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The Future of Earthworm Management on Bowling Greens

Utilising cultural, soil acidification and wetting agent strategies

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This is what we are trying to preserve - worm cast free playing surfaces

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Question?

With Carbendazim registration now revoked and with the use up date of August 31st 2017 now passed, how are we going to try to achieve this with only mainly cultural and soil acidification practices to be able to utilise in the future?

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Managing expectations

The era of having worm cast free playing surfaces could now be at an end!

The problem – for example woods or ball being deflected by casts appearing on surface after rain surface smearing and slippery surfaces

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Worm casting affecting turf maintenance equipment

Maintaining cutting efficiency and accurate heights of cut are virtually impossible with high down time on constant cleaning of equipment and re grinding and sharpening

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Earthworm overview

- There are 25 species of Earthworm found in the UK
- 17 species are non casting therefore beneficial
- 8 species are casting which can create problems in managed amenity and fine turf areas
- Life span depending on species can vary between 4-8 years
- The main casting species are the *Lob Worm*, *Black Headed Worm and Grey Worm*

Worms generally favour slightly alkaline loam based soils containing good levels of organic matter, but are also a considerable problem in sandy loam soils as well such as on bowling greens

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Three common earthworms in the UK

Left is Lob worm (Lumbricus Terrestris) - lives in vertical burrows up to 3 metres deep! feed on fallen leaves and decaying organic matter – such as thatch accumulation. Population approximately 20- 40 per m2

Middle is Black – headed worm (Aporrectodea Longa) lives in open alkaline grassland and cultivated soil, size 12 cm long
and feeds on soil, population approximately 5 – 20 per m2

Right is Grey Earthworm (Apporrectodea Calignosa)
Feeds on soil in mainly arable and pasture land



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Microscolex Phosphoreus Worm

Originated from Argentina first seen in UK in 1899
Exhibits Phosphoresce in the dark when touched
produces very small casts mostly during the day during August and September - favours sandy root zones - Greens

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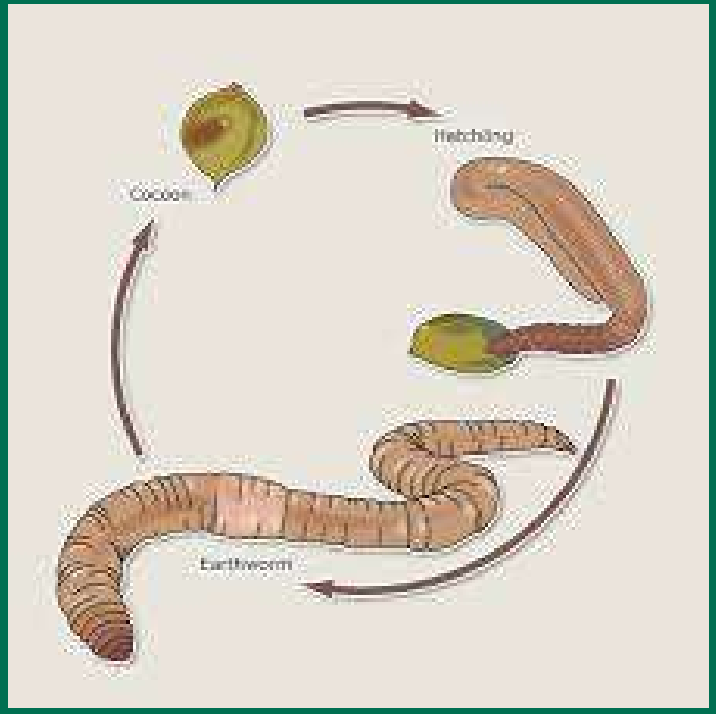
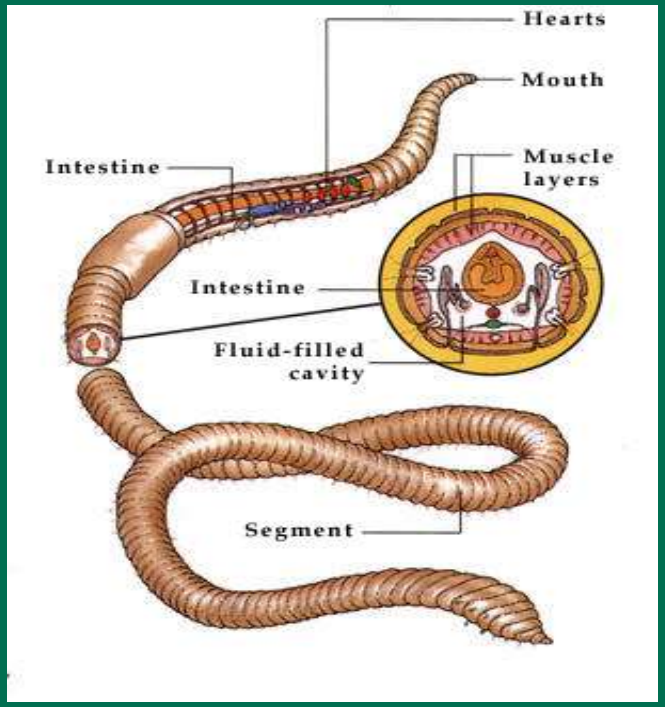
Life cycle & anatomy of Earthworm

After earthworms mate their fertilised eggs are held in a protective cocoon. The baby worms (hatchlings) emerge and burrow into the soil where they grow into juvenile then mature worms





Benefits of earthworm activity

- Earthworm activity (burrowing) within the soil profile creates channels within the root zone for plant (grass roots) to develop and colonise into and helps in the drainage and aeration of the soil profile
- Earthworms also are a vital part of the soil eco management system by helping to break down organic matter releasing nutrients for subsequent plant uptake
- In Agriculture and Horticulture earthworm activity is actively encouraged however in Turf culture surface activity leading to the formation of casts are a major problem for the turf manager, particularly with the recent revocation of the last available active ingredient - Carbendazim

Worm control in the past

Earthworm control in the past involved a number of highly toxic chemicals some are listed as follows which although highly effective in controlling surface casting were extremely hazardous to the environment wildlife and to humans such as

- Copper Sulphate
- Potassium Permanganate
- Derris Dust – respiratory poison
- Mowrah Meal- obtained from an Indian bean tree *bassia latifolia*
- Lead Arsenate – can cause harm to grass species
- Mercury based products – used in fungicides and lawn sands
- Chlordane – (Organochlorine) liquid or Granular form
- Carbaryl
- Thiophanate Methyl
- Carbendazim

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Worm control in the past continued

Some products such as Mowrah Meal were applied as expellents as they acted as an irritant to the earthworm after application copious amounts of water had to be applied and the affected worms were then swept up and removed.

- Derris dust an extremely poisonous chemical to inverterbrates was another chemical used with considerable effect
- Mercuric Chloride was used but again was found to be extremely poisonous to humans and to other mammals.
- Chlordane used from the early 1960's to the early 1980's – very persistent in the soil lasting up to 6 years in certain soil types such as heavy clay based soils.
- Carbaryl – another active Ingredient widely used in the 1970 & 80's
- Carbendazim used for around 30 years – targeted casting species only but results were variable originally sold as a fungicide.

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Mowrah meal application

Mowrah meal use in the past watering in after application !

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Integrated Turf Management

Integrated Turf Management programme is an ecologically based programme and encompasses all procedures to encourage development of a healthy plant or sward for example

- Correctly adjusted machinery to avoid surface scalping
- Correct nutrient input for chosen grass species and areas of use
- Reduction of shade, and improvement of airflow around the turf.
- Accurate Irrigation applications based on the plants requirements and the use of wetting agents and surfactants on a regular programmed basis
- Regular Aeration and attention to drainage issues
- Thatch and surface litter reduction through scarification, verti cutting & coring

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Cultural control

Cultural controls along with other accompanying techniques are now at the forefront of earthworm management for the turf manager, these are

- Clipping removal by box cutting (including fairways and outfields)
- Regular thatch and surface litter control reducing the percentage of organic matter and subsequent food source through mechanical operations such as aeration, verticutting, scarification, coring and the use of the 'Graden' type of machine for thatch reduction.
- Sensible nutritional programmes based on soil analyses if required with the aim of providing the correct amount of nutrient to the sward and nothing more.
- Accurate irrigation use, utilising soil moisture metres to ensure soils are not over irrigated which can reduce organic matter breakdown favouring earthworm colonisation and activity
- Increased use of sandy top dressing which may deter earthworm activity
- Efficient leaf removal from turf areas

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Leaf Clearing on Bowling Greens and Sports Pitches

Species such as the Lob Worm will feed on leaf litter so these need to be removed immediately

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Composting grass clippings

Before composting any grass clippings where certain pesticides may have been applied check the product label to see if composting is allowed

Dumping piles of grass clippings in the woods for example should be discouraged because of the risk of Nitrate contamination to the environment caused by large concentrations of grass clippings degrading over a very small concentrated area leaching into soil water and water courses etc dedicated bays should be constructed for efficient composting

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Top Dressings (sands and soils)

- Always check the Ph of top dressings before purchase and application
- Always ask the supplier for a technical specification document if required.
- Top dressings should ideally be moderately acidic with a Ph between 5.5 – 6.5
- Alkaline top dressings should be avoided as will encourage earthworm activity

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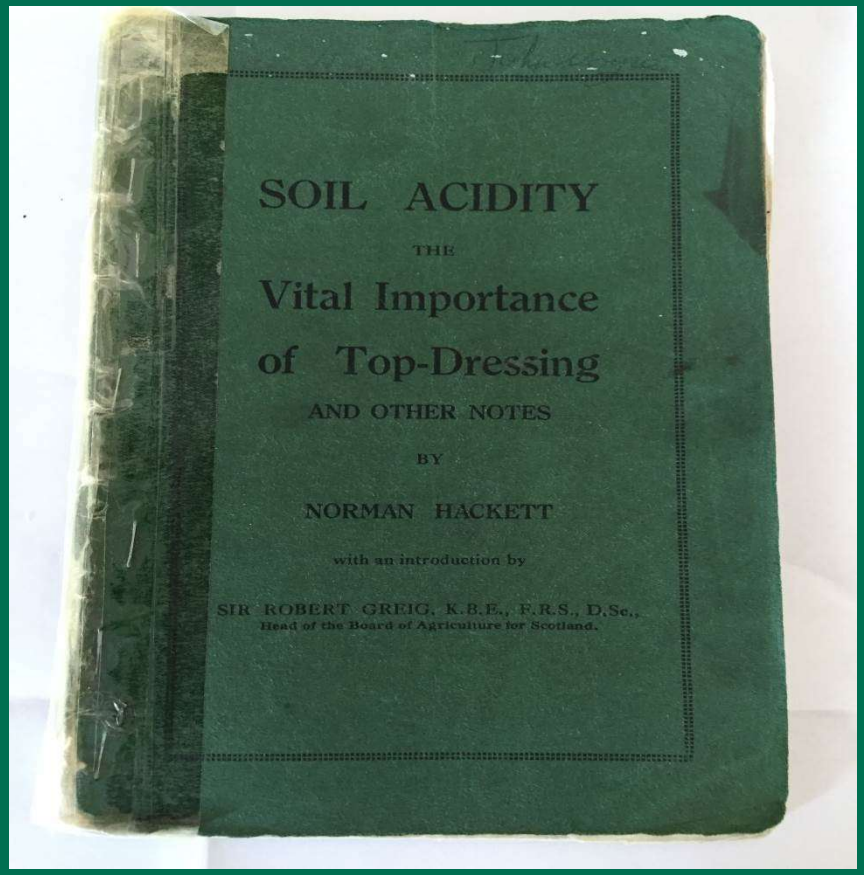
Soil acidity is nothing new this book dates back to 1928 !



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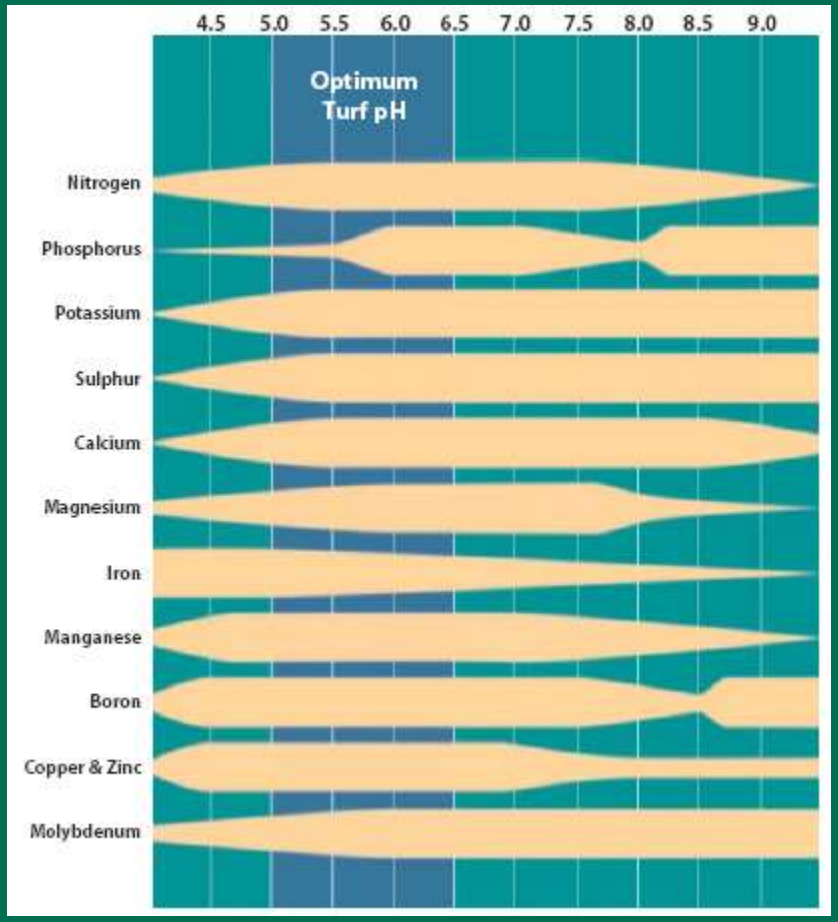
Nutrient Availability & pH



Acidic Nitrogen Fertilizers

- E.g. Sulphate of Ammonia, Urea
- Immediate growth response
- Reliable cool weather performance
- Immediate colour response
- Acidifying? helps in reducing worm cast activity by reducing soil pH
- Available in granular and liquid form

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Iron Products - Advantages

- Iron Sulphate available in granular or liquid form
- Percentages of iron range from 4 % to 20 %
- Available in Ferrous Sulphate, Chelated, or Complex formulations
- Advantages are soil acidification, will harden off the plant during the winter period, help reduce worm casting and help in fungal disease management

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Iron Products - Disadvantages

- Turf scorch is a major issue so always apply with care and over use can increase drought susceptibility in turf
- Turf blackening is a problem with Iron Sulphate applications so apply these during the non playing period autumn – winter
- Apply non blackening formulations based on complex or chelated formulations which are less prone to blacken turf during playing season.
- To avoid exacerbating black layer problems regular aeration and the use of penetrant wetting agents during the autumn and winter periods will probably need to be increased to improve water percolation

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Penetrant Wetting Agents

- These type of wetting agents are designed to ‘flush’ the moisture through the rootzone creating drier conditions
- Regular monthly applications of penetrant wetting agents now part of new earthworm casting reduction strategy
- Applications between from at least October to April need to be considered
- Reduction of surface water will help to keep root zone relatively dry
- Apply in between applications of Iron products on a monthly basis 1 week apart if possible during the close season

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A selection of Iron, Sulphur, and surface penetrant products to apply to help reduce surface acidity and surface water retention

Other methods of management

Apart from the application of chemicals other methods were and are still used which will help deter surface casting activity

- Applications of acidic fertilizers based on Ammonium Sulphate, Urea, Potassium Sulphate, and Iron Sulphate all help to reduce the surface Ph of the soil helping to deter surface worm activity.
- Avoiding applications of Lime and the use of non acidic fertilizers such as Potassium Nitrate can be quite successful where soil pH levels are between Ph 6 upwards where most casting activity occurs
- Plant Growth Regulators based on Trinexapac- ethyl which can reduce the clipping yields are particularly useful on areas where clippings are left to fly such as fairways and winter sports pitches and may help by reducing the available food source and organic matter such as the volume of grass clippings for the earthworm to use a food source.
- The use of water acidifying agents are also very useful in high Ph situations, particularly in hard water areas

Accompanying problems

As earthworm populations naturally increase as the 'chemical effect' of pesticides gradually reduces in time other problems will become more apparent such as :

- Muddy playing surfaces with a 'knock on' effect effecting machinery performance ie heights of cut, dried casts, dulling mower blades with increased cylinder regrinding being required, and players having to cope with muddy playing surfaces which could possibly impact on club revenues with reduced green fees etc as bowlers are deterred by playing bowls in certain situations
- Increased weed infestations caused by un germinated weed seeds in the soil seed bank being brought to the surface within worm casts,- leading to a reduced reduction of sward quality and changes of the vegetative composition of the sward unless a programmed herbicide programme is put in place – possibly further increasing chemical applications in the form of selective herbicides.

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Other accompanying problems continued

- As well as the aforementioned issues increased damage caused by for example Mole activity will be a major issue as surface levels can be ruined caused by their burrowing activities – make friends with your local mole catcher!
- Damage caused by Foxes and particularly Badgers looking for earthworms to eat can be catastrophic, with turf areas being ripped apart Badgers are protected by law and cannot be harmed control measures apart from reducing their food source- worms and other grubs include trying to encourage them away from areas of play by luring them with nuts etc may have some limited success
- Increased bird damage (Starlings and Crows) caused by pecking and tearing of the turf may also impact on overall sward quality.

Worm casting and increased weed invasion- note weed invasion possibly being caused by un germinated weed seeds being brought to the surface contained in worm casts

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Surface thatch accumulation and worm activity below surface

Aerification displacement chart outlining how much organic matter material can be removed depending on size or type of tine or Graden blade used and relative centres

International Sports Turf Research Center

Aerification Displacement Chart

Tine Size	1.25" x 1.25" Centers	1.5" x 1.5" Centers	2.0" x 2.0" Centers	2.5" x 2.5" Centers	5" x 5" Centers
¼" Hollow Tines	3.14%	2.18%	1.23%	0.79%	
3/8" Hollow Tines	7.07%	4.91%	2.76%	1.77%	
½" Hollow Tines	12.57%	8.73%	4.91%	3.14%	
5/8" Hollow Tines		13.64%	7.67%	4.91%	
5/8" Hollow Vertidrain					1.23%
¾" Hollow Tines				7.07%	1.77%
¾" Hollow Vertidrain					1.77%
1" Hollow Tines					3.14%
1" Hollow Vertidrain					3.14%
7/8" Drill & Fill (7" Crs)					1.23%
Graden Verticutter (1.5 Blades @ 1" Spacings)	1mm Blade 3.93%	2mm Blade 7.85%	3mm Blade 11.81%		

Note: 1/4" Quadtines remove as much material as Regular 1/2" Hollow Tines
3/8" minimum for ease of topdressing fill if replacement of material is required
For double aerification make two passes at approx. 37° (slightly less than 45°) to minimize overlap

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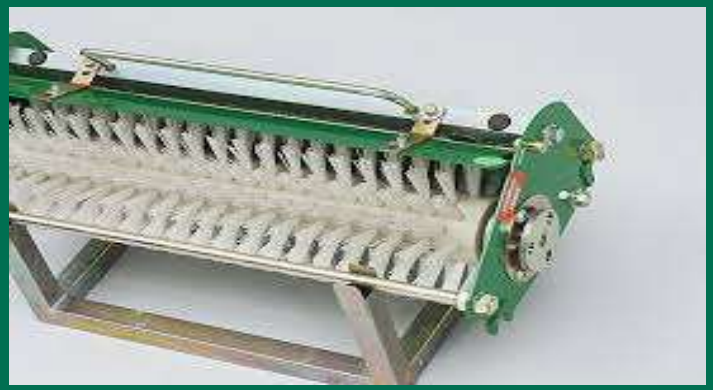
Brushing and Thatch Control



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Powered Scarifiers – reducing the food source for Earthworms

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Hollow coring – thatch removal

Top dressing applications – dried sand applied through a drop spreader after coring

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Thatch reduction - utilising a Graden sand injection machine

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Sand injection operation Graden on a golf green

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Debris removed using Graden – note the volume of organic matter (thatch) removed in a single pass from a bowling green!

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Reducing Clipping Yields

Primo MAXX PGR reduces clipping yields by up to 33% for up to four weeks when applied at full label rate

Mowing time is reduced

By reducing the clipping yield subsequent organic matter build up is reduced in the turf canopy which is food for the Earthworm

Cleaner turf after mowing

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Examples of activity and associated damage to turf

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Bird scaring kite over a bowling green are they effective?

Drainage issues

Although the beneficial effects of earthworm activity are well documented playing surface drainage can be severely affected.

- Large deposits of worm casts particularly on heavy clay loam soils can if left unchecked 'seal off' the surface creating poor drainage leading to for example increased moss invasion through impeded water percolation.
- Drainage lines (e.g sand slitting) effectiveness can be greatly affected because of reduced water infiltration and percolation and surface capping caused by surface casting
- Increased use of selective herbicides may have to be considered with the inevitable increased financial and environmental costs to help maintain an acceptable level of playing surface quality because of a possible increase in weed populations requiring control, unless people are more acceptant of weeds in turf.

Sand slitting of turf

Keeping the sand slits free of worm casts (causing capping and smearing) is imperative for the system to work efficiently - note worm casts on surface

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Mole (*Talpa eurpoea)*

To the Mole areas of turf are considered good potential sources of food for example available worm populations therefore reducing the food source is one logical step in reducing activity, they are mainly solitary animals apart from breeding time

- The best time for the control of Moles is between Autumn and spring as their activity is unfortunately easily detected – mole hills
- Control in the past included gassing and dipping worms in strychnine and placed in mole runs ! – thankfully no longer carried out
- The use of humane traps is generally very effective if carried out on a regular basis.
- Sonic sound devices are also available with limited success

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Life cycle of the Mole

Most mole species are unable to store either food or fat, and all moles remain active throughout the year. As the ground's surface cools and eventually freezes with the arrival of winter, moles construct deeper tunnel systems in search of food retreating from the dropping temperatures. Visible activity above ground typically diminishes, giving the false impression that moles hibernate as many other mammals. An early spring, a prolonged period of unseasonably warm weather, or an insulating snowfall often trigger new digging, and consequently results in increased levels of lawn damage.

Moles can be active at all times of the day. However, researchers have reported that their movements follow the general pattern of four hours of activity alternating with four hours of rest. The movements of moles in an area are typically synchronized and are governed by the circadian rhythms which influence all mammal species. The life span of an Eastern mole varies with longitude as well as soil type (particularly sandy soils can cause rapid tooth wear resulting in early demise). Median age has been estimated at three and a half years, but a study conducted in South Carolina turned up one senior of six

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Mole identification and control

- Use of mole traps very useful if placed correctly in Mole runs

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Mole damage on Golf course and & the result of effective mole control!

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Badger

Size: Approximately 900 mm
Weight: 10 – 12 Kg
Life span: Approximately 6 years
Diet - Worms, Chafer grub larvae, Leatherjacket larvae

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Badger damage on Golf course

Badger Sett entrance

Damage after feeding on chafer grub larvae

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In Conclusion

Cultural practices such as Hollow coring, scarification, verti cutting, Graden operations as well as top dressing with straight sand or sandy top dressings will help deter worm activity.

- Avoid over watering, and over fertilization, which leads to thatch build up in turf
- Apply acidic fertilizers such as Ammonium Sulphate, Potassium Sulphate, and Iron sulphate to help maintain or reduce soil pH levels
- Avoid non acidic fertilizers such as Potassium Nitrate particularly in hard water areas
- With the recent revocation of the last of the chemical active ingredients (Carbendazim) the provision of quality managed sports turf surfaces has become increasingly more difficult with only cultural and nutritional programmes now available to the turf manager with limited results
- It is of paramount importance that club secretaries, managers and members are kept informed of the forthcoming problems that may manifest themselves because of the lack of an effective chemical control programme in the future.


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Thank you for your attention
Any questions?