YOU CAN'T FIGHT NATURE

BY GUY LONGSHAW

Greenkeepers are increasingly looking at ways to improve the quality of turf surfaces in a time of increasing demand from golfers while at the same time attempting to reduce the use of chemical fertilisers and pesticides

They have moved away from the heavy feeding and watering which has in the past produced "Poa puddings" and are now using more efficient and frequent aeration, top-dressings and trying to be more sparing with fertilisers and irrigation water.

Reducing pesticides

Many greenkeepers are keen to reduce pesticide use for a variety of reasons, pressure from the environmental lobby, cost, inconvenience of dealing with hazardous chemicals and increasingly because of the realisation that fungicides kill beneficial soil micro-organisms as well as the pathogens (disease-causing fungi) they are intended for.

What greenkeepers are often battling against, particularly in the case of older soil based greens, is an imbalance between the processes of "production" of new grass and "decomposition" of dead grass. See fig l.

Compaction, poor surface drainage and the use of fungicides can all reduce beneficial soil bacteria and fungi, thereby reducing the amount of natural decomposition occurring in the rootzone. Fertilisers are used to increase growth, so it is easy for an imbalance to occur, with dead organic matter (thatch and/or soil organic matter) tending to accumulate in the greens.

Vicious cycle

The greens can then get stuck in a vicious cycle which is difficult to break. The turf environment favours diseases such as fusarium, so fungicides are regularly needed which also kill off beneficial bacteria and fungi and upset the relationship between microbial decomposition and plant growth.

Symbio began working on ways to address this imbalance in sports turf in the UK in l 990 but the development story begins way before this in the early 1980s with a team of scientists working with the French Ministry of Agriculture. The way of thinking behind their research, has been adopted by greenkeepers in several situations.

Mediterranean "sewer"

The original team was looking at pollution in the Mediterranean and began research to investigate the natural processes of decomposition of the pollutants.The plan was as follows:

1. To identify the species of micro-organisms responsible for breaking down the various organic substances and to culture and refine these strains.
2. To deliberately introduce these strains into to the waste treatment plants to boost their efficiency and improve effluent quality.

Stage 1 was very successful but Stage 2 led to what could be described as an "environmental problem". The introduced bacteria had problems with their new environment insufficient or variable aeration, fluctuations in nutrient levels, difficult pH conditions and if that wasn't enough – toxic chemicals entering the system which were added to control pathogenic microbes.

If you are beginning to wonder what this has to do with greenkeeping think of fig. 1 as a chart showing just some of the "environmental factors" affecting bacteria and fungi in a rootzone.

"Biofixation"

The research team then began looking at ways of protecting their "bugs" in this hostile environment in the form of various mineral substrates introduced with the micro-organisms under laboratory conditions.

By adapting various naturally occurring minerals the team began producing mineral "carriers" which could protect and enhance the activity of the bugs. By the late 1980s this had lead to the patenting of the process called "Biofixation".

The scientists now had a highly porous honeycomb-like mineral structure and a way of attaching their benefical bacteria and fungi within the internal spaces.

"Superbugs"

The 'Biofixed' micro-organisms had huge advantages over free bacteria and fungi – they were very effective at out-competing 'undesirable' bacteria (such as filamentous bacteria which can cause problems in sewage works); they formed into robust colonies despite harsh environmental conditions; they degraded their "food" more rapidly and, crucially, they could withstand biocides at up to 200 times the concentration sufficient to kill the same "free-floating" bacteria and fungi.

By l988 companies across Europe were being set up to market these "Biofixations" and expand the product development effort.

In 1990 Symbio was launched in the UK at a time when the research had increased to take "Biofixations" into several new areas such as degrading specific industrial wastes, decontaminating urban lakes and ponds, and cleaning up polluted soils.

At this stage, the research team now had a store of industrially useful strains of bacteria and fungi which they were able to "Biofix" and target particular environmental problems. The list of effective strains which they could 'fix' was also growing all the time.

Figure 1

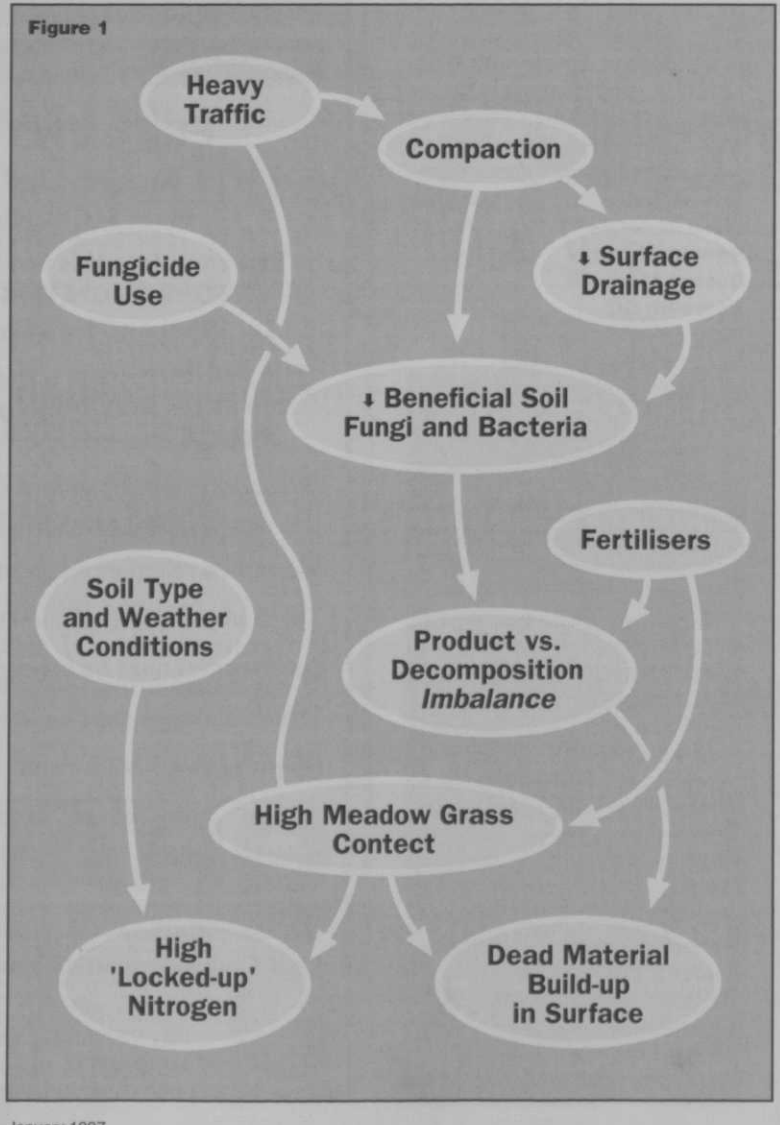
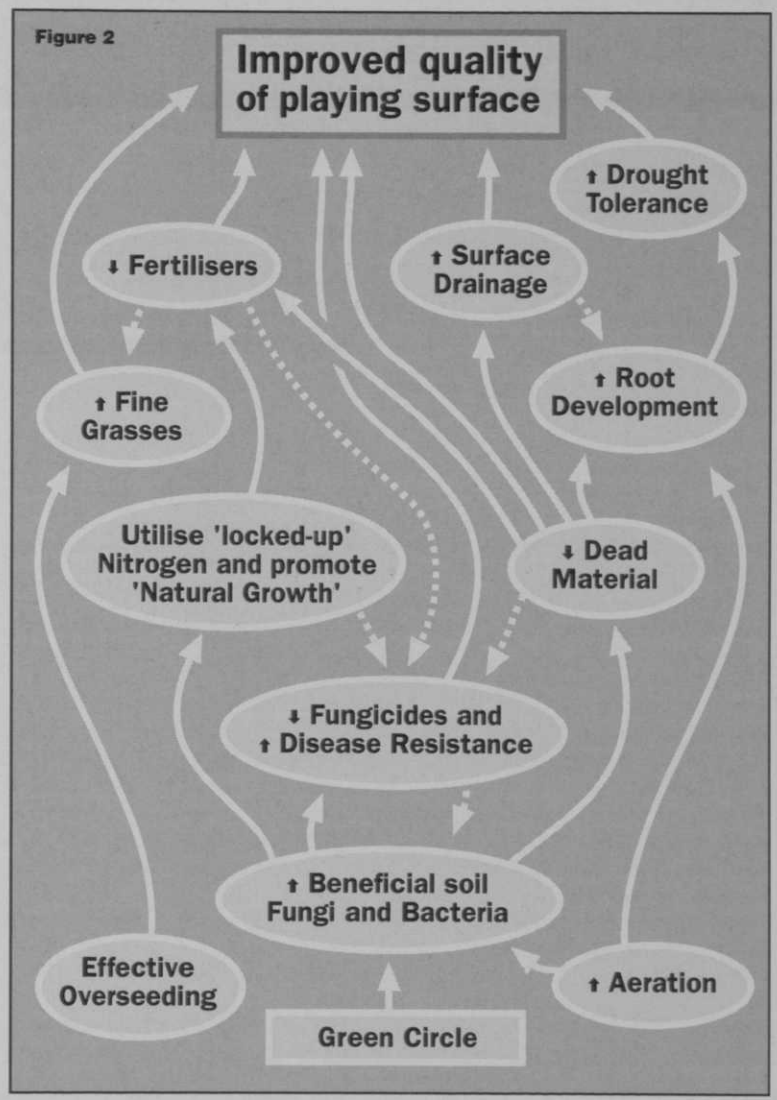


Figure 2



Biological approach

Following field trials in France Symbio was ready in 1992 to launch its "Biological Approach to Sports Turf Management" with the first version of "Green Circle" – a cocktail of microbes chosen for their ability to:

a) Break down cellulose (the main component of thatch) releasing the stored nutrients

b) Break down soil organic matter, releasing this nutrient source

c) Help supply nutrients to plant roots and

d) Compete against and suppress certain disease-causing fungi.

The selected micro-organisms were mixed together with the appropriate starter nutrients and trace elements and were "Biofixed" to protect and enhance their performance in "difficult" environments. Green Circle was originally developed to fit into the greenkeeping scheme of things as outlined in Figure 2.

To follow the diagram began at the bottom. Translate the arrows as "leads to" or "helps with". E.g. increasing soil bacteria and fungi "leads to" reduced dead material, this "leads to" or "helps with" improving root development and increased surface drainage which "help with" improving the playing surface.

The dotted arrows show a kind of "positive feedback" e.g. reducing dead material and "feeding it to the grass", (thereby reducing the requirement for artificial fertiliser inputs) can lead to reduced incidence of disease and therefore reduced fungicide use. Here we have a way of attempting to break the vicious cycle described earlier which can lead to organic matter build-up and fungicide-dependence.

Ongoing product development has produced a range of biofixation products and "bug-boosting" cocktails, and because Symbio was now leading the research and application, manufacturing was moved from France to the UK in February '96.

An "environmental perspective"

What line of thinking made the original research team come up with the idea for the Biofixation process? It can really be best described as an "environmental perspective".

They looked at the environment that they were putting their "bugs" into, decided what "environmental factors" were making life difficult and tried to minimise their effects by protecting their "bugs".

Of course the way to get the best results is to improve the environment which you are putting them into as much as possible, e.g. if they need good aeration, try to improve this, if they need certain trace elements, add these, and if certain chemicals which kill them can be avoided, avoid using them or reduce their use, where possible.

Dr Alan Gange's article 'Getting to the Root of the problem' (*Greenkeeper International*, June) highlights research showing mycorrhizal fungal infection of roots appreciably lower on greens than on neighbouring aprons. At one course he also found a bacterial population 1/4000th of that expected on healthy soils.

What are the "environmental factors" in these rootzones which could be responsible for the observed differences? The list could include: compaction and soil porosity; drainage, aeration and moisture levels; levels of organic matter, cation exchange capacity, pH, levels of iron and other metals, levels of sulphur, soil nutrient status, fungicide use, other trace element levels.

Greenkeepers are already looking at these factors in relation to their known direct effects on grass plants, but as we increasingly accept the reliance of healthy plants on a healthy soil full of microbial life, we are increasingly looking at how these factors and others affect the life in the soil (and thus how they indirectly affect the plants).

Available oxygen

For example adequate aeration is well known to be of crucial importance to both plant roots and beneficial soil micro-organisms. Take the situation of soft thatchy greens on soil rootzones – drainage is slow and the thatch layer easily becomes saturated with water.

The greenkeeper tailors his cultural practices to give maximum available oxygen in this thatch layer so that aerobic (oxygen-requiring) micro-organisms can break down the thatch.

He wants to avoid allowing the "environmental conditions" to develop where anaerobic bacteria take over. (These bacteria function without oxygen, turning available sulphur into hydrogen sulphide and available nitrogen into nitrite. Both of these compounds are toxic to plant roots and to aerobic bacteria.)

So, in addition to aerating and improving drainage to provide as much oxygen as possible, he must also think carefully before adding substances to this environment which themselves require oxygen (i.e reduce its availability) or provide sulphur (e.g sulphate of iron, most fertilisers and organic feeds).

Clearly these substances are vital to greenkeepers, but all products need to be used at the right time and under the right conditions.

"You can't fight nature"

Bacteria were among the first living things to colonise the earth, followed not long after by multi cellular fungi. Plants were on the scene long before the very simplest animals.

Ancient associations are often found in nature in which different organisms cooperate to their mutual benefit (a term called Symbiosis). The relationship between some of the fungi and plant roots explained by Dr Gange in June's *Greenkeeper International* can be so close that the fungi themselves are difficult to study in isolation because they are hard to culture away from their "host" plant.

So, over many millions of years of evolution, certain bacteria, fungi and plants have evolved to benefit one another in soils. Any good greenkeeper will tell you that you can't fight nature – h will always win. If you manage your grass and ignore aspects of its nature (such as what is growing all over its roots and in the surrounding soil it inhabits) you will miss something important and nature will make your job more difficult.

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