

Langmaid: If we are going to do that, we are going to have to allow the Ae as not being required. If you demand an Ae in the definition of these things, we are stuck.

Cann: At the order level, the Ae is not diagnostic.

Day: In the current definition of Ferro-Humic Podzol they may or may not have an Ae horizon; it is not diagnostic now, at great group level. It says "in some cases the Ae may be thin, indistinct or missing".

I have mixed feelings about that, because that recommendation depends on what you decide to do about chemical criteria. If it is your intention to drop chemical criteria as part of the definitions at subgroup and above, then I am against it, because of the problems it would create with the distinction between brunisols and podzols.

Smith: Why were these Mini Podzols introduced in the first place? Is it because these are very extensive soils in this part of the world?

Ehrlich: They were to take care of what were originally called brown podzolic or acid brown wooded soils, to get them into the podzolic order, because they had Bf horizons according to the present criteria.

Day: The only difference is on the thickness of the Ae.

Chairman: This is the only difference that we have written in. Site 14, Nova Scotia, was typical of the kind of thing we are thinking of. With 1 or 2 inches of Ae, in fact, it has gone in as orthic, but there are soils like that on which an Ae cannot be found, except in every fourth hole. These have been classed as Mini Podzols and the differentiation, I think, is unnecessary at this level.

Day: The result is that you end up mapping complexes of series, but that is not going to be changed. If you drop it from the subgroup, and maintain the distinction in thickness of Ae at the series, you will still end up mapping complexes of series.

Chairman: Yes, but it is a question of whether we are making too fine a distinction at too high a level. This is what is under consideration here.

Day: One of the main advantages I can see, is in limiting the number of families required.

Chairman: It will effectively do this in the Maritimes, I think.

<u>Motion</u>: It was moved by P. K. Heringa, seconded by W.A. Ehrlich, "that the Mini Subgroups in the Podzolic Order be eliminated". <u>Motion carried</u> unanimously.

Cann: Mr. Chairman, that is all I have to say, except to mention that somewhere along the line we have to do something about putting placic horizons into the gleysolic order. Also, we are now faced with a group of podzols in Newfoundland in which the Ae horizons contain considerably more clay than the underlying B. I am not too sure what we can do with them.

J.L. Nowland then presented his paper on Soil Family Classification.

In review of the system of soil family classification for the Eastern Regional Meeting of CSSC, September 24, 1971, I wish to present a few general observations based upon limited experience and some specific suggestions for revision of the system.

Many of the suggestions for revision of the classification derive from the proposals of the Subcommittee on Soil Families at the 1970 national meeting, and the Memorandum of March 1, 1971, circulated to soil survey units over the signatures of John Day and myself. Some derive from study of the latest material from the USDA.

At this stage my purpose is to promote discussion, to explore present thinking and to seek some measure of consensus for transmission to the chairman of the CSSC Subcommittee on Soil Families, prior to the next national meeting.

General Remarks

1. The concept of the soil family developed amid high hopes, most of which are unrealized, or being but slowly realized, in this country. The Subcommittee on Soil Families reported very limited progress on soil family groupings, and ascribed it to the moratorium on changes in the Canadian system of soil classification, or complacency. The moratorium clearly could not be responsible for poor progress with a system in existence before it commenced, unless deficiencies in the system, real or imagined, induced complacency.

2. Since family groupings are unlikely to reveal many new soil-plant relationships (SSCC, p. 157), their usefulness is to be sought elsewhere. According to the Subcommittee "family grouping becomes a yardstick for checking and establishing proper limits to soil series". This is true but in itself poor justification for having soil families. Close scrutiny during the family grouping of Nova Scotia soils did indeed reveal that many "series" contained too wide a range of characteristics while others could have been merged, but the point was more clearly demonstrated when it came to committing the range of series characteristics to paper in the national card index file.

3. The usefulness of the soil family concept lies in the generalization of soil information at a level higher than the soil series. It would appear that one reason for generalization is the production of a generalized, but "categorically detailed", soil map of the province or region at a scale somewhere between 1:100,000 and 1:500,000. From the response to its questionnaire, the Subcommittee reported that such a family map was "ruled out". Ontario and Quebec employed soil textural classes and groups of families or series in their categorically detailed generalized maps. The Alberta and Saskatchewan maps used great groups at a small scale, and are probably not therefore categorically detailed.

4. In Nova Scotia attempts to construct a family map at a scale of 1:500,000 had limited success. The intricacy of the map units almost equalled that of soil series units, because 80% of the series boundaries are inevitably great group or subgroup boundaries. Many of the soil separations were too fine for the purpose intended. On the final map, half of the map units are single families and half are groups of two or three families, cartographically generalized.

5. When Nova Scotia soil families are portrayed at the scale used in county mapping, 1:63,360, there are no special cartographic problems, but we find many single series families. These result partly from too many fine distinctions being built into the subgroup classification. Excessive discrimination at the great group and subgroup levels in podzols is one of the concerns expressed in Dr. Cann's presentation. It breeds irrational separations, at least in the Maritimes, between families of Mini and Orthic subgroups, and of Ferro-Humic and Humo-Ferric great groups.

6. There are many other instances, however, of insufficient discrimination at the subgroup level. A case exists for elevating ortsteins and fragipans to subgroup criteria, as proposed by the Subcommittee on Soil Families. It is my belief that pseudogleying (gleying by perched water) should be recognized at the great group level in the Gleysolic Order. It would seem, then, that the difficulty with soil families is not entirely a question of excessive subgroup discrimination.

7. The large number of single series families also suggests that too wide a range of characteristics are allowed in some so-called soil series. This is true for some soils in the Maritimes when the guidelines on range of hue and texture are considered (SSCC p. 179). But again there are many other soils in which too much importance has been attached to minor lithological differences and mode of deposition in the separation of series, and a modern re-grouping would result in fewer series. The definition of soil series is really quite flexible.

8. The frequency of single series families is not, therefore, to be taken as a fault in the family or series classification. Neither should it be regarded as evidence of limited usefulness of the family concept as an additional taxonomic level of abstraction. Rather, it would seem that the usefulness of the soil family is as an alternative basis for mapping units, in place of the series. The family mapping unit can be used only at about the same scale as series mapping units (ideally, 4 inches to 1 mile for mapping, 1 inch to 1 mile for publication, in the Maritimes), but it has the advantage in the Maritimes of avoiding many lithological separations of doubtful significance. Adoption of family-based mapping units would also accelerate appreciably both the detailed mapping of farmland and the semi-detailed or reconnaissance mapping of forested land. I would be prepared to advocate on a trial basis the adoption of family mapping units for published maps in Nova Scotia, even in advance of improvements to the mineralogy criteria suggested below.

Suggested Revision of the Treatment of Soil Families in the System of Soil Classification for Canada

1. "Control Section for Soil Families" (pp 167-168)

It must be noted that this material describes the control section used at the series level, and was taken from that point of the U.S.D.A. text concerned with "Series differentiation within a family". The control section for soil families differs in the following respects:

(a) It is terminated by a fragipan, duripan or petrocalcic horizon, because these horizons are barriers to rooting. It follows that the thickness of these horizons are not considered at the family level.

(b) It is amended in those soils with Bn or Bt horizons to give added emphasis to the effects of these horizons.

We have to resolve this inconsistency by either adopting the USDA formula or producing a simplified control section. A priori, I am in favour of a simplified version if feasible, omitting the special treatment of Bn and Bt horizons on the assumption that where they have a significant effect on water movement, this will be brought out by our criteria of contrasting textural layers. I am also inclined to allow the family control section to include cemented horizons and fragipans, these features to be used for family separation as consistence criteria in their own right. These questions, however, should be the subject of close scrutiny by the Subcommittee on Soil Families before a decision is made.

2. "CRITERIA" (p. 168). This heading should be changed to CRITERIA AND GUIDELINES to reflect better the content of the ensuing sections.

3. In the USDA system particle-size classes do not take into account the spodic horizons of Cryaquods, Cryohumods, Cryorthods and Cryic Placohumods, on the assumption that the high organic matter content results in a limited relationship between particle-size and other soil characteristics. While this may be true, I suggest that we can ignore this exclusion for the sake of simplification. Some views from British Columbia on this point would be welcome.

4. Strongly Contrasting Textures or Nonconforming Layers (p. 170)

(a) I suggest that an introductory sentence is required directly following the heading:

"Strongly contrasting textural classes are used to identify significant variations within the control section, which affect properties such as water movement and retention, and which have not been identified at a higher taxonomic level."

(b) I also suggest a concluding sentence as follows:

"The scheme is flexible so that in some areas additional combinations of less contrasting textures may be used if judged to be significant".

Both of the above statements are broadly consonant with the intent stated in the draft USDA text, except that the latter implies that vertical changes in the pore size distribution are the sole reason for identifying contrasting textures.

5. "Table 1 Possible Combinations of Strongly Contrasting Textures"

Amend Table 1 to read as in the attached draft.

Difficulties have been experienced in the Maritime Provinces in not having "moderately fine" included as a lower contrasting texture. Other changes have been made to lend more precision to the table.

Although the texture classes as presently defined do not correlate exactly with the particle-size classes in the U.S.D.A. scheme, greater congruity would be achieved by adding the classes medium-skeletal and fine-skeletal over fragmental and fine and very fine over medium-skeletal. For some reason the Americans omit the combinations of fragmental over any other class, and coarse-skeletal (sandy skeletal) over fine, which the Canadian system recognizes and should retain, if they exist.

REVISED TABLE 1 (p. 170) (draft)

	Fragmental	Coarse-skeletal	Medium-skeletal	Fine-skeletal	Very coarse	Moderately coarse	Medium	Moderately fine	Fine and very fine
					OVER				
Fragmental			X	X		X	X	X	X
Coarse-skeletal						X	X	X	X
Medium-skeletal									X
Fine-skeletal									
Coarse	X		X	X			X	X	X
Medium	X	X			X				X
Moderately fine	X	X			X	X			
Fine and very fine	X	X	X		X	X	X	X	

6. MINERALOGY (p. 170)

Omit the first two paragraphs and substitute the following:

"Mineralogy classes are based on the approximate mineralogical composition of selected size fractions of the segment of the soil (control section) that is used for the designation of texture classes. If contrasting textures are recognized the mineralogy of the upper part of the control section defines the family mineralogy. A family map be 'medium over coarse, mixed', but not 'medium, mixed, over coarse'".

"The mineralogy classes in Table 2 are those suggested in Soil Taxonomy (USDA 1971). In this scheme 'mineral soils are placed in the first mineralogy class of the Key that accommodates them, although they may appear to meet the requirements of other mineralogy classes'. Determination of the clay mineralogy of fine and very fine textured soils is based upon the weighted average of the control section."

"It is recognized that in the absence of quantitative data the selection of classes depends upon judgement, that the classes listed cover specific parent materials, and that most Canadian soils will have 'mixed' mineralogy. The montmorillonitic class is common in the Prairie Provinces."

I suggest that the existing material on p. 170 is disjointed and uninformative. The above description is generally consonant with the USDA draft text and March 1st Memo of Day and Nowland.

7. Table 2 KEY TO MINERALOGY CLASSES (p. 171)

The following changes should be made to make the table congruent with the U.S. Key:

(a) "Classes applied to loamy, silty and clayey soils". (p. 171) This should be changed to "Classes applied to any textural class if not specified otherwise". "Glauconitic","carbonatic" and "gypsic" classes should come under this heading.

(b) The "fine-carbonatic" class has been dropped from the U.S. scheme. I suggest we follow suit in the interests of simplification, unless a need can be demonstrated.

(c) "Classes applied to sandy, silty and loamy soils" (p. 171) Should be changed to "Classes applied to coarse, coarse-skeletal, medium and medium-skeletal soils", and placed after the "Gypsic" class.

(d) "Mixed" class.

Add the determinant size fraction 0.02 - 2.0 mm.

(e) "Classes applied to clayey soils" (p. 172)

Change to "Classes applied to fine and very fine textured soils". This is suggested in order to use Canadian terminology, but noting that "clayey" soils in the U.S.D.A. scheme have more than 35% clay, and therefore include some finer silty clay loams and clay loams. These would be excluded from the fine class in the Canadian scheme.

(f) A "Chloritic" class appears in the U.S.D.A. scheme after "Vermiculitic". I suggest we ignore it unless a need can be demonstrated.

(g) Delete the footnote referring to "sepiolitic" soils unless a Canadian need can be demonstrated.

(h) Delete the "mineralogy subclasses" (sulfurous, calcareous). These have been dropped from the U.S.D.A. scheme and no need has been apparent in Canada. Calcareous soils can be identified under "Reaction and Calcareous Classes". (See below).

8. "4. <u>Depth Classes</u>" (p. 173)

Delete all the material in this section and substitute the following:

"Depth classes are applicable only in lithic and cryic subgroups and soils having a paralithic contact within a depth of 20 inches.

The following classes for mineral soils are used:

Very shallow: soils less than 7 inches (18 cm) thick to a lithic, paralithic or cryic contact.

Shallow: soils between 7 and 20 inches (18-50 cm) thick to a paralithic or cryic contact. The designation "shallow" is redundant where the contact is lithic".

"A lithic contact is a layer of rock the hardness of which is 3 or more on the Mohs scale. In a paralithic contact the hardness is less than 3. A cryic contact is frozen soil or a level at which the temperature is less than 0°C on August 21st".

On page 173, the phrase "Although .... provinces" is immaterial. "Very shallow" is preferred to "micro" as being more descriptive and easier to use adjectively. "Paralithic" contact is included in the definition of shallowness since it is implied in the bald final sentence of the existing text. (It is also used in the USDA scheme).

In the USDA scheme "petrocalcic" (Bcac) and "petroferric" (Bfc) horizons also define the lower limits in shallow families. This requires discussion, but it would seem preferable to accommodate these features under "Soil consistence" (see below).

9. "5. Soil Climate" (p. 173)

As recommended in the Memo of Day and Nowland the whole of this section should be deleted and the following material substituted.

"The definitions accepted for the soil climatic map of Canada are recommended for adoption as soil family climatic ceiteria. In this system the soils can be grouped according to their temperature and moisture regimes which are as follows:

Temperature		Moisture	
1A	Extremely cold arctic	a	peraquic
2A	Very cold subarctic	b	aquic
3C	Cold continental	c	subaquic
3M	Cold maritime	d	perhumid
4C	Very cool continental	e	humid
4M	Very cool maritime	f	subhumid
5C	Cool continental	g	semiarid
5M	Cool maritime	h	arid
6C	Mild continental		
6M	Mild maritime		
7C	Moderately warm continental		
7M	Moderately warm maritime		
8C	Warm continental		

"The symbol t is used for mountain climates with complexes of varying temperature and moisture regime due to significant variations in vertical zonation or aspect. It should be appended to the climatic class symbol where appropriate, e.g., 3Mtd on the west coast near Prince Rupert or 2Atg in Yukon Territory".

"The detailed criteria basic to each of these climatic classes are to be found in the report of the Subcommittee on Soil Climates, CSSC Proceedings, 1970, and the Soil Climatic Map of Canada". The classes have been changed slightly recently and are subject to further change.

10. It is doubtful, in my opinion, that pedoclimate fulfils a useful function as a criterion for soil family separation within an area the size of a province. The boundaries between climatic zones are extremely diffuse even where data are available, and they can take no account of overriding microclimatic effects. Certainly in the Maritimes it is neither practical nor useful to split up morphologically similar soils which are presently mapped in the same series, but which are widely dispersed in different climatic zones. Where the morphology changes in accord with climatic differences the soils are adequately separated and characterized at the subgroup level; this also appears to hold good in the Prairies.

Pedoclimate criteria may be of more value in interpretive agronomic situations than in taxonomy. I suggest that they be retained only for optional use as family differentiae. They can also be used pragmatically as a last resort to differentiate between families occurring in widely separated areas that happen to be alike in all other family criteria.

11. Soils having a moisture deficiency limitation affecting plant growth are poorly differentiated at the family level, unless by the accident of textural criteria. Within a pedoclimatic zone, a family may contain soils both with and without significant growing season deficiencies. In the Maritimes, the adoption of a water-holding capacity criterion would provide a more solid basis for differentiating these soils than texture, the only recourse at present. I expect that such a criterion would be useful in the drier areas of Canada.

12. "6 Reaction Classes" (p. 173)

(a) The heading should be changed to "Reaction and Calcareous Classes" to cover the proposed content of this section.

(b) The following should be added as an introductory sentence.

"Reaction classes are applied to the whole control section, but are only used in the Luvisolic, Regosolic and Gleysolic Orders. In other soils, soil reaction is assumed to be sufficiently well characterized and understood in the subgroup classification. Reaction classes are not applied to soils with carbonatic mineralogy".

Discussion is required as to whether the Luvisols should also be excluded (and possibly whether the Dystric Brunisols should be included). The USDA system recognizes family reaction classes only in the Entisols and Aquepts. Within these taxa, reaction classes are not differentiated in sandy, sandy-skeletal and fragmental particle sizes, in Fragiaquepts and in soils with carbonatic mineralogy. I see no reason why we should exclude our coarse and coarse-skeletal textures and Gleysols with fragipans.

(c) Change paragraphs 6a, 6b and 6c to read:

"a) Acid: pH lower than 5.5 in all parts of the control section

b) Neutral: pH 5.5-7.5 in at least some part of the control section.

c) Alkaline: pH higher than 7.5 in at least some part of the control section".

This was one of the recommendations of the Soil Family Subcommittee at the 1970 national meeting. The system is unsatisfactory in my experience for soils in which the pH rises rapidly with depth, and the weighted average may mean little. One possible solution that avoids complicating the scheme further is to restrict the control section for reaction classes to the top 20 inches. I suggest this would be preferable to the USDA system, which recognizes only two classes, acid and nonacid, separated at pH 5.0 ($CaCl_2$) and determined over the full control section. Calcareous classes use the 20 inch depth (see below).

13. "Calcareous Classes" (p. 174)

(a) Delete "(See also Carboratic Class under Mineralogy)" which is unnecessary.

(b) Add the following directly after the heading:

"Calcareous classes are applied to a section from a depth of 10 inches (25 cm) to 20 inches (50 cm) or a lithic or paralithic contact if shallower, or to the whole soil if the contact is shallower than 10 inches (25 cm). They are only used in the same taxa as reaction classes and for similar reasons".

The reduced control section is used in the USDA scheme and seems to have much to commend it. I suggest that the 10 to 20 inch depth could be used for both reaction and calcareous classes, deliberately diminishing the significance of subsoil variations.

Restriction of the taxa in which calcareous classes apply follows USDA practice; they are recognized only in Entisols, Aquepts and some Aquolls.

14. "Special Horizons" (p. 174)

(a) Change heading to "Soil Consistence" to reflect the type of separations described in this section.

(b) Delete the three existing sentences and substitute the following:

"Certain extreme conditions of soil consistence not recognized at the subgroup level, are grounds for soil family separations. These include fragipans and ortstein horizons, which should be identified by the adjectives "fragic" and "ortstein" in the family name, if the following conditions are satisfied.

Fragic: an x horizon that is present in 50% or more of each pedon within a depth of 40 inches (100 cm).

Ortstein: A Bf, Bfh or Bhf horizon that is at least weakly cemented, when moist, into a massive horizon that is present in 50% or more of each pedon.

The term "noncemented" is not used in the family name or description."

These changes follow the suggestions of Day and Nowland and the definitions are derived from the USDA draft text. In the USDA scheme, it is stated that no single family should include soils both with and without cemented horizons. Most soils with duripans and petrocalcic (Bcac) horizons are differentiated at higher taxonomic levels, and so these features are redundant in the family description. The desirability of including these horizons and also thin ironpans, as family consistence criteria in Canada is matter for consideration.

15. "Consistent Nomenclature"

Omit "acid" and change climate designation in the St. Nicholas family.

Change climate designation in the Gatineau family.

Should Canada Adopt the USDA System?

In this review I have adhered to the principle of keeping the Canadian system of soil family classification congruent with that of the USDA. Correlation is thereby facilitated and we are able to draw heavily upon the fruits of the large U.S. effort. The question arises, why not adopt the USDA scheme in its entirety?

The case against such a move seems to rest upon three propositions:

(1) Some of the complexity of the USDA system can be avoided because of the narrower range of soils being considered within Canada.

(2) In a few sectors of family classification, such as texture and soil climate, the home grown approach may prove superior for Canadian needs.

(3) Faults and deficiencies in the USDA scheme can be avoided.

The validity of these points would have to be carefully examined in the light of field experience; I confine myself here to a few cursory observations.

1. A fundamental question is the distinction in the USDA scheme between texture and particle-size class, the latter covering the whole soil less than 74 mm. The particle-size class is used for soil families because it is "a compromise between textural class and engineering class". One consequence is that gravel is taken into account in differentiating the four "loamy" classes (coarse and fine silty and loamy) which do not therefore correlate with the Canadian medium and moderately fine classes. The situation has recently been changed by the adoption in the U.S. of new textural class limits and names, after detailed study of the practical significance of the particle size class parameters. While I have not had time to study the new scheme, I am in favour of adopting the principle of particle-size class to replace our textural classes at the family level. But again, detailed study by the subcommittee on Soil Families is required.

2. Consideration of gravel by both volume and weight becomes confusing in the USDA text. 35% gravel by volume is used to define skeletal classes, but the weight of the gravel is added to that of the sand in separating coarse and fine silty classes (15% by weight).

3. Attempts to bridge the gap between pedological and engineering classifications are desirable, but in my experience the engineer's interest is focused on the characteristics of soil distinguished at the series and series-phase level rather than the family level, especially lithology, slope and depth to impermeable layers.

4. The USDA mineralogy class key, which Canada has adopted seems to cater only to extreme cases and is of limited use in glaciated areas, so that the bulk of Canadian soils appear to fit only the "mixed" class. I suggest it would be preferable to replace the Key with one in which more realistic mineralogical separations are made. What is required is a "pedological classification of soil parent materials" for application at both the family and series levels. This would be a considerable undertaking, but could be developed along the lines indicated by Brewer (Fabric and Mineral Analysis of Soils, 1964, Ch. 6).

Such a classification, if feasible, would be an evaluation of the significance of lithological differences; it would offer guidelines as to whether tills derived from Triassic and Carboniferous sandstones in Nova Scotia are sufficiently different mineralogically to warrant series separations; whether the mineralogical suites in certain granites and schists warrant family separations; what percentage adulteration of a sandstone till with basalt warrants a series separation, and so forth. Most soil surveyors would appreciate guidelines as to what constitutes real lithological, and thereby mineralogical, differences in the establishment of soil series. Neglect of this field has resulted in great disparity between provinces in the recognition of lithological differences, and the present mineralogical classification at the family level does little to solve the problem.

5. At this point in time, a fundamental decision needs to be taken in Canada. We cannot continue to take only certain portions of the U.S. system of family classification and incorporate them in the Canadian system. The portions we take become riddled with ambiguities in the absence of the whole supporting framework.

If we adopt the USDA system in its entirety we gain from the intensive study supported by vast data which has led the Americans to a conviction that their soil family separations are meaningful for plant growth, land management and engineering interpretations. Against this must be weighed the possibility that we will acquire a system that is unnecessarily complex for our needs, a hammer to drive in a thumb tack. There may be other difficulties in taking the family criteria from one system of classification and grafting it on to the subgroups and great groups of another system.

Should Canada develop its own system of family classification, for example, if we continue to use textural groups instead of particle size classes, the implications would demand the attention of a special study group, not merely the exchange of correspondence prior to a busy national meeting. Furthermore, the effort might be useless if the group presently studying the feasibility of adopting the whole USDA taxonomy reports in the affirmative.

In conclusion it must be said that any evaluation of the system of family classification will be greatly facilitated by good feedback from pedological practitioners, particularly those who have made an earnest attempt to use it. I, therefore, invite comments and criticism and would be grateful for anything in writing following this meeting. I think it important that concrete suggestions and broad-based opinion in writing go from this meeting to the Soil Family Subcommittee prior to the next national meeting.

Fragipans

C. Wang

In 1930, Kellogg described a compact and brittle layer associated with podzols in Northern Wisconsin. Marbut (1936) described soils with fragipan in coastal-plain region near Washington, D.C. and because of the high SiO_2/Al+Fe ratio in pan horizons, he suggested that silica was the cementing agent and it was called "silica pan" by Winters in 1942.

In Canada, Stobbe first mentioned the occurrence of a "hard pan" thought to be cemented with silica in certain poorly drained soils associated with Grey-Brown-Podzolics in the Appalachian foothills of Quebec in 1937.

Because it usually has high silt content and is brittle, fragipan also has frequently been referred to as "silt pan" or "brittle pan" as well as "silica pan".

The modern concept of fragipans have been defined by Carlisle et al in 1957 as "Compact horizons which are hard to extremely hard when dry and firm to very firm when moist and display the property of brittleness when both dry and moist". Therefore, the presence of brittleness when dry and moist is one of the most important characteristics of fragipans. However, I would like to add the property of "slaking to the definition of fragipans, because practically all the fragipan samples slake when soaked in water, and this property may be important from the genetic point of view. This will be discussed later.

Usually displayed in fragipans are high silt, very fine sand and fine sand, low clay content, low organic carbon, low sesquioxide, high bulk density, low to very low hydraulic conductivity. They may also show a coarse polygonal pattern on both the horizontal and vertical planes, weak pedological structural expression within the polygones outlined by the bleached cracks; the pans normally have clearly identifiable upper boundaries but often diffuse lower boundaries and presence the bodies of moved clay.

Fragipans have a definite relationship with the soil moisture regime, not only in the expression of the pan but also in the depth to the pan from the soil surface. Fragipans are best developed in moderately well and imperfectly drained soils, weaker pans are found in either well or poorly drained soils. In non-eroded soils, a fragipan could occur anywhere between 8 to 35 inches below the soil surface. In a fragipan soil, catena fragipans are closer to the soil surface as the drainage becomes poorer.

Fragipan has never been found in calcareous layers, although, some fragipan soils may have a calcareous parent material.

The existence of fragipans in the Maritime provinces have been positively identified recently. Nowland estimated that Cumberland County, N.S., alone has about 300,000 acres with fragipans. Fragipan horizons are also found in some soils in N.B. Undoubtedly, with the awareness of the presence of fragipans, more acreages of fragipan soils will be mapped in the future.

According to the fragipan soils I have seen in Maritime provinces, they are present in three orders; namely, Podzolic, Brunisolic and Gleysolic. Fragipans are also found in Alfisols or Luvisols in Eastern U.S.A.

The fragipans normally occur below Podzol horizons (such as Bf, Bhf,, Bfh, or Bh) and color B horizons (Bm) in Podzols and Brunisols and occur within the Bg horizons of Gleysols. In Eastern U.S.A., fragipans are found either above, below or within argillic (Bt) horizons.

It is generally accepted that fragipans are genetic horizons. They are known to be components of soil profiles developed in residuum, glacial drifts, lacustrine, loess, and alluvium. They are usually continuous horizons, maintain a relatively constant depth within the profile and a constant spatial relationship to other soil horizons within one kind of pedon.

Just how the fragipan developed into such a dense and brittle layer is still not clear. However, the slaking property of fragipans has ruled out silica as a cementing agent; as a matter of fact, the slaking phenomenon may suggest that there is no chemical cementing agent at all. The high bulk density and brittleness of the pan may be a result of close packing of the mineral particles.

The purpose of this talk is to caution soil surveyors in Canada, Eastern Canada in particular, to be aware of the presence of the fragipans. It is not only interesting to know how the pans are formed but also its impermeability and denseness cause practical problems in land use and therefore, in soil classification.

Wang: There is one thing I did not mention. The fragipan usually has a very abrupt upper boundary, but the lower boundary is diffuse. The fragipan normally has a high bulk density, but the parent material could be lodgement till of equally high bulk density. I cannot go into detail as to how I think the fragipan is formed (display chart). Briefly, I think the fragipan used to be part of a Bt horizon which became greatly degraded. Clay that was not leached out remained at the points of contact between the coarser particles. The rest of the clay may have been diffused through the C horizon, giving it a slightly higher bulk density, equal to or even slightly higher than that of the fragipan.

Day: Is there any information in the literature about the physical close packing aspects of loess deposits which have fragipans?

Wang: In loess we also have high bulk density, but the fragipan often occurs in a Bt horizon rather than in podzolic horizons. The high bulk density may be due to the clay that has been washed in, as well as to physical close packing. I have not studied fragipans in loess.

Day: I wonder if there is a possibility that there is something in the condition of basal till which initiates the process.

Wang: This is true. Much of my material is derived from the work I did at Cornell. The two soils were on lodgement till with two feet of ablational till on top. There was a weak stone line at the zone of contact and the pan started right at the stone line. Here, the basal till had a lot to do with the high bulk density of the pan, because it started with a high bulk density. Not all fragipans are formed in this way, because loess, for one, starts with a low bulk density.

Day: and is relatively permeable.

Ehrlich: Are there any materials known that could possibly mellow a fragipan, for instance, $CaCO_3$?

Wang: I do not know, but I would suggest that one does not have to use $CaCO_3$ which is not very soluble. When I saw gypsum outcrops in Nova Scotia I thought of the possibility of applying gypsum when deep ploughing the fragipan. I do not know what would happen, but the fragipan always has a very low amount of exchangeable Ca. I would hesitate to add too much lime to break up the pan since there may be trouble with deficiency of minor elements. Gypsum may be a better thing to try.

Ehrlich: Suggested trying some experiments on material in the laboratory.

Wang: We would probably have to do this in the field.

Baril: I think the significant thing about fragipans is not so much their bulk density, but the capillary porosity. Going down into the pan there is a marked rise in capillary porosity, a rise in the ratio of capillary to total porosity, suggesting that clay is filling the pores.

Wang: More research is required along these lines. I would like to mention that not all fragipans have an A'x horizon.

Acton: Was your Ae gleyed at all? Was the thin section you showed from the Ae horizon?

Wang: Yes, the A'e is gleyed and of very light color. The section was from the Bx.

Farnham: Do you find the fragipan much deeper - in the C horizon?

Wang: Yes, but the lower boundary of the pan is diffuse and difficult to detect. A sharp lower boundary is exceptional.

Farnham: In Lincoln, Grossman ran a thorough two-year study of all aspects of the formation of a fragipan. He found that it was not a Bt. We called it Bt, by the finger method, but it did not turn out that way and we still had the "x". This was a loamy sand till, not a sandy loam, and the B horizon was a loamy sand.

Wang: Fragipans are normally found on lighter textures.

Farnham: I notice in all cases in your diagram you have a Bt, but there is not necessarily a Bt in all of them.

Wang: No, but an A+B or B+A horizon is common, and this is a zone of degradation of a Bt. Often, clay moves out of the Bt and into the C horizon and is undetectable by mechanical analysis. Frequently, enough clay remains for the horizon to still qualify as a Bt. Most fragipan soils in U.S.A. are Inceptisols which have Bm horizons, and gradually I would think they would become Spodosols. In Canada, the same features are found in degraded Brunisols and they may go eventually to Podzols. A lot more data is needed to support this idea, and I could be entirely wrong.

The Chairman ended the discussion at this point and thanked the participants for their efforts in making this a successful and productive meeting. He called on the national chairman, Dr. Ehrlich, for a few remarks. Dr. Ehrlich commended the organizers of the organic tour for their efforts and briefly discussed the responsibilities of the Canada Dept. of Agriculture for conducting all soil surveys requested by the Dept. of Environment. He also pointed out that a new chairman will be appointed for the next national meeting which probably will be held in the spring of 1973.

The meeting adjourned at 5 p.m., September 24.

Participants in the Eastern Regional Meeting

C.J. Acton	Research Branch, C.D.A.	Guelph
R. Baril	Dept. of Soils, Univ. Laval	Quebec City
D.B. Cann	Research Branch, C.D.A.	Fredericton (Chairman)
J.H. Day	Research Branch, C.D.A.	Ottawa
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