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Editor's Note

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Has the Polypedon's Time Come and Gone?

By Craig A. Ditzler, USDA-NRCS, National Soil Survey Center, Lincoln, Nebraska; craig.ditzler@usda.gov.

A few months ago, Dr. Dan Yaalon, one of the editors of the newsletter of the Commission on the History, Philosophy and Sociology of Soil Science, International Union of Soil Sciences, and Council on the History, Philosophy and Sociology of Soil Science, Soil Science Society of America, initiated a discussion regarding the polypedon. After I expressed my thoughts on the topic, Dr Yaalon asked me to share them here. In this brief article I will discuss the definition of the term as it was first used in Soil Taxonomy, summarize some of the criticism about the concept, and provide the most recent viewpoint about the polypedon concept as it appears in the *Soil Survey Manual* and in *Soil Taxonomy*, 2nd edition.

The Definition of the Polypedon

I recently entered the term "polypedon" into the Google search engine. It returned 245 Web pages containing the term. Most of them provided some sort of definition, and I've listed several of them here.

- A group of contiguous similar pedons.
- A group of contiguous pedons that belong to the same soil series.
- A collection of pedons that are much the same.
- Functionally equivalent to soil series.
- Polypedon is to a pedon as a population is to an individual among living things; a swarm of gnats to a single gnat, a forest to a single tree, etc.
- Union of soils whose forming factors are so similar that they give morphological and functional characteristics which fall into specific ranges.
- A volume, to the depth of the solum, of relatively uniform soil material.
- Smallest area of any one kind of soil.
- Basic soil object (soil body) for classification in the field.
- A three-dimensional body with definite recognizable boundaries.
- The soil in the landscape that contains many pedons.
- Many pedons together in one area; the soil unit used in preparing soil maps.
- A soil volume that consists of more than one pedon.
- The basic mapping unit.
- The smallest unit of soil that totally describes the soil variability in terms of horizontal and vertical dimensions.
- A number of pedons that are associated with one another.
- A volume of relatively uniform soil.
- A volume of soil having properties within the limits of a soil series.

Clearly, many definitions of the term "polypedon" are being used. I found it somewhat amusing to even have found a reference explaining the workings of computer programs that check spelling. It seems to assume that polypedon is not a real word and suggests an appropriate correction for "polypedon" is "polyhedron."

When it was published in 1960, the Seventh Approximation did not include the term “polypedon.” Rather, it included a discussion of “The Soil Individual” (p. 4): “The soil individual, or ‘a soil’ consists of one or many contiguous pedons, bounded on all sides by ‘not-soil’ or by pedons of unlike character in respect to one or more characteristics diagnostic for a soil series.”

The motivation for devising the polypedon concept was that the pedon, while useful as an entity for sampling, was too small to reflect the shape characteristics of the soil surface or to show the full range of properties for the series. In an article titled “The Pedon and the Polypedon” published in 1963 as part of a Soil Science Society of America Symposium held in 1961, William Johnson introduced the term “polypedon” for the soil individual. He wrote: “The polypedon is defined as one or more contiguous pedons, all falling within the defined range of a single soil series.” He went on to state that polypedons “are the real objects that are placed in classes of the lowest category of the system. They are comparable to individual pine trees, individual fish, and individual men.”

In the first edition of *Soil Taxonomy* (1975), a section titled “The polypedon, a unit of classification” (p. 5) states that the polypedon “consists of contiguous similar pedons bounded by ‘not soil’ or by pedons of unlike character.” It goes on to state that “the limits of the polypedon are also the conceptual limits between soil series, which are the classes of the lowest category in this system.”

Note that the polypedon concept as it developed in the context of Soil Taxonomy included the following points:

1) Pedons making up a polypedon are all members of a single series, and

2) The polypedon is the object (individual) we classify.

Criticism of the Polypedon

Soon after Johnson’s article appeared in 1963, Knox (1965) published a thoughtful piece titled “Soil Individuals and Soil Classification.” He pointed out a critical weakness with the concept of the polypedon. He argued that the polypedon cannot effectively be the individual we use to classify the soil because you must first know the series placement of all the pedons *before* you can determine which can be grouped together to make up the polypedon. Defining polypedons as consisting of pedons from a single series and then saying that we use the polypedon as the object we classify clearly is a circular argument because you must already know the classification before you can identify the polypedon. So Knox convincingly states, “Accordingly, polypedons seem to be of little significance or utility with respect to the placement of soil into classes.”

The requirement for polypedons to be made up of pedons that are all members of a single series results in real difficulty because soil series limits do not necessarily reflect natural bodies of soils but instead are constrained by the limits of the family and higher categories. Soil series are human constructs. They are defined, and frequently revised, on the basis of our concepts about the soil. Series are defined to meet the needs of soil surveys; some are defined narrowly, some more broadly, depending on anticipated use of the information. They may reflect observations of natural soil bodies, but they are not themselves natural soil bodies. As Knox pointed out, “Because polypedons have no existence apart from series classification, their significance as individuals seems less than the significance of individual pine trees, individual fish, and individual men.”

Another difficulty is that it is not practical to determine the proper series placement for all pedons that are potentially members of a polypedon. To reliably determine which pedons meet the series criteria, one would need sufficient data to confirm all relevant diagnostic properties, such as mineralogy, clay activity class, base saturation, and organic carbon content. Given these constraints, if one could actually observe and delineate a “polypedon,” it would surely resemble a Swiss cheese with many holes in it! Note that because the polypedon is constrained by the limits of the series, it cannot be equated with a map unit delineation, which typically has more than one soil taxa (some of which are referred to as “inclusions”). The polypedon cannot be observed in any practical sense in the field.

Furthermore, what are we to do in areas where we have not developed soil series concepts? In Alaska, for example, many areas are mapped at relatively small scales and map units are correlated to taxa at levels higher than the series. Should we conclude that there are no polypedons in these areas? Does the polypedon now become all contiguous pedons in a particular family, subgroup, or great group?

Recent Viewpoints About the Polypedon in the U.S. Soil Survey

The concept of the polypedon was addressed when the *Soil Survey Manual* (1993) and the 2nd edition of *Soil Taxonomy* (1999) were updated and published. The authors recognized the shortcoming of the polypedon concept. As a result, the polypedon's flaws were acknowledged and its importance was minimized. It was effectively dropped.

In the *Soil Survey Manual* a discussion of the polypedon states (page 19):

> In practice, the concept of the polypedon has been largely ignored and many soil scientists consider a pedon or some undefined body of more or less similar soil represented by a pedon large enough to classify. Polypedons seldom, if ever, serve as the real thing we want to classify because of the extreme difficulty of finding the boundary of a polypedon on the ground and because of the self-contradictory and circular nature of the concept. Soil scientists have classified pedons, regardless of their limited size, by deliberately or unconsciously transferring to the pedon any required extensive properties from the surrounding area of soil.

The 2nd edition of *Soil Taxonomy* refers to the polypedon in chapter 5 (pages 116 and 117). In part, it states:

> Applying the pedon and polypedon concepts to mapping and classification has been the subject of debate and a source of misunderstanding in soil survey for decades (Hudson, 1990 and 1992; Holmgren, 1988). Some notable problems are that in reality soil profiles rather than pedons (i.e., three-dimensional volumes) are really sampled and classified (Holmgren, 1988), that soil property variation prohibits the selection of one profile or a few profiles to represent variation within delineated soil bodies (Hudson, 1990), and that soil-landscape units and soil map units are composed of more than one polypedon (as Application of Soil Taxonomy to Soil Surveys defined by USDA, SCS, 1975) and contain soils with properties outside the ranges of established taxa.

So I think the polypedon concept is limited in its usefulness. It is of interest in the historical context of the development of ideas in soil classification. Additionally, when series concepts are tested, we can consider, at least for easily observable properties, what a polypedon might look like based on our understanding of the landscape. This informal process helps us to refine series concepts so that more pedons fit within the defined range of the series. However, the concept of the polypedon is fatally flawed because:

1) It is not a natural entity in its own right, and its existence depends on the limits of the series;
2) As series limits are refined, presumably the boundaries of the polypedon would expand or contract;
3) It is not clear what the polypedon consists of where series have not yet been established; and
4) There is no practical way to observe a polypedon in the field.

Soil scientists working in the soil survey program have found it possible to describe, sample, classify, and map soils without giving the polypedon much thought. There is no need to revise the polypedon definition because we simply do not need it. The polypedon's time has come and gone.

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Soil Information Software Updated

From "NRCS Technology News," October/November 2004.

The National Soil Information System (NASIS) is a software program that is used for the development and maintenance of soil survey information. Since the initial release of NASIS in 1994, enhancements and upgrades have occurred generally on an annual basis. This time the application modifications will result in a major overhaul and redesign.

The primary purpose of the NASIS Redesign project is to move NASIS from its current computer environment of a UNIX X-window based system that utilizes the INFORMIX relational database management system software to a platform that is more in line with other NRCS computer applications. This new platform will use Microsoft, and it is anticipated that this change will improve many of the network problems we have been experiencing.

A secondary part of the redesign is to incorporate several new functionalities into NASIS. They include: Data Compare tool; a Data Aggregation tool; integration with the Laboratory Information Management System database from the Soil Survey Laboratory; and integration with the Official Series Description and Soil Classification databases.

We also are looking at opportunities to improve the screen layouts or interface into NASIS to make the system easier to use. A NASIS users' group was organized in 2003 to assist the NASIS design team in addressing this issue. The user group suggested about 85 possible changes and enhancements.

Incorporating these enhancements will likely result in changes in the way that some operations are handled, but in the end these upgrades should provide soil scientists and other users with easier access to NASIS.

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Plan Underway to Evaluate the National Benchmark Soils List

From "NRCS Technology News," December 2004.

The MLRA Soil Survey Regional Offices, National Soil Survey Center, and the newly established National Geospatial Development Center will be working together to evaluate and update the national list of benchmark soils. The current list, which is a compilation of individual states' preferences, contains 1,215 soil series and was last updated in the 1980s. This was well before the completion of many soil surveys in the United States.

One objective is that the revised national benchmark soil list has adequate geographic representation, such as by Major Land Resource Area or Land Resource Region. Another objective is to evaluate the list for "data completeness," which will be useful in formulating plans for future soil survey investigations.

A benchmark soil is one of large extent, one that holds a key position in the soil classification system, one for which there are a large amount of data, or one that has special significance to farming, engineering, forestry, ranching, recreational development, urban development, wetland restoration, or other uses.

The benchmark soil list helps the research community to focus their investigative effort on key soils that have the greatest potential for applying new technology across a large area, and also for transferring new technologies to similar soils, thereby optimizing cost-benefit ratios. Benchmark soils are useful in planning many kinds of studies, including the assessment of conservation effects on soil erosion, dynamic soil properties, soil quality, studies of soil erodibility factors, crop and range plant adaptation and yield, and fertility.

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Some Observations on Publication of Soil Surveys From the 1960s to 1986

By Joe D. Nichols, Retired Soil Scientist, Soil Conservation Service, Fort Worth, Texas.

I read W.W. Johnson's "Publication Backlog," in Issue 26, NCSS Newsletter, a little late but thought some readers might be interested in the history of how publication was accelerated.

At the 1963 National Work Planning Conference of the NCSS, in Washington, D.C., Dr. Charles Kellogg stated that we were having trouble getting the soil correlation, the manuscript, and the compiled maps in a timely manner. After that conference, committee work in the Work Planning Conferences, and other meetings worked on the problem.

The short story is that Soil Survey Publications averaged 38 per year from 1963 to 1970; 54 per year from 1971 to 1973; 97 per year from 1974 to 1979; 121 per year from 1980 to 1982; and 71 per year from 1983 to 1986. These figures include the lag time from being sent to GPO and publication. The figures are a little better than they look here because one of the speed-up items was multiple survey area publication. These figures match the goals reasonably well in William Johnson's Soil Survey Acceleration Publication Plan in the report of the 1971 National NCSS Work Planning Conference. A.A. Klingebiel reported at the 1973 National NCSS Work Planning Conference that in 1972 we had published more acres of soil surveys than we had mapped. Favorable numbers of soil surveys are shown in Dr. Donald McCormack's, "Record Number of Soil Surveys Published" in the 1980 Soil Survey Horizons. Don stated that in 1979 the backlog of correlated surveys was 349. Getting down to the 200 surveys needed in the pipeline was a goal of the next few years.

In 1952, the SCS Soil Survey and the Bureau of Soils unit were combined. In 1953, the SCS Regional offices were eliminated. By 1959, Soil Correlation was under the State Soil Scientist and most of the Senior Soil Correlators promoted to the PSC offices. (More detail is in Gardner's thesis and my chapter on "Memoirs of a Soil Correlator.") In 1964, four National Technical Centers were established and the five PSC offices combined into four and placed in the Centers. My idea is that this period was one of great personal cooperation in the combination of two agencies and leadership at all levels. The importance of the Regional Work Planning structure has not been as widely recognized, as it should have been for stability during this period.

Dr. Kellogg began the work of the overhaul of the soil survey program and Mr. William Johnson furnished very good leadership for completion of the work. A history of the committee work is in the reports of the Regional and National Work Planning Conferences. In 1973, William Vaught, Director of the South National Technical Center, chaired an SCS-wide committee to organize the text and map work to get everyone on the same page and moving forward. Reports of this committee work were not widely distributed, but results showed up in the form of memoranda and instructions. Changes had been made in organization, correlation procedure, manuscript text preparation, including word processing and pre-written sections, mapping on publication photography and compilation by states until Cartographic could catch up, and coordination of interpretations with the Soils 5 forms and computer-generated tables for manuscripts were put into effect. A computer tracking system for surveys named CASPUSS was enacted. This work was done at a time when Soil Taxonomy was being tested and sampling for laboratory data was greatly accelerated.

Responsibility for final correlations and series and interpretations had been transferred from NHQ to the PSC offices. The many changes in a short period helped balance the program. For the next few years not much information was given on soil survey reports and I do not have any numbers. By 1987, word was already coming out on a new productivity report indicating the need for improvements in the survey program.

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NCSS Retirements

From "Spade and Auger," Volume 29, Number 3, Fall 2004, a newsletter of the Society of Soil Scientists of Southern New England (http://nesoil.com/ssssne/fall04.pdf).

The National Cooperative Soil Survey has announced the retirement of Maury Mausbach, Jim Ware, Earl Lockridge, and Rick Bigler.

Maury Mausbach—Deputy Chief for Soil Survey and Resource Assessment. Maury's career has been closely tied to the technological advances in our agency over the last 37 years. He was a pioneer in developing soil morphology software. He guided the soil survey through its transition to the digital age, and he coordinated transition of the National Resource Inventory from a 5-year cycle to a 1-year cycle, giving our internal and external clients access to the latest resource data. Most recently, he has been in charge of our contributions to the Conservation Effects Assessment Project—CEAP—which will be important to creating the conservation programs of the future.

James (Jim) Ware, Soil Scientist, Soil Survey Division, retired from Natural Resources Conservation Service (NRCS), Washington, D.C., on January 3, 2005. Jim worked for NRCS for 33 years. He was in the Army Reserves for 26 years for a combined federal service of 33 plus years. Jim started his career in North Carolina then worked in Virginia, the Northeast National Technical Center in Pennsylvania, and the State Office in Raleigh, N.C., before joining the Soil Survey Division Staff in Washington, D.C., in 1989. Jim has made many contributions to the scientific field of soil science. He has worked extensively the last few years on the Smithsonian Soils Exhibit, which will open in the near future.

After a very rewarding career in soil survey, Earl Lockridge, Training Coordinator, Soil Survey Division, National Soil Survey Center, Lincoln, Nebraska, retired on December 31, 2004, after 31 plus years of government service. Earl began his career with the SCS in Iowa. During his career he served as a Soil Scientist, Project Leader, Assistant State Soil Scientist, Soil Scientist (Quality Assurance), and Training Coordinator. He worked in Iowa, Indiana, Missouri, Minnesota, and Nebraska. Earl was at the National Soil Survey Center from October 1987 to his retirement.

Rick Bigler, Soil Scientist (NASIS), Soil Survey Division, National Soil Survey Center, Lincoln, Nebraska, retired on December 31, 2004, after 33 plus years of government service. Rick began his career with the SCS in North Dakota. After a 2-year tour with Peace Corps (Malaysia), he returned to North Dakota as a Soil Scientist and later became a Project Leader. Rick then moved to Minnesota, where he was a Soil Specialist in the State Office. He was at the National Soil Survey Center from July 1989 to his retirement. ■

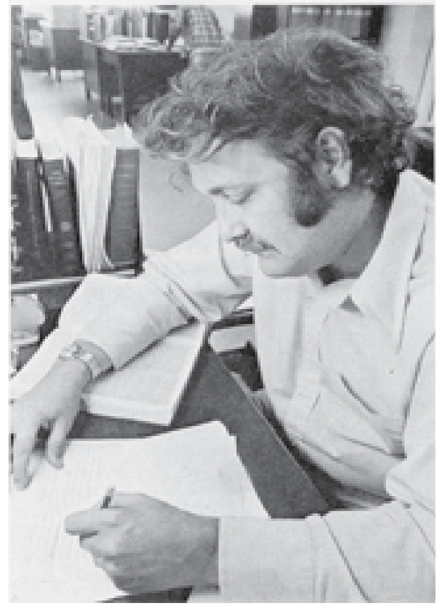
Stan Anderson Does Not Retire

By Stanley P. Anderson, Editor, NRCS, National Soil Survey Center, Lincoln, Nebraska.

After more than 30 years of distinguished Federal service, Stan Anderson, editor, NRCS, National Soil Survey Center, Lincoln, Nebraska, has announced that he will not retire. “Sometimes, it’s not what you do but what you don’t do that’s important,” Stan said in an exclusive interview. He added, “When I heard of the retirements of Maury Mausbach, Jim Ware, Earl Lockridge, and Rick Bigler, I had to resist the temptation to follow the monkey principle.” When asked to define the this principle, he said, “Monkey see, monkey do.”

Stan began his Federal career in 1974, when he joined the Soil Survey Editorial Staff in Hyattsville, Maryland. In 1976, he was transferred to the Midwest Technical Service Center in Lincoln, Nebraska. He has remained in Lincoln to the present day, despite a baffling series of reorganizations. These included consolidation of all soil survey editors in Maryland; dispersal of the editors to the four TSCs (or NTCs) in Portland, Ft. Worth, West Chester, and Lincoln; consolidation of the editors in Lincoln; and dispersal of the editors to various MO offices. Stan says that he does not expect to be around for the next consolidation.

Robert Ahrens, Director of the National Soil Survey Center, is said to be devastated by Stan’s nonretirement.



Stan Anderson at the beginning of his career. This picture was included in a 1974 issue of an SCS magazine celebrating the 75th anniversary of the National Cooperative Soil Survey. Note the crude editing instrument in Stan’s left hand. Also note the cool sideburn.

Stan earned a B.A. degree in English at the University of Minnesota in Duluth and M.A. and Ph.D. degrees in English at the University of Maryland (home of the Terrapins, a.k.a. Terps). When asked how his years in graduate school affected his career as a soil survey editor, Stan exclaimed, “Go Terps!” There may be a hidden meaning in this apparently unresponsive exclamation, which could be considered a veiled reference to soil in*terp*retations.

Stan is married to Janet Shell Anderson, a retired lawyer. Stan and Janet have been married since 1968. They have three sons—Robert, Michael, and Joseph. Speaking on condition of anonymity, Janet has indicated, “I expect to enjoy every moment of Stan’s nonretirement.” ■

Dr. David Hammer Joins NSSC Staff

Dr. David Hammer

Dr. David Hammer has joined the staff of the National Soil Survey Center in Lincoln, Nebraska, as National Leader for Investigations and Director, Soil Survey Laboratory.

David was born and raised in rural Illinois, where his father, Dick Hammer, managed cooperative grain elevators. Dick's challenge was in taking a cooperative that was in trouble and making it "well." Once the facility was cleaned up, operating smoothly and making a profit, the challenge was gone and the family moved to another small town.

Having no mountains, trees, or trout streams to occupy him in rural Illinois, David's attention was captured by the ever-changing, endless sky that was the primary natural feature of the corn- and soybean-clad till plain landscape. He went to the U. S. Naval Academy so that he could qualify for Naval Aviation. He graduated with a B.S. in engineering and was commissioned in the U.S. Marine Corps, which gave him an aviation waiver for his high-frequency hearing loss. He attended The Basic School at Quantico prior to attending flight school. He flew the A-4 Skyhawk for the Marine Corps and had a tour in Viet-Nam.

After his discharge from the Marine Corps, he returned to Illinois and attended the University of Illinois. He was accepted in the forestry program, but was immediately fascinated by soils when he saw the Marbut collection in an introductory soil science class. He received his M.S. in forestry, but had collected nearly 30 credit hours in soils classes.

He was fortunate, after graduation, to be employed in the Forest Land Grading Program in Washington State, and he mapped soils in Whatcom and Skagit Counties in the cooperative soil survey. Mapping soils whetted his curiosity and presented more soils questions than he could answer, so he decided to pursue a Ph.D.

The University of Tennessee had committed to establishing a characterization laboratory to support the cooperative soil survey, and David was hired as a research associate with the assignment of organizing the laboratory and representing the University at progressive field reviews. At one of the field reviews, he met Dr. Glen Smalley, who was developing a landform-based forest site evaluation system for the U.S. Forest Service. David received a grant from the Forest Service to evaluate the classification system, and that research was his doctoral thesis.

He then was hired as an assistant professor at the University of Missouri, where he organized the soil characterization laboratory that supported the cooperative soil survey in Missouri. He remained at MU for 18 years, was promoted to full professor, and eventually became Chair of the Department of Soil and Atmospheric Sciences. He taught more that a dozen different courses, but soil classification, genesis of soil landscapes, and pedology were the courses he most enjoyed. He mentored 18 graduate students, and served on committees for more than 80 others.

After the Department of Soil and Atmospheric Sciences was eliminated by the dean, he transferred to the Department of Civil and Environmental Engineering, where he taught hydrology and urban watershed management.

Dr. Hammer's research included soil spatial and temporal variability, surface mine reclamation, effects of the flood of 1993 on soil genesis, forest site productivity, applications of GIS for soil survey and land use, the use of a soil-based productivity index as a surrogate for crop yield prediction, and the effects of urbanization on stream hydrology. He has co-authored a textbook on soil geomorphology and has published more than 100 scientific journal articles and reports. He was very active in the cooperative soil survey effort in Missouri, which enjoyed excellent collaboration among the Missouri Department of Natural Resources, NRCS, and the University. The Missouri soil characterization laboratory annually characterized more than 6,000 samples. Several of David's graduate students are employed by NRCS or ARS. ■

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