# The Living Soil-Absorbing Shock The Natural Way

*By Eliot C. Roberts and Fred V. Grau*

***Sports turf, more than any other type of turf, needs to be managed with consideration of the condition of the soil and the roots growing in that soil.***

The best plays in sports—like a leaping catch in baseball or football or a diving header in soccer—depend upon the skill of the player and the turf under his feet. Amateur and professional athletes soon learn to judge the hardness of fields they play on. One unforgiving collision with poor turf and promising careers can abruptly come to an end.

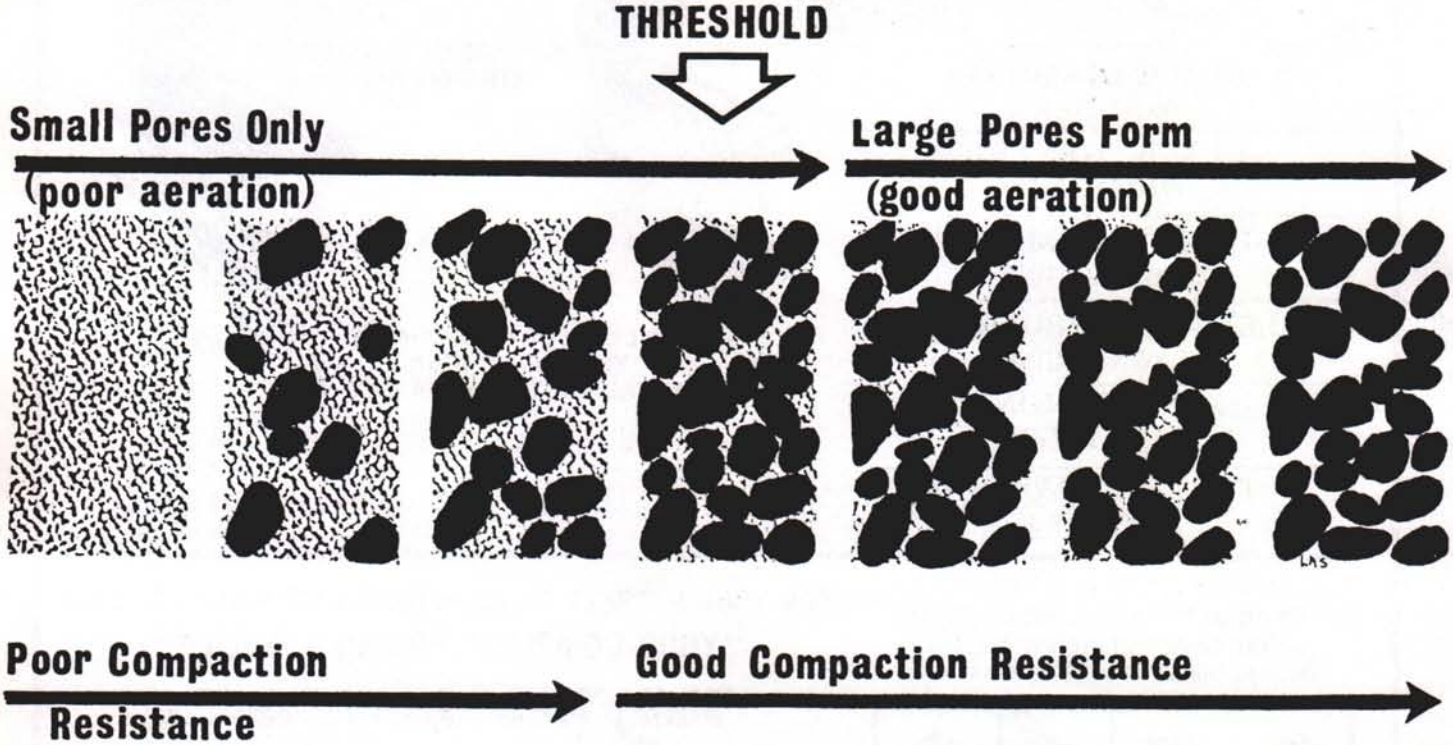
The athlete who is likely to come in contact with the ground should be able to expect a good dense turf to serve as a shock absorber. It's important for everyone who manages sports turf to understand what makes turf and soil absorb shock well.

Sports turf soils need to be firm to provide stable footing. Soft and spongy soils may be great to fall on, but they are dangerous when an athlete is required to change directions quickly.

Let's not forget that the turf takes a beating too. Turfgrasses used for sports surfaces are subjected to the harshest of growing conditions. The physical wear of the sport on the turf is damaging and limits the persistence of the turfgrass plant. Seldom is there adequate time between practices and games to allow for recovery of the turf.

Furthermore, athletic activity compacts soils even under the most favorable conditions. With field use, the soil structure begins to collapse and the healthy relationship among soil, air and moisture is disrupted. Poorer soil restricts root growth and plants are weakened as a result.

We make matters worse at times by close clipping. Such mowing practices may give fields a well-groomed appearance, but they



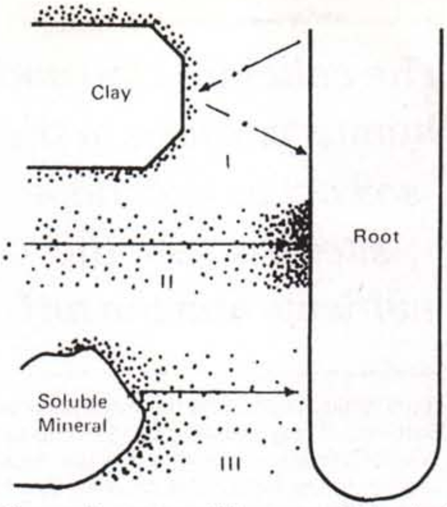

**Soil organisms help particles in the soil combine with other particles to improve drainage and relieve compaction.**

restrict root penetration into the soil and place the turf in a highly vulnerable position where recovery from injury is most difficult.

Sports turf, more than any other type of turf, needs to be managed with constant consideration to the condition of the soil and the roots growing in that soil. Any practice that amends the soil for optimum root growth should be employed. Failure to manage the turf below the surface is frequently the cause for turf failure above the surface.

A variety of mechanical and chemical techniques are commonly-used to improve the condition of sports turf root zones. But there is one major factor in soil management that is frequently overlooked by sports turf managers—those organisms living in the soil. These micro- (very small) and macro- (small) organisms contribute to the shock absorbing characteristics of sports turf. Since they are so small and hidden within the soil, we seldom remember they are there. In fact, they are so important, we should make a major effort to promote their general welfare.

These organisms were here on earth long before man. Billions of years ago, three and a half billion according to experts, micro-organisms like these played a major role in the development of our oceans, the atmosphere around the earth and the eventual formation of our soil. Working in conjunction with physical, chemical and other




**Clay and humus particles are a vital part of nutrient exchange and help buffer chemical reactions between the roots and nutrients.**

biological processes, micro-organisms helped break down native rock into soil. Since they were working with different types of rock and in different climates, not all soils are alike. Some soils are much older than others. One observation on soil formation is very clear: those soils that are most productive agriculturally were formed under grassland conditions and are high in organic matter and very active biologically.

These native soils can support sports fields under restricted use. Since restricting field use is frequently not practical, there is a trend in athletic field construction to increase the sand content of soils to a point that resists compaction and increases internal drainage. This, in turn, improves root penetration.

These amended, or artificial root zones, are especially favorable for sports turf. However, changing the soil disrupts many natural soil functions and processes. For example, replacing a portion of the soil with sand also changes the content of colloidal clay and humus of the root zone. These very small, surface-active particles are important sites for chemical and biological reactions. They also store water and chemicals needed for plant growth. By reducing their number, you effectively reduce the exchange capacity (cation and anion) of the soil.

**Up-To-Date Root Zones**. Realistically, we don't even need soil to grow turfgrasses. They can be cultured in solution or sand so that all essential nutrients along with oxygen can be supplied in dissolved form through the roots. Some sports fields have such a high sand content that they come close to qualifying as a hydroponics system.

However, these root zones also change over time. As roots develop and enter continuous cycles of growth and decomposition, organic matter accumulates within the root zone encouraging the establishment of populations of micro-organisms and

*continued on page 28*

**The Living Soil**
*continued from page 27*

macro-organisms. These populations may be quite different from those found in natural soils with much lower sand content.

The value of these organisms as shock absorbers may well be much less in this instance since the hydroponic systems are dominated by chemical reactions. In addition, they are not well buffered and may change rapidly over time.

Striking evidence of this lies in the fact that turf fertilization in hydroponic systems requires direct application of nutrients in amounts required to meet plant needs. In natural soils, we indirectly fertilize the turf by fertilizing the soil. The colloidal clay and humus particles in the soil act as exchange sites between the nutrients and the turf. These particles also act as buffers between the fertilizer and the turf.

Sports turf grown on natural soil is rooted into a medium that is usually highly buffered. Plant nutrients and all sorts of compounds within the soil system (both beneficial and harmful) are made more or less available to grass roots by the soil colloids. The colloids and the micro-organisms act as chemical shock absorbers to the turfgrass plant.

It's sometimes difficult to think of soil as a combination of small particles. We can easily see and understand soil components such as stone, gravel, and coarse sand. It's

***The colloidal clay and humus particles in the soil act as exchange sites between the nutrients and the turf.***

more difficult to picture the much smaller particles of clay, silt, and sand contained in soil. Clays are so small that they are measured in minute units called microns. Sands and silt are slightly larger and measured in tiny units called millimeters (one millimeter is one thousanth of a meter). Coarse sands are nearly 40 times larger than fine sands. Silts range in size between fine sands and clay particles.

Since we seldom deal with particles this small, it is necessary to compare sand, silt, and clay sizes with some things we are familiar with in order to picture their size. If we could enlarge a particle of medium sand to the size of the White House in Washington, DC, then a silt particle would be about the size of the President's limousine and a clay particle would be about the size of an orange the President is eating while riding to the Capital.

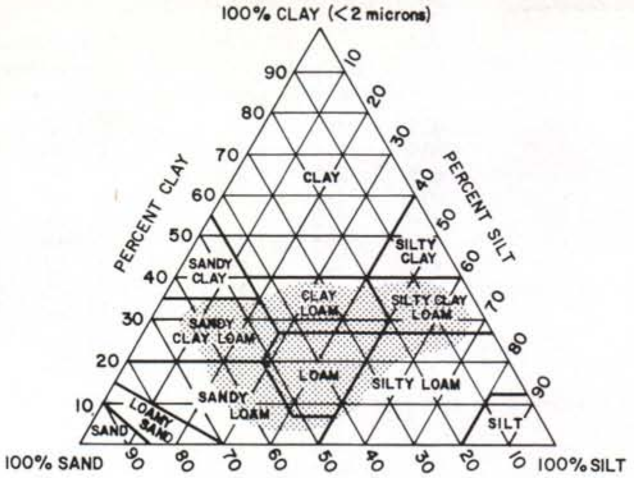
With particles this small, there are very many of them in the soil. For example, a pound of medium sand contains about 2.5 million particles, while a pound of silt will contain more than 2.5 billion particles and a pound of clay will contain over 40 trillion particles. Despite their small size, the surface area of the particles is large. A pound of sand has a total surface area of 20 square feet. A pound of silt has 220 square feet of surface area and a pound of clay would have 5,500 square feet.

Now, if you think a clay particle is small compared to a particle of sand, consider how small a molecule of water is compared to a clay particle. If you emptied the contents from a two liter bottle and filled it with sea water, and if you could tag each molecule of water in the bottle and then pour the water back into the ocean, once that water was equally distributed the world over, two liters of water from any sea would contain about 30,000 tagged water molecules.

Despite the small size of many soil particles and water molecules, there are huge numbers of them in the soil and they have a very large surface area. The greater the surface area, the more activity can take place on these surfaces. It is this high surface activity combined with living organisms in the soil that make soil a living, dynamic system than can serve as a shock absorber for sports turf.






**Soils are classified by the amount of sand, silt and clay they contain. The shaded area represents soil preferred for sports turf.**

Large numbers are not limited to soil particles, micro-organisms and molecules. There are some 35 million grass plants per acre. One single grass plant can produce 375 miles of roots that have a surface area of roughly 2,500 square feet.

Putting it all together, sports turf culture involves large numbers of plants with the potential for extensive root contact with soil particles, nutrients and organisms that are all part of the most amazing system ever created or devised.

**Soil Organism Benefits**. Natural processes in the soil convert organic matter (dead leaves, roots, insects, manure, etc.) into humus. Humus is colloidal in nature, meaning it tends to form and stabilize clumps or aggregates of soil. These aggregates are essential to holding and exchanging nutrients for plant growth.

As organic matter decomposes, a variety of products and by-products result, including cellulose, starches, sugars, oils and fats. In addition to undecomposed residues, there may also be proteins, amino acids and lignin. These are attacked by the micro-organisms living in the soil. The micro-organisms utilize what they can and release carbon dioxide, water, some alcohols and organic acids. They may also release unutilized ammonia for conversion to nitrate, a source of nitrogen used by turfgrasses.

Nitrogen is required for decomposition of organic matter to occur. For this reason, some forms of organic matter decompose more rapidly than others. If sufficient nitrogen is lacking, a supplemental application of nitrogen must be made for decomposition to continue. This is the reason fertilizer is added to compost piles. Without enough nitrogen, organic matter may remain undecomposed or it may rob nitrogen from soil reserves needed for turfgrass growth.

Populations of micro-organisms vary considerably in the soil. High populations are favored by adequate moisture, warm temperatures and the presence of organic matter. Localized dry spots, cool temperatures and low organic matter levels discourage these organisms. Population changes can take place quickly as conditions become more or less favorable.

A good sports field soil should contain billions of micro-organisms per pound. Even high sand fields contain beneficial micro-organisms, although not as many as organic soils. Beside their value to soil health while living, they also release nutrients back to the soil as they die. These nutrients include significant quantities of nitrogen, phosphorus, and potassium, in addition to small quantities of calcium, magnesium and sulfur.

**Macro-Organisms**. Many small animals occupy the root zones of sports turf and contribute to the living nature of the soil. Each acre of turf contains millions of insects, spiders, mites, nematodes and other creatures. Earthworms are perhaps the best known of all soil macro-organisms. Depending upon how favorable soil conditions are, there may be as many as 70,000 earthworms per 1,000 square feet.

*continued on page 30*

**Average Contents and Moisture Retention Values for Various Soil Types**

| *Soil Type* | *Sand* | *Silt* | *Clay* | *Available Moisture* |
|---|---|---|---|---|
| | *% by weight* | | | *% by volume* |
| Sand | 92.5 | 5.4 | 2.1 | 4.0 |
| Loamy sand | 80.5 | 15.4 | 4.1 | 7.5 |
| Sandy loam | 61.1 | 28.0 | 10.9 | 13.1 |
| Loam | 40.0 | 41.2 | 18.8 | 13.4 |
| Silt loam | 19.6 | 61.3 | 19.1 | 17.9 |
| Silt | 3.4 | 89.3 | 7.3 | 21.1 |
| Sandy clay loam | 57.1 | 19.6 | 23.3 | 10.4 |
| Clay loam | 26.8 | 41.9 | 31.3 | 11.5 |
| Silty clay loam | 11.3 | 56.5 | 32.2 | 14.5 |
| Silty clay | 6.5 | 47.3 | 46.2 | 12.1 |
| Clay | 10.2 | 31.0 | 58.8 | 11.0 |

## The Living Soil

*continued from page 29*

In a year's time, earthworms may deposit as much as 40 pounds of soil in their casts on the surface for each 1,000 square feet of root zone. These casts are greatly enriched in comparison with the surrounding soil. For example, the nitrate content of casts can be three times greater than the surrounding soil. The phosphorus content is frequently six times greater and the potassium content ten times greater. These increases in plant nutrients are a result of the digestion processes of the worm.

**Shock Absorption**. Sports turfgrasses are living plants subjected to harsh growing conditions most of the time. Without the assistance of the organisms living in the soil, the physical and chemical processes taking place there can change little to accomodate the stress of unfavorable conditions imposed on the grass, particularly its roots. It is the living organisms in the soil that share the good times with the bad with turfgrass roots. They work together to make things better for each other.

Basically, the turf generates roots. These live a short time and die off only to form more roots. The dead roots serve as a source of food for soil organisms which, in turn, release nutrients and improve the physical condition of the soil by producing humus and related products.

Since both roots and soil organisms are alive, they compete with one another for space, moisture and nutrients. This struggle can be harmful when population imbalances occur. But most of the time, they cooexist extremely well. The net result is a buffering of soil reactions so that there is less damage from the extremes of too much or too little anything.

Excessive fertilizer in the root zone can be utilized by soil organisms protecting the roots from fertilizer shock. Soil organisms also break down pesticide residues to cancel out their pesticidal properties when they are no longer needed.

By their activity, soil organisms help in the formation of granules and improve soil structure. They cannot substitute for mechanical soil cultivation, aeration and coring. But they do help stabilize improved soil structure following these mechanical operations.

**Soil Component Characteristics Defined by the USDA**

| *Soil Separate* | *Particle Diameter mm* | *Number of Particles/Gm* |
|---|---|---|
| Very coarse sand | 2.00-1.00 | 90 |
| Coarse sand | 1.00-0.50 | 722 |
| Medium sand | 0.50-0.25 | 5,777 |
| Fine sand | 0.25-0.10 | 46,213 |
| Very fine sand | 0.10-0.05 | 722,074 |
| Silt | 0.05-0.002 | 5,776,674 |
| Clay | under 0.002 | 90,260,853,860 |

Soil moisture relationships can also be improved by soil organisms. By decomposing organic matter they create substances that increase the moisture holding capacity of the soil as well as improve aeration. They are not likely, however, to improve moisture conditions in hydrophobic (hard to wet) soils since this problem is caused by fungi rather than the physical condition of the soil.

These benefits to sports turf come about as positive means for lessening the stress of the game on the grasses involved. The shock of physical injury to the grass is reduced. The shock of soil compaction on air and moisture requirements of roots is lessened. And the shock of misapplication of chemicals (either too much or too little) is cut.

**Taking Care of Organisms**. Sports turf management has come a long way in the past 20 years—perhaps out of necessity. The tremendous use on athletic fields and golf courses has forced the turf manager to apply all available technology to help turf withstand wear-related injuries. In our rush to find solutions to field problems we must make certain that we meet the needs not only of the turfgrass, but also the needs of soil organisms associated with grass roots.

We suggest that sports turf managers consider a number of adjustments to their current maintenance program to improve the health of the organisms living in the root zone of their turf. Incorporating these changes will provide the shock absorption needed by today's sports turf.

**Soil Mixtures**. Root zones for sport turf should be constructed to contain sufficient clay and organic matter to create a favorable cation and anion exchange capacity for grass growth. No set specifications can be made that will satisfy all conditions. Physical testing of soils and soil amendments is necessary to prescribe the right soil mix. Such a mix will not only promote grass growth, it will also favor the activity of soil organisms.

**Topdressing**. Material used for topdressing must be of the same texture as that of the root zone. Any variation from this in terms of higher silt and clay content could be disastrous. Sand topdressing is used under some conditions with satisfactory results. However, for best microbial activity select material exactly the same as the root zone.

**Biological Activators**. Some topdressing materials are formulated with biological activators. These contain organic substances that are conducive to the population growth of soil microbes. Some contain cultures of specific organisms.

A good healthy sports turf soil will not require biological activators and little benefit should be expected from their use. A poor sports turf may benefit from treatment with these activators, however. The critical factor is the amount of root growth. Where roots are inactive and organic matter content of the soil is low, activators seldom do much good. When applications of the activator are timed so that roots are still active and organic matter is still readily available for decomposition, benefits are more frequently noted.

*Slow-release natural and synthetic organic fertilizers best meet the needs of both turfgrasses and soil organisms.*

**Pest Control**. Insecticides, fungicides and herbicides are essential in the culture of heavily used sports turf. "Organic" methods of turf management will *not* make turf sufficiently resistant to insects, diseases and weeds to eliminate the use of pesticides. Do not exceed the rates and frequency of application that are recommended by the manufacturer. Also apply pesticides at the proper time to achieve the best results. When this is done, injury to turfgrasses and soil organisms will be minimal.

**Fertilization**. Slow-release natural and synthetic organic fertilizers best meet the needs of both turfgrasses and soil organisms. These are subject to decomposition by soil microbes. Other fertilizers used in sports turf fertilization should be applied in such ways that they duplicate the the slow nutrient release properties of natural and synthetic organics. This may involve use of sulfur-coated urea or IBDU. It may mean frequent applications of urea or methylene ureas or inorganic materials in relatively small amounts. Most importantly, it means reducing nitrogen applications during stress periods and ocassionally utilizing iron, either as chelates or other turf formulations, instead of nitrogen to maintain turf color and vigor.

**Wetting Agents and Irrigation**. Soils that do not wet uniformly cannot support either a healthy, vigorous turf or an active population of soil organisms. Regular use of nonionic surfactants is advised.

Rainfall is seldom adequate for meeting the water requirements of sports turf. Although some fields are overwatered, many others dry down too far because of inadequate irrigation systems. Irrigation schedules should be programmed to prevent excessive dry down while avoiding constantly-wet conditions. Soils probes or moisture meters can be utilized to determine the necessary frequency and depth or irrigation for each field. Take factors such as shade, wind and weather into consideration and check and adjust system operation frequently. You want to apply water in such a way as to encourage deep root penetration.

*continued on page 32*

**The Living Soil**
*continued from page 31*

**Aerification**. Sports fields are always prone to compaction regardless of the soil mixture used. This means that regular aerification or coring is necessary. Spiking may also be needed on a frequent basis to loosen up surface compaction. Both grass roots and soil organisms require oxygen and release carbon dioxide. Neither can survive in compacted soil.

**Mowing**. In sports turf, the grass roots are the source of organic matter that conditions the soil and makes it a living, dynamic system. Close mowing restricts root growth and reduces the amount of soil organic matter that is available for soil microorganisms. Mow sports turf as high as the play of the game will allow. Even a small increase in leaf length will help make a sturdier grass plant by increasing carbohydrate production for use in root growth.

**Seeding**. As grass plants wear out, they must be replaced by new plants. The frequent seeding of sports fields is necessary in order to introduce new plant life. Use seed that germinates quickly and produces seedlings of high vigor such as the new turf-type perennial ryegrasses. Fine fescues, Kentucky bluegrasses and turf-type tall fescues are also used for sports fields. New improved grasses that have increased disease and insect resistance, enough vigor to heal injuries fast and crowd out seedling weeds are highly recommended.

**Conclusion**. Scientific information on soil micro- and macro-biology is much more extensive than many people realize. In 1955, Dr. William Albrecht of the University of Missouri published a paper entitled "The Living Soil" in *The Golf Course Reporter*. Thirty-three years later the subject is still very much alive. A one-day seminar entitled "The Biology of Turfgrass Soils" will be presented at the Golf Course Superintendents Association of America Convention in Houston, TX, in February 1988.

There is no doubt that soil microbiology and biochemistry are complicated subjects. Despite the wealth of information on the subject, only limited discussion of soil microbiolgy is found in the trade journals or in the programs of leading turf conferences across the country. Clearly it is a difficult subject to learn. Nevertheless, it is very important for sports turf managers to have a grasp of the fundamentals to protect the beneficial organisms and the roots below the surface of our valuable sports turf.

We must keep in mind that sports turfgrasses are living plants subjected to harsh growing conditions most of the time. Without the assistance of the organisms living in the soil, the physical and chemical processes taking place there can change little to accomodate the stress of unfavorable conditions imposed on the grass, particularly its roots. It is the living organisms in the soil that share the good times with the bad with turfgrass roots. They work together to make things better for each other.