THE EARTH BENEATH OUR FEET: EXPLORATIONS IN COMMUNITY[1]

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Our friend, the earth beneath our feet, is supporting us as we sit here in this room. As I have been preparing this essay, I have heard myself muttering under my breath: "I wish that I could help my hearers to love the soil as much as I do; and I have only fifty minutes in which to attempt that. " (I sound like John Muir(1838-1914) who felt that only he knew how to love mountains (Helmers,1993).) And then I realized that each of us has an instinctive bond already, a natural friendship with the soil.

"Our native soil claimed us all from the start;
Gave us our landscape, and captured our heart."(Hole,1985)

We are all children of Mother Earth whose family is diverse, including as it does: fungi, bacteria, slime-moulds, mites, springtails, nematodes, earthworms; roots of hemlock, maple and mint; people, badgers and oven birds. I am thinking of land life on this planet (Farb, 1960).

My remarks are from the point of view of a person who has been privileged to follow a professional career in the study of soils. I had the opportunity to map soils in Franklin County,Indiana; and in ten counties in Wisconsin in the field operations of the Wisconsin Geological and Natural History Survey(Hole,1976).I worked for a year at

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the soil and water conservation research station near Coshocton, Ohio. I participated in the development of a new taxonomy of soils, world-wide, sponsored by the Soil Conservation Service and cooperating state universities, and by soil specialists around the world. I had a chance to teach , do research and carry on extension work on behalf of the soil resource. I have been fortunate. I speak for the fragile soils of this planet.

I have studied a book written by my friends Carl Glocker and Robert Patzer, entitled Soil Survey of Dane County, Wisconsin,published in 1978 by the Soil Conservation Service in coöperation with the University of Wisconsin here in Madison. Carl and Bob walked across the 1,198 square miles of Dane County and drew boundaries between bodies of the sixty-two different kinds of soils that they identified. On map number 90 I see this building, as photographed from the air. I see that this building sits on a body of Virgil silt loam. This is a dark, moist, deep soil that is named after Virgil, Illinois, a village about one hundred miles south of here, near which this soil was first discovered. (Soils are named after places. If you wish to have a soil named after yourself, it will be necessary for you to establish a village and get it named after you. Then you will need to persuade some soil mappers to name a soil after your village.) I myself slept last night in east Madison in my home which is supported by a body of Dodge silt loam, a soil that was named after Dodge County, Wisconsin, where that soil was first described. Dodge County was named after Governor Henry Dodge(1782-1867),who was declared Governor before soil science had come into existence. Governor Dodge had no idea that in the 1950s his name would be appropriated from the road map of Dodge County to serve as the name of a soil formed in three feet of

fertile dust (called loess) blown by winds onto sandy,stony landscapes shaped by a continental glacier. I have learned that about 15,000 years ago a glacier sat where we are. The glacier here was about a third of a mile thick and was composed almost entirely of ice. It was a small, slowly-moving mountain, pushing south from Canada. When the ice melted, about 10,000 years ago, winds blew a lot of dust around. The local winds left four feet of fertile dust on the site of this Wisconsin Center building. For thousands of years oak groves and intervening patches of prairie vegetation grew here by the shore of Lake Mendota.

If anyone had asked me this morning, at breakfast, where I was going today, I could have replied: "Well, I plan to leave our patch of Dodge silt loam and go west to a patch of deeper, moister Virgil soil on which the Wisconsin Center Building sits." I know all this because I have read the book by Carl Glocker and Robert Patzer. I could take a soil auger and drill down in the soil hereabouts to confirm what is reported in the soil survey book, with its maps. Information about the geography of the earth beneath our feet is available to the public. In fact, I know of no other nation on the planet which provides such easy access for its citizens to soil maps and reports. Who loves a bur oak, Quercus macrocarpa(Curtis, 1959),can also love a Virgil silt loam, Udollic Ochraqualfs (Glocker and Patzer,1978).

It is a pity that we are not able, today, to view the beauty of the Virgil silt loam, as it could be seen in a trench 25 feet long and five feet deep and wide. The pattern of layers, called soil horizons, is impressive. At the top of the soil is a natural,vital litter of decomposing leaves of trees and grasses, that overlies about ten inches of a dark, soft granular silt loam. Below that is a mass of fragile soil blocks, the size of my thumb, of yellowish brown soil that has

delicate spots of light brownish-gray, as delicate as the spots on a fawn. This mottled soil extends down to a depth of four feet. But only soil surgeons (ditch-diggers in common parlance) are privileged to see the inner architecture and color pattern of the soils that support land life. Like us and the many other air-breathers, the soil takes in oxygen and exhales carbon dioxide. Rarely is the deep soil ever exposed to sunlight. The secret beauty of any soil must be kept hidden if the plant roots and the myriads of associated creatures are to do their work of maintaining land life. I suggest that on a basement wall of every building there be a mural showing the cross-section of the local soil in full color, with enlarged pictures of some typical soil animals and root structures.

Hans Jenny (1899-1992), Swiss-American soil scientist(Schultz, 1992;Hole,1992), on the faculty of the University of California at Berkeley, had this to say about the beauty of soil as seen in fresh excavations. "(The soil) resembles abstract art.. if you are used to thinking of soil as dirt, which is customary in our society, you are not keyed to find beauty in it. Soil speaks to us through the colors and sculptures of its (cross-section), thereby revealing its personality; we acknowledge it by giving (the soil)a name...but we don't mention our emotional involvements. In fact, our soil language is lifeless, and the soil descriptions in our publications are utterly boring to farmers, ranchers, foresters, sportsmen and newcomers who are supposed to read them... We may want to talk more openly about soils and do it more enthusiastically. We may even become more interesting persons. We may gain new friends, and they might hold a positive opinion of the soil

resource." (Jenny, 1984a; Jenny,1968)

I am being selective in this essay, choosing material from a variety of perspectives of the earth beneath our feet. Celestine Crawford, a soil scientist who has mapped soils in New Mexico, once wrote: "I think that we all enjoy working with something as real as land (Crawford, 1977)." Because the earth beneath our feet is literally supporting and nourishing us every day of our lives, and stands ready to receive us back when we die, the land is working with and for us. Therefore it is natural for us to work and live with the soil in mind. I encourage all of us to reclaim our earth birth-right, which is awareness of and companionship with the soil. I speak up for the right of a soil to exist, and not be consigned to abuse and even to extinction. If the human race could nonviolently restrict its numbers, the soil and its biota(Hole, 1981) would have a better chance to be. I emphasize the concept of ecosystem, of which soil is the rooting zone.

This University grants academic degrees to the scholarly. I have invented some unofficial soil-related degrees for which I think we all qualify, scholarly or not. First is T.N.S., meaning "temporarily not soil." As long as I am alive I am using nutrients that I take up from the soil. But I am only temporarily not soil. Another label is S.B.S., "supported by soil." While we yet live we are indeed supported by soil. Now consider M.O.B.S., "maker of bodily soil." In 1913, as a new-born babe, I set to work making soil, for which diapers were needed. It was a matter of life and death. Nearly every day of my life since then I have made some soil. E.O.S. stands for "extension of soil." We are extensions of soil that are more

mobile than those extensions of soil that we call trees. The massive core of a tree is dead. With the help of woodpeckers and beetles and microorganisms, the core of a tree trunk may change to soil long before the tree falls to the ground, thereby announcing that it is indeed soil again.In contrast we human extensions of soil are fully alive. A.S.K.S. is an abbreviation for "a special kind of soil."That is what we are. So we have come full circle from thinking that we are not soil, although only temporarily not, to thinking that we are all unique forms of soil. Finally I offer T.N.S.S. which means "temporarily not sea sediment." The ocean waves beat unceasingly at the shores of all lands. Is it possible that some day the waves will complete the job and the land, soils, people and all, will be converted to marine sediment?

Leonardo da Vinci (1452-1519) wrote:" We know more about the movement of celestial bodies than about the soil underfoot." Here we are, five hundred years after Leonardo, able to read thousands of books and articles about the origin and behavior of the soil (Jenny,1980). Better still, we know methods of research into the soils of our landscapes that stretch to the horizon, awaiting our questions. That's progress!

Are we telling our children early on about the earth beneath our feet? As little children we all were charmed with the verse written in 1804 by two English women, Ann and Jane Taylor:

"Twinkle, twinkle, little star
How I wonder what you are
Up above the world so high
Like a diamond in the sky."

I propose that we have a similar verse about the earth beneath our feet. My offering is, "Darkle, darkle, little grain." "Darkle" is a word meaning to vibrate with vitality in the dark. The grain is a tiny fragment of rock in the soil. A cluster of grains makes a crumb of soil.

Darkle, darkle, little grain.
I wonder how you entertain
A thousand creatures microscopic.
Grains like you, from pole to tropic
Support land life upon this planet.
I marvel at you, crumb of granite!.

Nearly thirty years ago the Department of Soil Science on this campus of the University of Wisconsin seriously considered renaming itself the Department of Soil and Water Science(Beatty,1991,p.91). Today, it remains the Department of Soil Science, but it deals with all components of soil, not the least, water.

In 1984 Hans Jenny was asked this: "As a student of the sciences, how did you get interested in soil?" In reply he said, in part: "It was the other way around. I had an interest in soil, and to comprehend it I needed science. In my research I tried to learn how soils are formed, how nature creates soils, and how long it takes to make a soil...One question looms large. What does nature have in mind, what is her goal of soil evolution?" (Jenny,1984a).

I dedicate this paper today to Hans Jenny and to what I call the "Jenny Society." By the Jenny Society I mean a nature study and recreation group analogous to the Audubon Society,but focusing on soils. On Audubon bird trips we stand on or near bodies of soil that support vegetation and water that attract birds. We use binoculars. We have bird books and make lists of birds seen and heard. The Jenny Society that I propose involves taking soil walks. The soils do not come to us, as birds do. Instead of binoculars we carry slender soil augers with which to drill holes one inch in diameter, to bring up material from a depth of three

feet or so. We get prior permission to use the auger on lands visited. I often take along a bag of cardboard panels about five inches across with a groove an inch wide down the middle in which soil may be glued. We go home with miniature soil exhibits. We have books about soils and make lists of soils seen. We wound the soil landscape ever so slightly with the auger. We disturb the soil at a given point about as much as a dozen earthworms would, or 300 ants. The openings that we make help water to soak into the ground when the next rain comes.

During the soil walk, or afterwards, we may sing soil songs, write soil poetry, make soil art (lapel pins, paintings, pottery and sculpture from clay, color photographs); and we work in gardens, forests, and even on farms.

Also I offer this paper as an event in an otherwise unannounced celebration of the hundred and thirty-fourth anniversary of the establishment in 1860 of the new natural scientific discipline known as pedology or soil science (Yaalon,1993).

The two words, earth and soil , both refer to the upper,loose layer on the land which is cultivable and in which growing plants root. The English word earth and the words for soil in French, Spanish, German and Russian have no negative connotations that I am aware of. But the English word soil connotes, not only loose material in which plants root, but also corruption, pollution, dirtiness and even moral defilement. In the title of my talk I have avoided the word soil and have focused on the earth beneath our feet. The word pedology comes from ology, science, and ped, the foot. Pedology means the science of that on which we put our foot. The rest of my title is "explorations in community." The human race is a community that includes people who live in harmony

with the land; and people who have lost the sense of being connected to the soil. Communities of animals that live in the soil, along with bacteria, fungi and algae, are very much connected to the soil. Plants and animals that live much of their lives above ground are ultimately dependent on the soil. Soil landscape communities are made up of soil bodies that fit together a little like pieces in a jigsaw puzzle (Hole and Campbell,1985).

In our solar system the third planet in distance from the sun is the one on which we set foot. In Genesis 8:8 we read that Noah "sent forth a dove, but the dove found no place to set her foot, and she returned to him in the ark, for the waters were still on the face of the whole earth." Then the flood was over. The face of the earth has ever since been the place on which footed creatures set foot, including ourselves. One of the greatest walkers in our Great Lakes Region was Frank Leverett, a glacial geologist with the U.S.Geological Survey. He walked from Iowa to Madison, Wisconsin to apply for a job mapping glacial features (Leverett,1929;Winters,1980).

The alchemists recognized four elements: water, air, fire, and the more stable earth. Yet the earth beneath our feet is not entirely Terra firma nor Terra productiva. A soil formed from fertile sandstone can in the course of a million years be so leached of plant nutrients as to be sterile.. an unproductive sand with a hardpan that obstructs root growth (Jenny,1980). Fortunately for us and other creatures on land, most soils are young to middle-aged, and are still relatively fertile and productive. They keep recycling nutrients. Soils of Wisconsin are quite young. They are mostly less

than 20,000 years old. We benefit from the work that glaciers did in shattering and powdering rock, by which nutrients are made more available to plants.

This planet could have been named hydro in recognition of the hydrosphere, the envelope of water. This planet could have been named atmo for the atmosphere; or litho for the rock mass; or bio for life forms. Instead, the planet is called earth. Earth, ground or soil lies like a blanket on the land. The earthy blanket is a grand mixture of bits of rock, water, air, plants and animals and their residues. Soil is the root domain of lively darkness and silence on which land life depends. Soil is an object of scientific inquiry. The earth beneath our feet also has a mistique, which explains why people kneel and kiss the ground and call it Mother Earth.

In ancient scriptures, Adam and Eve of the Biblical account of Genesis, have names derived from Hebrew words meaning soil and life. Adam, soil; Eve, life (Hillel, 1991). The Latin word Homo is from humus, a constituent of soil. In chapter 2 of Genesis, man is directed to serve and preserve the Garden of Eden. In the teachings of Buddha the earth and all life forms are sacred. To the Greeks the earth was Gaea, a maternal goddess. I know of no Biblical account of the creation of the soil. I offer the following first draft of an earth myth about that.

THE CREATION OF SOIL: AN EARTH MYTH

When, in the course of creation, the Great Spirit was ready to make land plants, roots and all, the Spiritual One walked to and fro on the bare granite rock of the lands above the seas. The hard granite sparkled in the sunlight. The Great Spirit spoke to the rock: "Granite! I would like you to consider giving up some of your rigid-

ity. Would you be willing to become loose in your upper part?"

"Loosen up, Lord? Give up my strength and security? I would be subject to erosion by water and wind! You ask too much!" replied the ancient rock.

After some thought the Great Spirit continued:"Granite, let me share with you my plan. I am creating land plants with roots. The roots need soil to survive."

"Land plants? Roots? Soil? What are these?" asked granite.

The Great One explained: "Plants are green, growing tissues that can capture energy from sunlight and use that energy to make more tissues, even forming flowers,fruits and seeds. Roots of plants are white ropes and strings, with conduits and tubers that grow in darkness. If some of your hard rock could be loosened up, roots could grow in your fresh dust. We would call your loose part soil. From soil, plant roots will obtain rock-borne nutrients and can draw water from fresh films supplied by rains and dew."

Granite was still afraid. "But Lord, I am troubled by the thought of being loose and vulnerable to erosion by wind and water!"

"Dear Granite," the Great Spirit spoke in a comforting tone. "Let us make a covenant between you and the plants, that in exchange for your becoming crumbly over your rocky lands, the plants will spread their roots through your loose, earthy parts and will bind them together. The plants will also spread their green leaves over you, as a mother hen spreads her wings over her chicks. In these ways the plants will protect you from erosion."

Granite pondered, as only an ancient granite can ponder. Then came its reply, tumbling out across the plains and echoing between the mountains: "Yes, Lord! I am willing! Loosen me up! Make me into soil in a layer on top of me! Bring in the new plants and carpet

the landscapes with forest, prairie and marsh. I will risk myself for life's sake!"

And it was so. And the Great One saw that it was good. (End of myth.)

Actually, much of the transformation of rock into soil is accomplished by carbonic, nitric and sulphuric acids that are generated in soil a little at a time. The acid soil solution weathers rock particles to clay, and in the process liberates plant nutrients that were rock-bound before.

By 1860 researchers in the western world were studying soils scientifically. It was in that year that the Bavarian-American E.W.Hilgard (1833-1916), at the age of 27, published a perceptive report on the soils of the state of Mississippi (Jenny,1961). He may be said to have been the first professional soil scientist on the planet. He shifted the emphasis of his career from geology to soil science (Hilgard,1884;Pittman, 1981). His major work in pedology was at the University of California at Berkeley.

For the sake of some humor, I suggest that we interrupt this account for a moment to honor Alice in Wonderland (1865) as the first woman soil scientist. You may recall that Alice was led into this field of study by a white rabbit. She followed the rabbit and found herself falling down a vertical shaft, on the walls of which were shelves with bottles of materials. She took one bottle from a shelf and set it on a lower shelf as she floated by. I suggest that Alice was acting out what soil scientists call "cation exchange"(Harpstead et al,1988). And where did Alice land? She landed mercifully on a pile of sticks. Modern soil science classifies such a pile as an O (organic) soil horizon. Let us return to the historical record.

In Russia, V.V.Dokuchaev (1846-1903) published a book on the Russian Chernozem, the black soil of the steppes. The U.S. federal soil survey program under the leadership of C.F.Marbut (1863-1935) adopted the soil classification developed by Dokuchaev and his students. T.C.Chamberlin(1843-1928), of this University, in 1883 published a large soil map of Wisconsin and accompanying treatise. Franklin H.King (1848-1911) had a brilliant career as an agricultural physicist on this campus from 1888 to 1901. In 1909-1910 Professor King visited Japan, China and Korea at his own expense. His goal was to learn how ancient civilizations have maintained agricultural productivity of their soils. King had observed in the United States that farmers here wore out naturally fertile soils at an extravagant rate. He and his wife published his book (1911), entitled: "Farmers for forty centuries." This book encouraged American farmers to be stewards of the soil.

The new science of soil needed an internationally standardized terminology. In 1883 T.C.Chamberlin, in his treatise on soils of Wisconsin, wrote:"There are few subjects upon which it is more difficult to make an accurate and at the same time intelligible report than upon soils. The difficulty arises partly from the nature of the subject, and partly from the vagueness of the terms used in speaking of soils."The observant Inuit(Eskimo)have many words for snow and ice. The paucity of words for soil in our vocabulary reflects our unfamiliarity with soil. We humans inhabit the above-ground leaf-domain (Jenny's vert-space) which is sun-lit daily. We rarely see below-ground. We use the one word soil for a multitude of conditions. To provide a

precise vocabulary about the earth beneath our feet, specialists in the new soil science have examined countless soil landscapes, have dug pits and described and tested soils in place, and have taken samples to the laboratory for careful analysis. There is even an official soil color chart (Munsell Color Company, 1954). There are many new terms used in describing soils accurately(Foth,1978;Buol et al,1985).

Recently I sojourned at a center for study and contemplation. There I got in the habit of hugging trees on pleasant days. When one hugs a tree, one puts ones arms around the elephant leg-like, or telephone pole-like part of the tree. The other two parts, namely the mass of foliage suspended in mid-air around and above the observer, and the delicate root system out-of-sight in the soil, are not huggable. If I ask myself what part of a soil might be huggable, I give myself a chance to visualize just what an individual soil looks like. Most soils that I have seen have no pillar-like part that you can put your arms around. In fact, an individual soil is shaped more like a pancake than a telephone pole.

Imagine a sequoia redwood tree that is 3,000 years old, and more than 250 feet tall, with a diameter breast-height of 27 feet and a canopy diameter of 100 feet. The tree has been growing in a volume of soil for 30 centuries. Thanks to natural recycling of nutrients and to weathering of additional nutrients from rock particles, the soil is still fertile (Zinke and Crocker, 1962). How big is the soil body that supports this gigantic tree? (Stephens, 1982). The soil body is about seven feet deep and four hundred feet in diameter. It might take twenty people to join hands around

the trunk, and 250 people to stand around the periphery of the root system, linking hands. If we had permission to dig a pit seven feet deep fairly near the trunk, we could see four major layers in cross-section. At the top we would see leaf and bark litter measuring six to thirty-six inches thick, being thickest nearest to the tree trunk. Below that we would see twenty inches of dark, granular surface soil called the A horizon. Then we would come to five feet of reddish-brown clay loam, called the B horizon. Under that is a paler mass of weathering rock called the C horizon. This soil body, seven feet thick and four hundred feet across is too small to show on a published soil map with a scale of four inches equals one mile. Soil bodies on such maps are commonly 600 to 1,000 feet in diameter.

Let us reflect briefly on the fact that the soil blanket, which is mostly loose material, precariously bound together by adhesive clays, crystals of minerals such as carbonates and iron oxides; and by bacterial gums,and by roots, supports some very large organisms. One of these is a body of fungus that is a pathogen on roots of some trees. Recently foresters discovered at the Wisconsin-Michigan boundary a 1,500-year-old body of the fungus Armillaria bulbosa that occupies about one percent of the volume of the upper foot of 37 acres of forest soil. The body of fungus is about a quarter of a mile across (Smith et al, 1992) and is a network of threads of pale tissue, like an extensive delicate seaweed floating in the opaque slow-motion ocean that we call soil. The fungus weighs about 1,000 tons, as much as a blue whale, the largest animal on the planet. A giant sequoia tree may attain that weight. Incidentally, the upper seven inches of soil on an acre of cropland weighs about the same.

In the Wasatch Mountains south of Salt Lake City is a clone of aspen. The clone is genetically one individual. It weighs more than 6,000 tons, or six times the weight of the Armillaria fungus body, and six times the weight of a blue whale.

If we wish to find a soil small enough for one person to hug, we might look in a peat bog for a showy orchis (Orchis spectabilis) The root system might be four inches thick and two feet in diameter. To hug such a disk of peaty soil would be a wet experience.

Actually there is a large body of peat bordering Lake Wingra not far from the Wisconsin Center building. The peat is probably as much as 2,000 years old. It is a mass of plant debris that occupies about half of the area of the original Lake Wingra. The rest of the lake is destined to become a peat bog, too, if nature is allowed to take its course. We observe that nearly everything on land that is not soil now is likely to turn into soil. Lakes become bodies of peat and muck soils, trees fall over and become soil again, as do butterflies and people, when they die.

We have been considering one way to define an individual soil body, namely, in relation to an individual plant, including its root system and the host soil. A colony of ants (Baxter and Hole, 1967) or a colony of termites (Carroll, 1969) can build a soil body full of channels and chambers, both below ground and in mounds. To hug an ant mound is to invite insect bites. In prairies, the interweaving of root systems and ant mounds is so intricate that it is simplest to consider the whole prairie community of slowly shifting plants and animals as one soil individual. We draw a boundary around a patch of prairie that may be a mile across. That becomes

a soil individual in our geographic classification, but we know that it is composed of thousands of interpenetrating soil bodies.

Pioneer soil scientist E.W.Hilgard studied native forest ecosystems in Mississippi(Jenny,1961). He found that the patterns of the original vegetation coincided with soil patterns on the landscapes. Several of us Wisconsin pedologists had our chance, a rare one, to map soils and native vegetation together in the tribal lands of the Menominees, west of Green Bay,Wisconsin(Milfred et al,1967). The Menominee Tribe gave us permission to do this investigation, which showed that forests and soils have created eachother. Today, in most of Wisconsin, native vegetative cover no longer exists. And so we are forced to classify and map soils on the basis of what I call "domesticated soil remnants."

Another way to delineate soil bodies is by the lay of the land. Visualize a level soil body on the flat top of a hill with steep sides. The boundary of the level soil is at the abrupt change in slope.

In some parts of northern Wisonsin in sandy terrain, there are funnel-like depressions as big as a small city block, into which cold air drains on cold nights, even in summer. The climate of the soil at the bottom of the depression is colder than the soil climate on the surrounding plain. The climate on the top of Blue Mounds in Iowa County, Wisconsin is cooler than the climate on lower-lying Military Ridge. Climatic domains also define distinct soil bodies, at different scales.

Different kinds of geologic materials define soil bodies. In a sand dune,stablized by vegetation, a sandy soil develops that is distinct from an adjacent soil body formed in clayey beds of an ancient lake bottom, now dry land. Sandstone strata give rise to different soils from those formed in dolomite (calcium-magnesian limestone).

Volcanic ash-derived soils are widespread around Mt.St.Helens.

The last criterion for defining distinct soil bodies is the time factor. In many river valleys there are natural terraces or benches that rise on either side of the river, like stairsteps. Studies reveal that the benches farthest from and highest above the river are the oldest; and that the lower benches are progressively younger. The valley displays a community of soils that differ primarily in the number of thousands of years of soil aging. The older the soils, the more acid and more clayey they are (Jenny,1941,1980).

SOIL ABUSE AND ITS CONTROL

Human history and natural history together record abuse of the soil resource, particularly under intensive industrial agriculture. Ancient cultures have collapsed in no small measure from abuse of soils and of people on them.

In this country European settlers removed native vegetation, exposing soil to agents of erosion, as grain, cotton and tobacco were raised and harvested.In the southern Piedmont region on the east coast the top foot of soil was eroded from cotton fields which became gullied and then abandoned. The geographer Carl Sauer (Cronon,1983) commented that the settlers had not learned "the difference between yield and loot." "Ecological abundance and economic prodigality went hand in hand: the people of plenty were a people of waste"(Cronon, 1983). "The settlers practiced ecological imperialism"(Crosby,1986). The immigrants brought "biological allies"in the form of plants, animals and pathogens (including small-pox) which out-competed native biota and people (Crosby,1986). In the case of the passenger pigeon (Ectopistes migratorius), settlers' dominance meant annihilation, reducing pigeon numbers from two billion in 1850 to zero in 1914 (Pointing,1991). The soils have not been quite the same since the demise of the passenger pigeon. Surely we human beings can avoid presiding over our own extinction!

After 134 years of development, soil science has given us information on which to base practices of stewardship of the soil resource. The North American continent provides us with remnants of pristine wild ecosystems. Also we have available a spectrum of soils ranging from little to greatly altered by human activity, both before and after 1492(Butzer,1992).

Research to ascertain the nature and capacities of soils was promoted by the founding in 1862 of land grant colleges of agriculture and engineering across the nation (Jenkins,1991). People differed in their opinions about mixing classical studies...science, arts and letters..with practical or profane studies...agriculture, engineering, forestry... on a single university campus. The fact that several members of the faculty of the Department of Soil Science here have been elected to the National Academy of Science indicates the high quality of their work on this versatile campus. Researchers at this university have taken an interest in practical problems on farms and in diverse environments all over the state. The University of Wisconsin has distinguished itself on many campuses in soil science, at Madison, Stevens Point, River Falls, Platteville and others.

In the "dust bowl" days of the 1930s the entire nation was caught up in concern about soil erosion (Debailleul,1990; Johnson,1991; Lapham, 1949). As long as farm folk were in desperate straits, intrusion of government into the lives of private landowners was welcome. But elimination of abuse of soil seemed unattainable. Time and again emphasis was shifted from maintaining health of the soil to increasing crop yields and farm income, at the price of soil degradation. "Crop yields register the productivity of an entire agricultural ecosystem composed of soil, plant varieties, density of planting, weed and pest control, irrigation, fertilization, culti-

vation, length of growing period, mode of harvesting, and last but not least, the prevailing weather. In practice, the constellation of growth factors is covering up soil degradation by heightening yields. Soil decline has to be evaluated by field examination of the soil itself, including follow-up work in laboratories and greenhouses. Soils deserve having standing in their own right. Their role is broader than producing food...Soils maintain the water household of a landscape and contribute to aesthetic experience (Jenny,1984b)." Jenny suggested that crops be bred to have higher contents of carbohydrates in the root systems in order to feed the soil. Wes Jackson's goal is to have permanent fields of mixtures of grains and legumes that are perennial (Jackson,1980; Jackson et al, 1984).

The soil survey of the fifty states will be done by the year 2,000, if progress goes according to plan. With all the new knowledge accumulated by soil scientists, including field research data, we the people can be ready to care for the soil. In the past only about half of the farmers requested conservation plans and about half of them carried out the plans (Jenny,1984b). A detailed audit of each parcel of land could be made regularly to determine the state of health of each soil body, and to take appropriate action or inaction. A soil body on the land is as important as a furnace or refrigerator in the house. The soil has no vote nor voice but ours. Who will speak for the dumb acres? Wisconsin soils are not in danger of being flooded by the sea, as Dutch soils are, but our soils are in danger of steady washing toward the sea. Many of our farmers have improved erosion control since the dust bowl days. In response to economic incentives to protect soils, between 1985 and 1988 soil erosion in this country decreased by a third(Myers,1994). But the rate of soil erosion in the United States is still

on the order of one hundred times the rate it was and is in some undisturbed ecosystems and under certain rotations on farms(Jenny, 1984b).

In 1928 Glenn Frank, then president of this University at Madison, wrote that "conservation will involve a sweeping reform of the American mind (Beatty, 1991)." Sam Rayburn said, in the 1950s, that "the greatest domestic problem facing our country is saving our soil and water." (Young, 1956). In 1990 C.M.Woodruff of the University of Missouri wrote: "Farmers today are little better off than they were in the depths of the depression when average corn yields were never in excess of the 30-bushel category. The primary benefits of high crop yields have been the support of an agribusiness industry providing farmers with fertilizers, seed, herbicides, insecticides, machinery and huge tractors that leave no room for operators of small farms." Albert Gore, Jr. wrote:"We must make the rescue of the environment the central organizing principle for civilization."(Gore,1992) Prior to the Rio summit a group at congressional hearings called for a change in U.S. national policy "to ease ..the burdens on our biosphere and their effect upon the planet's people (Weiskel and Gray, 1992)." We can add: "and their effect on the planet's soils."

The Scriptures assure us that not one sparrow falls to the ground unnoticed by the Divine. I suggest that erosion of any crumb or grain of soil does not escape the notice of the Divine, to use Biblical language. We are going to pay more for food and fiber in the future as a result of honest book-keeping that takes into account hidden costs and that reports actual cost of health maintenace for our soils. Why not pay <u>now</u> for preservation and restoration of good agricultural and silvicultural soils, rescuing them from degradation and from

urban sprawl, rather than wait until good land is more scarce and more damaged.

WHAT CAN EACH OF US DO?

We can practice the enjoyment of the earth beneath our feet. Let us together build a ground swell of affection for and an understanding of the earth that supports us and other land life. By being conspicuous friends of the soil(as well as of birds, trees and grasses) we will help make it unthinkable and unacceptable that soils of our landscapes will be abused any longer.

The poet Walt Whitman said:"The press of my foot to the earth springs a hundred affections." Then he went on to say about those affections: "They scorn the best I can do to relate them." The poet confesses that the beauty of the touch of the foot to earth is indescribable.

I have thought that music by Johann Sebastian Bach (1685-1750) might be able to catch in a net of melody those "affections" that Whitman could not catch with words. In my experiments with some lines of violin music (see Bach,1740?) I have identified three melodies: 1)The walker's melody, describing the delight with which the walker moves;2) the environment's melody, describing the beauty of the landscape being traversed; and 3) the lowest line that I call the feet-melody, that may sound monotonous alone, but which gives power to the whole piece, when all three lines are played together as Bach intended.

I submit that our most repeated interaction with the earth is in walking on it. I think that the trust that a child feels in early years comes in no small measure from the support that the child receives from the ground

on which it walks. A child just learning to walk on a grassy lawn or on a living room rug follows an adventurous pattern. It is a matter of stagger, step and fall. The ground, be it lawn or carpeted floor, is always there ready to support the next try. We have inherited the sensitivity of the soles of our feet from remote ancestors who trod on forest floors, across grasslands, along foot paths and on beaches and rock ledges. Even if we are city dwellers, we bring our sensitive feet, with or without shoes, into contact with a substratum which supports our walking,skipping, running, jogging.. our dancing. Even we urbanites can practice imagining that we walk on well-grassed paths and firm sand beaches as we do our daily errands down corridors and sidewalks. The main thing is not to censor from our consciousnesses the rhythmic beat of those feet. We may let the affection-filled soles of the feet enjoy the clapping of foot and cordial ground in celebration of life. Our foot soles were especially made for that.

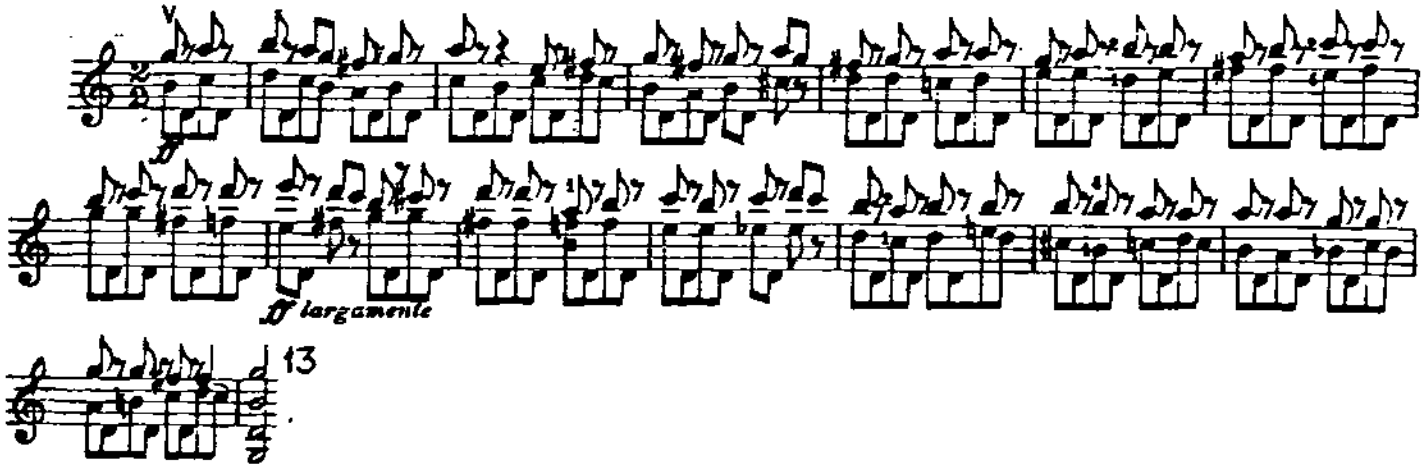
In closing, I offer a poem, which is an adaptation of lines to the Shaker song:"Simple Gifts:"

> 'Tis a gift to have soil; 'tis a gift to have land;
> 'Tis a gift to belong to the place whereon we stand.
> And if we are contented with the work that we are doing,
> We've discovered a community that's energy-renewing.
> When true community is gained,
> To bow and to bend we will not be ashamed;
> To turn and to turn will be our delight,
> 'till by turning, turning we come 'round right.
>
> (Hole,1985)

I have reached the end of this essay. Before I sit down I will call out through the window pane to the Virgil silt loam that has been supporting us this afternoon, "Virgil! Thanks for being there for us!"

LITERATURE CITED

Bach, Johann Sebastian, 1740?. Fuga, Sonata V. Violin Solo.



Baxter,F.P. and F.D.Hole, 1967. Ant (Formica cinerea) pedoturbations in a prairie soil. Soil Sci.Soc.Am.Proc.31:425-428.

Beatty,M.T.,1991. Soil science at the University of Wisconsin-Madison. A history of the Department, 1889-1989.

Buol,S.W.,F.D.Hole and R.J.McCracken,1989. Soil genesis and classification (3rd ed.).Iowa State Univ.Press, Ames.

Butzer, Karl W.,(Guest Ed.),1992. The Americas before and after 1492: current geographical research. Annals of the Ass. of Am. Geographers. 82(3):343-565.

Carroll,P.H.,1969.Soil-dwelling termites in the southwest region of the Ivory Coast.Soil Survey Horizons.10:3-16.

Chamberlin,T.C.,1883. Geology of Wisconsin. The Commissioners of Public Printing. 4 vols.

Crawford, Celestine, 1977. Femininity and soil survey. Soil Survey Horizons. 18(3):17-18.

Cronon, William, 1983. Changes in the land:Indians, colonists and the ecology of New England. Hill and Wang.

Crosby, Alfred W.,Jr.,1986. Ecological imperialism: the biological expansion of Europe, 900-1900. Cambridge University press.

Curtis,J.T.,1959. The vegetation of Wisconsin. University of Wisconsin Press.

Debailleul, Guy,1990. Evolution of soil conservation policies since World War II:Lessons for Canada.Canad.J. of Agric. Economics. 38:757-769.

Dokuchaev,V.V.,1883. Russian chermozem.Israel Prog.Sci.Trans., Jerusalem. 1967.

Farb,Peter, 1960. The living earth. Harper.

Foth,H.D., 1978. Fundamentals of soil science.Wiley and Sons.

Glocker,C.L. and R.A.Patzer,1978. Soil survey of Dane County, Wis. Soil Conservation Service, U.S.D.A.,Gov.Printing Office, Washington, D.C.

Gore,Albert,Jr.,1992. Earth in balance: ecology and the human spirit. Boston: Houghton and Mifflin.

Harpstead, Milo L,Francis D. Hole and William F.Bennett,1988. Soil Science Simplified. Iowa State University Press, Ames.

Helmers, Marguerite H., 1993. Creating the California alps. Trans. Wis. Academy of Sciences,Arts and Letters.81:65-78.

Hilgard,E.W.,1860. Report on the geology and agriculture of the state of Mississippi. Jackson, Miss.

---------- 1884. Report on cotton production in the U.S.A., also embracing agricultural and physico-geographic descriptions of several cotton states and of California. Tenth Census of the U.S.(1880).Vol.5 and Vol.6,U.S.Census Office.

Hillel, Daniel J.,1991. Out of the Earth. MacMillan.

Hole,Francis D., 1981. Effects of animals on soils.Geoderma. 25:75-112.

---------- 1976. Soils of Wisconsin. Univ.of Wis.Press.

---------- 1985. Some soil songs.Friends Press, Madison,Wis.

----------1992. A friend of the soil. The Land Report. 43:12-15. The Land Institute, Salina, KS.

Hole, Francis D. and James B. Campbell, 1985. Soil landscape analysis. Rowan and Allanheld, New Jersey,

Jackson, Wes, Wendell Berry and Bruce Colman (eds),1984. Meeting the expectations of the land; essays in sustainable agriculture and stewardship. North Point Press, San Francisco.

Jackson,Wes, 1980. New roots for agriculture. University of Nebraska Press.

Jenkins,J.W.,1991. A centennial history; The College of Agricultural and Life Sciences at the University of Wisconsin-Madison.

Jenny,Hans, 1941. Factors of soil formation. McGraw Hill.

---------- 1961. E.W.Hilgard and the birth of modern soil Science. Agrichimica, 3, Pisa, Italy.

---------- 1968. The image of soil in landscape art, old and new. Pont.Acad. Sci.Scripta Var. 32:948-979.

---------- 1980. The soil resource: origin and behavior. Springer-Verlag.

---------- 1984a. My friend the soil. J.Soil and Water Conservation. 39:158-161.

---------- 1984b. The making and unmaking of a fertile soil. In: Wes Jackson, Wendell Berry and Bruce Colman (Eds): Meeting the expectations of the land: Essays in sustainable agriculture and stewardship, North Point Press, San Francisco: 42-55.

Johnson, Leonard C.,1991. Soil conservation in Wisconsin: birth to rebirth. Madison,Wis.

King, F.H.,1911. Farmers for forty centuries. Democratic Printing Co., Madison, Wis.

Lapham, Macy H.,1949. Criss-cross trails.Narrative of a soil surveyor. W.E.Berg. Berkeley,CA.

Leverett, Frank,1929. Moraines and shorelines of the Lake Superior Basin.Prof.Paper 154A.U.S.Geological Survey.(also, see Winters.)

Myers , Norman, 1994. What ails the globe? International Wildlife. 24(2):34- 41.

Milfred,Clarence J., Gerald W.Olson,Francis D. Hole, F.P. Baxter and F.G.Goff, W.A.Creed and Forest Stearns,1967. Soil resources and forest ecology of Menominee County,Wisconsin. Bull.85,Soil Series 60, Wis.Geological and Natural History Survey,University of Wisconsin-Madison.

Munsell Color Company, 1954. Munsell soil color charts. Munsell Color Co.,Inc., Baltimore, MD.

Pittman, Walter E.,Jr.,1981. Eugene W. Hilgard and scientific education in Mississippi. Soil Survey Horizons.27:12-20.

Pointing, Olive, 1991. A green history of the world. London. Sinclair-Stevenson, Ltd.

Rayburn,Sam,1956, On conservation. From Valton J.Young,"The Speaker's Agent."

Schultz, Arnold, 1992.In memory of Hans Jenny. The Land Report. 43:9-10. The Land Institute, Salina, KS.

Smith,Myron L.,J.N.Bruhn and J.N.Anderson,1992. The fungus Armillaria bulbosa is among the largest and oldest living organisms. Nature. 356:428-431.

Stephens, Floyd G.,1982. Soil survey of Tulane County,CA, central part. U.S.D.A., Soil Conservation Service, Gov. Printing Office,Washington, D.C.

Weiskel,T.C. and R.A.Gray,1992. Environmental decline and public policy. The Pierian Press.

Whitman, Walt, 1892, Leaves of grass.

Winters, Harold A.,et al, 1978. Frank Leverett: Some insights based on his field notes and correspondence. Ann.Meeting, North Central Sec.,Geol.Soc.Amer., Ann Arbor, Michigan.

----------, 1980. Frank Leverett, Michigan's Master Geologist. Mich. History. 64(1): 11-13.

----------, 1981. Frank Leverett:Pleistocene scholar and field worker. Jr. Geological Education. 29:222-227.

Woodruff,C.M.,1990. A history of the Department of Soils and soil science at the University of Missouri. Spec.Report 413, College of Agric.,University of Missouri, Columbia.

Yaalon ,Dan H.,1993. Soil science in the eyes of the beholder; Better understanding of soil processes and of pedology urged. Bull. of the International Soil Science Society. No.84:13-14.

Young, Valton J.,1956. On conservation.(Papers of the Speaker's Agent. The House of Representatives.) Washington, D.C.

Zinke, Paul J. and Robert L.Crocker,1962. The influence of giant Sequoia on soil properites. Forest Science.8:2-11.