THE GOLF GREENKEEPERS' ASSOCIATION

ESSAY COMPETITION 1930-31

The Golf Greenkeepers' Association.

ESSAY COMPETITION, 1930—31.

Subject: MODERN GOLF GREENKEEPING.

1st Prize—G. Swinn, Hardelot G.C. No. 9.

(1) Assume it has been decided to construct a new green on a site covered with turf consisting mainly of Lolium Perenne (Perennial Rye Grass) and Dactylis Glomerata (Cocksfoot).

Give reasons for or against the suitability of these grasses for a putting green, and the nature of the topsoil and subsoil on which they would be found growing, and give particulars of the various grasses likely to adapt themselves to this class of soil, and ultimately form a good putting surface.

LOLIUM PERENNE.

This grass is, as a general rule, unsuitable in a mixture for putting greens, because its permanence varies very much with the nature of the soil and the climatic conditions. On loose, dry soils it fails to form a good-enough turf for a putting green. On the other hand, on rich loams and clay it does very well, and will form a thick turf very quickly, withstands drought well, and is practically permanent; in a hot, dry country would be useful, but only as a last resort.

The chief reason why it is not suitable for ordinary conditions is that it is a very heavy feeder, thus crowding out finer grasses, and soon exhausts the soil; very difficult to mow, the machine, instead of cutting it, only half succeeds, with the result that the grass turns yellow.

It will grow in almost any soil, but prefers rich loam or clay.

Topsoil, usually loam or clay.

Subsoil, usually gravelly.

DACTYLIS GLOMERATA (Cocksfoot).

Useless on a green, as it grows in large coarse tufts, a very heavy feeder. Its leaves are very broad and coarse, and with constant cutting would lie flat, thus crowding other grasses out.

Yields best on loams and clay; very often found on poor, dry soil, where, if the soil is deep enough, it will withstand drought well.

Is a very ornamental grass, grows very strong on medium or strong soils. Grows under trees very well; usually flowers in June.

PREPARATION.

Before one could hope to produce a good putting surface on soil of this description, it would be necessary to prepare the existing soil. First of all take off the turf—this should be cut at least four inches thick to ensure removing all the roots—this turf could be used for patching, or making new tees. Next, procure ashes; these can be obtained cheap as a rule from the local gasworks. It is difficult to lay down the quantity, but enough should be procured to put on at least six inches. If there are many large clinkers, put through a screen (one inch), now lay the ashes over the surface to a depth of at least six inches—more, if possible—dig a trench at one side of the green, and commence to turn the soil—thoroughly *mixing* the ashes with the soil, and not merely turning it over. This is most important, as the upkeep of the green afterwards will, to a great extent, depend on this work. If this work is well done, very few worms will be seen, and the green can be rolled as often as necessary, and without any danger of ultimately becoming "bound," as is very often the case when a green is made on this kind of soil. When the work has been done, a layer of prepared soil should be put on. this, if possible, to be light, sandy soil, to which has been added well-rotted manure, the whole to be turned two or three times and finally put through a half-inch screen.

When this preparation has been evenly spread over the surface, it should be made firm by "treading"—this is much better than rolling. It should be gone over twice, in reverse directions; lightly rake, taking care not to leave any holes; sow, rake in, and finish off with the roller.

MIXTURE OF SEED.

Festuca Ovina (Tenuifolia) ...	30
Festuca Ovina (Vulgaris)	10
Festuca Rubra (Genuina)	20
Festuca Duriuscula	10
Poa Trivialis	20
Poa Pratensis	10
	100

(2) Assume a well-drained putting green, made-up chiefly of Agrostis Canina and Fes'uca Rubra, with similar grasses predominating in its immediate vicinity, gradually deteriorates, un'il it comprises 50 per cent. weeds, i.e., plantains, daisies, buttercups, pearlwort, and coarse grasses.

There are, of course, several reasons why a green should deteriorate in this manner, amongst these reasons being a very dry period, and, more commonly, wrong treatment; in either case, the treatment would be practically the same.

The first thing, of course, would be to get rid of the weeds and coarse grasses, which is best done by hand weeding—a tedious job—but it will pay in the end; care must be taken in getting all the roots out. Careful tests should be made of the soil. Should this test result, as it probably will, in finding the soil in a very acid state, steps should be taken at once to remedy this—a job which will need to be carried out very carefully. After weeds, etc., have been cleared satisfactorily, the surface of the green should be

well scarified by raking and cross-raking—Spring-Bok rakes are fine for this work—otherwise it is a good plan to have the ordinary iron rakes filed to a "chisel edge"; in other words, the edge which is drawn towards you should be sharpened. This can be done by one of the men on the spot, and the rakes can be used for other work afterwards. By doing this, I find the rakes pull up much less of the existing grass, and a better "tilth" is obtained for sowing.

Now apply a dressing of pulverised chalk, at the rate of one pound to the square yard, rake lightly, and leave for at least five days to allow the "fire" to leave the lime. Another good raking should be given, and the green should be ready for sowing. A good mixture of South German Bent should be obtained from a reliable firm, and sown at the two-ounce rate; this will ensure a good turf in a short time; rake in, and roll in with a wooden roller. When the grass is well through, give a light dressing of compost, which should be composed of well-rotted manure, sand or very light soil—not forgetting to test this compost. This procedure should be followed every eight or ten days for the first two months, with the exception that every other dressing should be sand or light soil only, otherwise the grass will become too "fat." Test each month until the test results in what I call just over neutral or slightly acid; then the following, during the growing season :—Ten pounds Sulphate Ammonia, five pounds Sulphate of Iron, mixed with two hundredweights of sand, to be applied once per month. During non-growing season, compost only, alternated with sand or light soil only. Should the soil be alkaline or neutral, the same procedure, as regards weeds, etc., should be followed, but avoid lime or dressing containing lime. If a soil which is acid can be found, or even leaf-mould, either made up or bought, would be a great help. Applications of dressings as above. All this, of course, sounds very easy, but it will require patience before the desired result is reached. I would again lay great stress upon the importance of testing the soil and keeping a careful record. In conclusion, I would add that I am afraid I have treated all these subjects too lightly.

TEEING GROUNDS FOR WINTER USE.

I have found the following very successful, and have made these both on heavy and light soils :—

Assuming the place to be more or less on flat ground, first of all strip off any of the existing turf, which could be used for returfing. See that these are laid flat, not one on top of the other, as this causes the grass to turn yellow.

Take out the sand or soil to a depth of not less than one foot below the ground level, keeping this soil as near the tee as possible, as it can be used later.

From the local gasworks one can generally obtain coke screenings very cheap. This should again be put through a screen. There should be a good percentage of "clinkers." With these make drains in the form of a herring-bone, taking care to get a good "fall" either on one side of the tee or falling away all round. Should the ground be very low, make a "sump" at the side or end of the tee—the "sump" should be at least six feet deep and four feet wide, larger if possible. Fill this in with big stones or clinkers to start; continue with smaller ones to within six inches of the ground level, the remainder to be filled in with soil and turfed. Now see that the herring-

bone drain falls towards the "sump." Continuing the tee from the herring-bone drain, fill in now with the largest remaining coke and finish off with the small. There should be, from the bottom of the drain to the top of the coke layer, at least eight inches. Next put on the soil which was taken off in the first place, at least six inches of this, level, give a good treading until quite firm, and turf in the ordinary way. If well made, a tee of this description will be dry and fit to play on during the wettest period.

COCKCHAFERS.

I have found powdered napthalene very good to get rid of these grubs, providing—and this is very important—that the powder is put on at the right time, which means that the grubs must be near the surface. This is usually in September, but varies with the weather and the climate, so that no hard and fast rules can be laid down. They come to the surface before descending deeper for the winter. As soon as they are suspected, a supply of napthalene should be got in. The affected area should be carefully watched day by day. The moment the grubs are found near the surface, broadcast the napthalene at the rate of two ounces to the square yard, and well water in, when the grubs should come out to be swept up and burned. This, I know, sounds very easy, but success can only be obtained by putting on the powder at the right moment.

ANTS.

These are a real pest on some greens, and I have also used napthalene for these, with success. The powder should be broadcast at the rate of one ounce to the square yard, and not watered in, as it is the smell which drives them away, and the "scent" remains good for ten days.

LEATHERJACKETS.

I have tried several remedies for this pest, and I am strongly of opinion that if the greens could be rolled more it would go a long way towards a remedy. To back up this theory, I have noticed that, around the hole, for two or three yards, there have been no grubs, although the rest of the green has been infested; also, I have known a green where the players have been obliged to walk over the back part to gain the next tee, to become so firm that not a single grub could be found, although they were present in great numbers on the remaining part of the green. But as greens are usually made up at the present time, it is almost impossible to roll enough to do any good, as the surface quickly becomes "bound." I am a great believer in ashes. I think if ashes were more freely used in the preparation of greens there would be a great reduction in the number of pests we have to contend with to-day, and greens could be rolled when necessary without the risk of becoming "bound."

Anyway, once they are found in the green they must be got rid of at any cost. The usual procedure is: The greenkeeper reports to the secretary that the grubs are present; the secretary probably reports to one of the members of the Committee, who promises that, if the thing gets any worse, they will hold a meeting and decide what is to be done. In the meantime, the grubs are doing well and getting fat. At last it is noticed that the green is beginning (sic) to look rather in a bad way. There is great commotion, and powder is ordered to be delivered at once (or earlier). On arrival, opera-

tions are commenced, but too late to do any good, and it naturally follows that that make of powder is useless. I would not say this occurs in every case, but very often.

The same as in the case of the cockchafer grub, the only way to get rid of them is to keep a supply of powder—if only a small one, it will keep a considerable time—and the moment the grubs are seen, apply a small quantity, and, if successful, continue, and at once order more. Personally, I have not seen anything to equal "Kil-Jac," which is supplied by Messrs. James Carter, of Raynes Park. This is not an advertisement, but actual fact. If this powder is used when the grubs are active, and well watered in, the grubs will come to the surface in thousands. But, as I have already remarked, it is useless to put this or any other powder on when the grubs are too deep. This powder is a very good fertiliser. I am looking with great confidence to the research people, as regards these pests, and I firmly believe that they will eventually give us some very good material to work from.

TURF VERSUS SEED.

This is a question which has been much discussed, and varying opinions given from time to time; but I think it has been finally proved that seed, if well chosen, and proper attention paid to the preparation of the ground before sowing, and if sown at the proper time, will give much better results than turf. At the present time it is very difficult to obtain good turf, and, if found, is probably growing in a locality which is quite the opposite to the one it is proposed to transfer it to. Change of soil might easily kill the finer and, naturally, more desirable grasses; also, although quite near, the new place might be more exposed, which would have the same result. If a green is turfed, and a dry spell sets in, the turves will part, which means filling in the cracks with soil, and, eventually, sowing. It has been argued that a turfed green would be ready for play much earlier than a sown one. That may be so, but it would have to be exceptionally favoured. I contend that a green which is sown, if reasonable care is taken in the preparation of the ground beforehand, the seed sown at the right time, will be less expensive, practically free from weeds, and a good putting surface obtained just as quickly, and easier and less expensive than by turfing.

MOST SUITABLE SOIL FOR GROWING GRASSES.

PUTTING GREENS.

There has been, and still is, a great deal of discussion regarding this important question. Many opinions have been put forward—many of these by very able men. I have been greatly interested in these opinions, and I wish it to be understood that what I am about to set down has not been influenced in any way by these opinions; they are simply facts; and, in the experiments I have made over a long period, on different soils, and in different climates, I have come to the conclusion that a soil which is slightly acid is best for growing the finer grasses suitable for putting greens. In saying this, I do not mean the soil must be acid to the last degree—not a point higher than P.H. 5.5. I know it is very difficult to get and keep a green in this condition, and it can only be done by constant testing. Every greenkeeper ought to be in possession of a soil-testing outfit and a careful account kept of these tests, not only of the soil comprising the green, but the compost which is used. I believe this question of compost is where a good deal of the trouble origin-

ates. As an instance, we will take a green which has been newly sown on a perfect seed bed; the soil, on being tested, is just P.H. 5.5. Everything goes well for a time, then, all at once, for no apparent reason, the grass turns a sickly colour, thin, and full of weeds; as time goes on it gets worse, until it is more like a cabbage plot than a putting green. In the meantime, regular dressings of good compost have been applied, and everything to no purpose. Have these dressings been tested? In a good many cases, soil is very difficult to find, and, when found, is probably from a different locality, and which may be either very acid, alkaline, or neutral. If one wishes to keep the soil acid, it is useless to use soil for the compost which is alkaline, and vice-versa. Take leaf-mould as an instance. It is, perhaps, not generally known that this, as a rule, is very acid; therefore, if a green, when sown, is neutral, it naturally follows that if this green is dressed repeatedly with a compost made up of leaf-mould, it will, eventually, become very acid. Very often one finds greens, which are dressed with leaf-mould, in very good condition, carrying a beautiful sward of grass, and it is as equally sure that, in the end, that or those greens will deteriorate until nothing is left but weeds and coarse grasses, simply because the soil has become so acid that the finer grasses cannot live in it. I have actually seen this happen, that is why, when I say I believe in acidity, I only believe in it to a certain point, because it has been proved, over and over again, that a green which gets over a certain point of acidity begins to deteriorate until, as I have already stated, it is no longer worthy of the name. I remember, a short time ago, visiting a small, nine-hole course in this country. I was greatly interested in the greens, which most of them, were covered with as fine a sward of grass as one would wish to see. One old man was "looking after" the greens, and, upon my asking him what he used in the way of dressings and fertilisers, he replied that, as long as he had been there (nine years), nothing had been used except a little sand at times to "fill up the 'oles," as he explained. I took a sample of the soil, and upon examination, it registered just under P.H. 5.5. It therefore proves that this turf has been growing in an absolutely natural state, and there is not the slightest doubt that if one commenced to apply dressings to these greens, unless very careful attention was paid, they would, in about two years, be completely changed. It would be necessary to make up a compost which would correspond exactly to the soil of the green. To do this would be fairly easy, providing one had a testing outfit. Soil fertility forms a great part of our work, and there is not the slightest doubt that greenkeeping, to be successful, must be carried out in a scientific and systematical way, and I think the sooner we greenkeepers realise this, the better it will be for us and everyone concerned. This can only be reached by carefully testing existing soil and all compost before and after making up, and keeping a careful record.

2nd Prize—J. Gault, Westgate & Birchington G.C. No. 7.

PREFACE.

To my mind the most impressive lesson any greenkeeper can learn is the one acquired under adversity.

The real science of greenkeeping is not to be gained where difficulties in maintaining turf are never experienced.

Practical tests in overcoming trouble of any kind are the best way to obtain knowledge.

So, in answering the questions, as set out in this competition, I wish it to be clearly understood that I consider no routine method to be absolutely binding, as in greenkeeping. It is not wise to work by hard and fast rules.

Only careful study and experience in each case will bring perfection. Nevertheless, each question is dealt with in the hope that the answers, as given, may be of use to greenkeepers.

The various situations, and all the different kinds of soil, call for special care and suitable treatment in each case, and all points are best to be considered locally.

The chief factors in greenkeeping, which appear to be directly involved in the questions asked, are as follows :—

1. The habitat of grasses.
2. Their habits of growth.
3. The mechanical structure, chemical constituents, and bacterial condition of the soil on which they grow.

The habitat of grasses is of great importance as an indicator of the soil. No one expects to find a seaside grass growing in a forest, or a marsh grass growing on a dry, chalk down. They are even more true to their habitats than this, and the greenkeeper generally places the species roughly in groups :—

Meadow and pasture grasses.
Shade grasses.
Aquatic grasses.
Moor and heath grasses.
Seaside grasses.
Rudeval or vagabond grasses.

HABITS OF GROWTH. ROOT AND LEAF.

Grasses can be found growing from six inches to four and six feet tall, and each species possesses its own formation of root and leaf. We find the leaves broad or narrow, and roots are stoloniferous and creeping, or the single tuft roots. Only the creeping grasses are capable of forming the turf carpet. The tufted type can only form tussocks; they cannot spread, except by seeding.

THE SOIL. MECHANICAL STRUCTURE.

Soil is a mixture of finely-divided, earthy particles. The larger particles consist of sand, which is characterised by the small amount of water it can hold, and by its lack of cohesiveness when dry. The finest particles make up the clay, which is plastic, and holds water readily. Clay swells when wet and shrinks and cracks on drying. Other substances found in soil are chalk particles, which may form as much as 60 per cent. of a calcareous soil, and the humus, chemically known as humic acids, which gives the soil a dark colour, and represents the remains of decayed vegetation.

CHEMICAL CONSTITUENTS OF THE SOIL.

In fertile soil there are a large number of chemical constituents, all of which it seems unnecessary to name. The chemicals which appear to be used up in the maintenance of cultivated turf are, first of all, the elements, nitrogen, phosphorus, and potassium. These are the most important. It is, however, necessary to consider, besides these, the elements sulphur, calcium, magnesium, and iron.

THE BACTERIA OF THE SOIL.

The bacteria of the soil, together with the protozoa and fungi present, play an important part in the nourishment of the grasses. The nitrifying bacteria, which enable the plants to assimilate the nitrogen of the air, and the nitrification bacteria, which effect the oxidation of ammonium compounds to nitrates, are of great importance. The bacteria present in the soil are called the middlemen of the nutritive chain; they act as neutral bodies, speeding up the process of chemical action.

Question No. 1. Assume it has been decided to construct a new green on a site covered with turf composed mainly of Lolium Perenne (perennial Rye Grass) and Dactylis Glomerata (Cocksfoot).

Give reasons for or against the suitability of these grasses for a putting green, and the nature of the topsoil and subsoil on which they would be found growing, and give particulars of the various species of grasses likely to adapt themselves to this class of soil and ultimately form a good putting surface.

Lolium Perenne and Dactylis Glomerata are tuft grasses, and are, therefore, useless, as they cannot spread and produce an even turf.

Lolium has a sparse, tough, stringy foliage, and Dactylis is a very coarse plant, with broad, thick leaves. The ideal putting green is an expanse of very fine turf, with a surface as smooth as velvet.

The grasses which make up this turf must be very hardy to stand the vast amount of wear, and of a type which can quickly recover after spells of inclement weather, and, with these virtues, be inexpensive to maintain. Lolium Perenne is a vagabond grass. It appears to grow anywhere, and is not indicative of any special type of soil. Dactylis is a very fast-growing meadow grass, which forms much aftermath. It grows on any soil which is rich in humus. Grasses like Bromus Arvensis always indicate clay, but as there is no mention made of this grass, I presume the soil on the site of the proposed new green is a medium loam.

The presence of a vagabond grass generally suggests a fairly dry situation, with a porous subsoil, such as gravel, chalk, or sand. It is impossible

to state a definite mixture of grass seed, where so little is known of local conditions, rainfall, etc. A mixture of two or more of the following species will give good results (it is always unwise to sow one type of grass alone):—

Festuca Rubra (creeping red fescue).
Festuca Tenuifolia (fine-leaved fescue).
Agrostis Tenuis (New Zealand bent).
Poa Pratensis (fine-leaved creeping meadow grass).

The Agrostis are, undoubtedly, the best putting green grasses, but it is difficult to procure seed of some species. It is difficult for even an expert to distinguish between the Agrostis species. All the ordinary forms, A. Stolonifera, A. Vulgaris, and A. Canina, may be included under the A. Alba (Linn).

Question No. 2. Assume a well-drained putting green, made up chiefly of Agrostis Canina and Festuca Rubra, with similar grasses predominating in its immediate vicinity, gradually deteriorates until it comprises 50 per cent. weeds, i.e., plantains, daisies, buttercups, pearlwort, and coarse grasses. Give reasons for such deterioration, and particulars as to the best means of elimination, together with dressings to prevent recurrence.

The deterioration of grasses and presence of weeds show that poverty of soil is the chief trouble. Experience proves that even the finest turf, which undoubtedly this green was composed of, will gradually deteriorate unless topdressed with suitable manures. The regular attention to manuring greens will ultimately save at least 50 per cent. in their upkeep. A close, true sward of healthy grasses is assured where the proper manures are used.

RENOVATION.

While many of us doubtless, would prefer to lift and relay the green with suitable fresh turf, this course is not essential. The renovation of the green should be carried out in the autumn, when the soil is moist and warm.

MATERIALS REQUIRED.

Sufficient clean turf to substitute patches of weeds, coarse grass, parlwort, etc. Well-rotted compost, say 3—5 tons, according to size of green; 2cwt. balanced mixture of chemical and organic fertiliser; ½cwt. superphosphate.

METHOD OF PROCEDURE.

The patches of weeds should be lifted with a turfing iron in the ordinary way, and bare ground carefully dug, and all weed roots, etc., cleaned out. Fresh turf should be taken from the vicinity of the green, say the approach, which has been mown. This turf can be laid so as to ensure a good putting surface. Weeds not growing in clumps should be taken out by hand. If this is carefully done, the surface will not suffer much.

Turf taken from any out-of-the-way place can be replaced in the approach, to be worked up by mowing, etc. It seems unnecessary to state that the turf replaced must be of the proper kind. Natural organic manures are safe and useful dressings for putting greens, especially on poor, moorland turf.

The description of the grasses gives the impression that the green is situated on hilly or moor country.

The compost used may consist of horse manure, peat moss litter, old, rotten turf, leaf mould, and seaweed. In making a compost heap all the ingredients should be built in a dry pit and equally mixed. When the heap is completed, fresh seaweed should be put on top, and the stack allowed to remain at least a year. The stack should then be turned over at intervals until all ingredients are properly rotted. When the mixture is ready, it should be cut down fine and put through a quarter-inch screen. A little sand added to the heap will open up the mixture and make it more friable.

A number of compost heaps should be kept on any golf course where the soil lacks humus.

If a compost heap is not available, a mixture of one-fifth of sand and four-fifths of soil may be used to dress the green. The dressings must be put on very light as the turf can absorb it. Four light dressings, say, ½cwt. per dressing of a well-balanced fertiliser, applied when the grass is growing, will ensure a first-class, healthy turf. The compost or soil dressing will ensure a first-class putting surface, and render the soil mechanically more fit for turf. The fertiliser will ensure a chemically correct food, which, in spite of all arguments to the contrary, is very important.

Such growths as pearlwort are due to stagnation, and if, after the renovation work has been carried out, the pearlwort returns, a light dressing occasionally of an alkaline nature—superphosphate for preference—will soon cure this evil. Any putting green worthy of the name has necessarily an artificial surface, which must be porous as well as firm. The nature and condition of the soil, together with the added substance which forms a desirable turf and feeds the grass, determine its resistence to hard wear, drought, or routine mowing.

No greenkeeper should use any chemical or artificial manure if he does not, first of all, understand the effects to be expected from them.

The use of sulphate of ammonia, nitrate of soda, etc., are very dangerous experiments.

Phosphate manures have a tendency to encourage clovers, and many people now use ammoniacal manures to excess.

Question No. 3. Describe method of constructing a winter teeing ground, which you have tried and proved effectual.

Constructing a winter teeing ground is simple if stones, clinker, etc., are procurable. The stones or clinker are built along the bottom of the site, and covered over with a layer of soil, made porous by the judicious use of sand. The top six inches should be made up of good, rich soil, containing a sufficient amount of humus to carry the surface turf safely through the dry, summer weather.

As winter tees are seldom used in summer, the grass can be allowed to grow a little longer, and so conserve the moisture. The turf used should be of the same quality as that of the greens. When finished, the tee should have a drop from back to front of 1 in 144. To ensure a perfectly dry surface the tee should be wormed periodically.

The use of coarse tuft grasses in tees is a mistake, and I have never found that coarse grass possesses any virtues to compensate for its expensive main-

tenance and degenerate habits, and, when mown, the coarse stalks resemble hay stubble. Anything in the nature of dung should never be used in constructing teeing grounds. Dung forces a soft growth on grass, which must, above all, be wiry.

Question No. 4. Describe remedies which you have actually used and found satisfactory for the eradication of Leatherjackets, Cockchafers, and Ants.

I have never found cockchafers or ants do any damage to good turf. The only remedy for leatherjackets which I have found really effective is the preparation retailed by Messrs. Pattisson and Co., of Stanmore. This, if used to directions, is, in my opinion, one of the greatest discoveries in the history of greenkeeping.

Question No. 5. Should a newly-made green be turfed or sown.

Give reasons for your preference.

On light, sandy soil there is difficulty in producing turf from seed. I found, on this soil, a good plan is to select a plot of old turf. This I cut, top-dressed, and kept free from weeds. By that method there is always a good supply of turf ready for any purpose. The natural surface soil, on a clay field does not lend itself favourably to the production of fine turf. It is necessary on such a soil to use topdressings for years before the heavy soil is manufactured to the grist required.

Where existing turf is refined into a green, it should be of a suitable quality; if not, it is better to dig or plough it over and prepare the soil for sowing down the green with a suitable mixture of grasses.

Seeding is better on heavy soil, as turf produced from seed of the right kind is closer, more easily kept, and resists hard wear better than ordinary field turf.

Question No. 6. Which condition of soil is best suited for growing grasses suitable for putting greens, tees, and fairways, i.e., acid, alkaline, or neutral?

Acid conditions are the best for the production of fine turf, either for greens, tees, or fairways.

To my mind, the real answer to the question lies in the description of the mechanical condition of the soil.

Humus is the remains of decayed vegetation. It consists of the calcium salt of several organic acids, which are roughly designated humic acids.

Subject: MODERN GOLF GREENKEEPING.

3rd Prize—G. Sellars, Thanet G.C. No. 5.

One of the chief reasons for the great popularity of golf is that it especially caters for the invigoration of mind and body, through being played in the open air, on natural fields of beauty, moulded by man into what are termed "golf courses."

The subject of modern golf greenkeeping, dealing, as it does, with the care and maintenance of golf courses, is therefore an interesting and important one. It is, moreover, a complex subject, for, in addition to requiring skill and dexterity in manual work, modern greenkeeping involves a knowledge of many scientific subjects, including botany, geology, meteorology, and chemistry. Practical experience is a great asset, but, unless it is supplemented by scientific research, it is robbed of half its value.

While it would be a fallacy to state that every greenkeeper must be a botanist, geologist, etc., an acquaintance with such subjects will be of great value in helping one to understand the latest scientific methods of producing and maintaining first-class turf.

The successful formation of a Board of Research by the County Golf Unions, and the keenness of interest manifested in the educational schemes formulated by the Golf Greenkeepers' Association, indicate that important progress is being made in greenkeeping. Nothing succeeds like success. British golf courses are as good as any in the world, and if our Association continues to remain linked to the Board of Research, and both receive adequate financial support, it means that modern golf clubs will continue to have modern golf greenkeeping, and also modern golf greenkeepers.

Question 1.

The texture of the grasses forming a putting surface should be sufficiently fine so that they do not deflect a golf ball which has been properly hit in putting from the line the player desires to take.

This, I think, will be still more apparent if a lighter ball comes into vogue, as it will have a greater tendency to wobble over coarse herbage.

Lolium Perenne and Dactylis Glomerata are both unsuitable grasses for putting greens.

Lolium makes heavy demands on the soil; its blades are coarse, tough, and difficult to cut. The seed develops very rapidly after sowing, and, for this reason, is sometimes included in mixtures for garden lawns. The grass forms a large proportion of the herbage of both pasture and meadow lands throughout the country. It grows on almost every kind of soil, but thrives best on rich loams and clays.

Dactylis Glomerata has such a coarsely-tufted habit of growth that it can only be regarded as a weed.

Cocksfoot is found on a variety of soils, but grows best on heavy loams and clays, providing there is sufficient depth of soil to allow its roots to

search for moisture during dry weather. As both Cocksfoot and Ryegrass are lime lovers, I should imagine the topsoil on the assumed site to be alkaline, fertile, with clay predominating, and overlying a moist, clay subsoil.

With these conditions prevailing, the aftermentioned grasses would need to be supplied with a well-furnished home, to enable them to form a good, compact sward of turf, suitable for putting.

To accomplish this, fine and coarse breeze should be added to topsoil and subsoil respectively, and the surface of the site should be covered with a sterilised compost, neutral or slightly acid in reaction, of a light nature, but containing sufficient humus to ensure quick germination of seed.

The grasses are :—Festuca Rubra, variety Geniuma (red fesue foliage lower leaves bristle-like, slender, and permanently folded; dark green in colour; stem leaves inclined to be flat; pink basal sheaths). The membraneous structure, where blade and sheath join, called the ligule, is much reduced or absent. This species creeps extensively, and has great powers of withstanding cold and drought. Festuca Ovina (sheep's fescue) : Foliage short, bristle-like leaves, peramently folded, no ligule. The plants are individual in growth; they do not intertwine, and, for this reason, sheep's fescue should only be sown in conjunction with other grass seeds. The variety Tenuifolia, with its particularly fine leaves, is especially suitable for putting greens. Agrostis Vulgaris (common bent) : Foliage, lower leaves expanded, thin and tapering, ligule short and obtuse. This grass has creeping stolons, and succeeds well on moist soils. Agrostis Canina (brown bent) : Foliage, similar to Vulgaris, except that the ligule is long and acute, and the lower leaves more needle-like. Canina has come into much prominence as being the most suitable British grass for propagating turf by the stolon method. The pure seed is difficult to obtain, but mixtures of Canina and Vulgaris are imported from Central Europe under the name of South German Bent. Festuca Duriuscula (hard fescue) : Foliage, lower leaves permanently folded and bristle-like, dark green in colour, and rather fleshy. The growth is usually tufted but sometimes creeping. The seed is easily collected, and there is no difficulty in obtaining it.

Poa Trivialis and Poa Pratensis are among other grasses that could be considered suitable if a more mixed herbage is desired. The fescues and bents alone, however, form a very select herbage. They undoubtedly are the best species for putting greens on all soils, providing adequate preparations are made to suit their habits of growth.

Question 2.

The 50 per cent. deterioration of the well-drained putting green may be due to one or more of the following causes :—

(1) IMPOVERISHED CONDITION OF GRASSES.

The laws of nature favour the survival of the fittest. Nowhere is there more evidence of this than in plant life.

Fine-textured grasses of a putting green live under unnatural conditions. Close cutting and hard wear cause them to become weak and impoverished. Consequently, unless they are helped from time to time with suitable manures, they stand a poor chance in the struggle for existence against weeds.

Weeds absorb grass food, keep out air and sunshine, besides harbouring insect pests. Weed seeds are dispersed from hedgerows and waste places by birds, wind, and other agencies. Some seeds develop into annual plants, which quickly colonise and so become predominant.

Total neglect in feeding and watering the turf, and also not eradicating the weeds as they appear, would soon cause deterioration.

(2) THE APPLICATION OF COMPOSTS OR ANIMAL EXCREMENTS CONTAINING WEED SEEDS.

Great difficulty is often experienced in obtaining ingredients free from weed seeds for compost making. The seeds of certain plants are consumed by animals, pass through their digestive organs, and are so distributed in farmyard manures. Some stock owners use hedgeside rubbish, wood shavings, and other undesirable litter. The sweepings of lofts and barns are sometimes thrown over manure heaps. Using such material for making compost is asking for trouble. Good stable manure is very valuable, but care should be exercised when purchasing it. As a means of destroying seeds and pests in composts, some golf clubs have erected soil sterilisers.

A very interesting account of the sterilisation of compost is given in the 1930 (October) number of the Board of Greenkeeping Research Journal. It is claimed that, although weeds and pests are destroyed, beneficial bacteria are not affected.

A few years ago I piled up cone-shaped heaps of compost, and built bonfires round them. Afterwards, by experimenting in boxes, I found this material grew less weeds and was more adaptable for mixing with fertilisers than ordinary compost. I think sterilisation by heat will become a recognised practice in greenkeeping.

(3) APPLICATION OF UNSUITABLE FERTILISERS.

The information that Agrostis Canina and Red Fescue are growing in the immediate vicinity of the green suggests that these species are indigenous, or natives of the soil, which is probably light in character and neutral or acid in reaction.

The change in the herbage of the green may have been brought about either by the excessive use of lime or of manures rich in phosphates and potash. Such treatment would set up alkaline conditions, and so increase fertility of the soil; that deep-rooted, coarse grasses and leguminous plants would take precedence, to the exclusion of the Red Fescue and Canina.

EARTHWORMS.

Worms are natural cultivators. By their excavations they provide a means for air to penetrate into land, and also cause subsoils to become mixed with the organic matter contained in topsoils. In course of time this increases productiveness. It is, however, quite an undesirable affair on golf greens, tees, and fairways. Here, as already inferred, a permanent and exclusive crop is necessary, and if worms are allowed to carry out their system of cultivation, a muddy surface ensues, which, besides being a nuisance to players, is an ideal landing ground for alien seeds.

Having discussed probable causes of deterioration, I pass on to the elimination of weeds, and subsequent treatment of green. This work could be commenced in the early spring of the year.

If worms are present they will have to be eradicated. Mowrah meal spread over the surface, at the rate of 4 ozs. per sq. yard, and well watered in, is an efficient worm destroyer. Although it is somewhat expensive, it compares satisfactorily in price with proprietary wormkillers. There is no caustic action, and it is non-poisonous.

Copper sulphate is economical in price, and useful as a wormkiller. It entails some trouble, because it has to be dissolved before it is ready for use. As the substance is corrosive to metals, the best method of dissolving is by placing small quantities in muslin bags, suspended in wooden vessels of water; 1lb. to 50 gallons is a suitable quantity. Having disposed of worms, the next procedure is to give 3 dressings of lawn sand, at intervals of 10 days.

A good lawn sand can be made by mixing 3lb. sulphate of ammonia, 1lb. calcined sulphate of iron, and 15lb. sand. Rate of distribution 3ozs. per sq. yard. These dressings may temporarily scorch the surface, but while the grasses will recover, daisies and other small fry will be destroyed. Moreover, the combination of the two sulphates is toxic to many plants, including yarrow, clover, and pearlwort. Systematic hand weeding is the best method of tackling the buttercups and taprooted weeds.

Coarse grasses, such as Yorkshire Fog, will disappear if they are frequently stubbed with a sharp knife.

If the green features very large patches of weeds, these should be removed and new turf laid.

Renovators of various sizes, and similar in shape to a hole-cutter, are useful for taking out small clumps of weeds and replacing with neat plugs of turf. Scars caused by weeding operations should be liberally sprinkled with grass seed, and covered with fine rich compost to induce quick germination.

The dressings of lawn sand and grass seed should not, however, be put on the green simultaneously. Allow at least three weeks between the two operations. If Poa Annua is frequent, it can be reduced by applying, during winter months, two dressings of salt, at 1½oz. per square yard, mixed with four or five pailfuls of compost.

A short time ago, on the recommendation of the Director of Research at Bingley, I tried similar dressings of salt for improving the growth of Red Fescue in a turf nursery. The results were entirely satisfactory.

The disadvantage of outlining treatment for a green without being able to keep it under observation will, I think, be understood. It may be compared to a doctor prescribing for a patient he has never seen. However, from the information given, the following system of treatment would probably be suitable for preventing a recurrence of weeds, and, at the same time, maintain the turf in good condition. I assume the size of the green to be about 600 square yards.

When the new grasses have become established apply 8cwt. of prepared compost, mixed with 7lb. calcined sulphate of iron and 10lb. sulphate of ammonia. Work the mixture well into the turf with a switch rod or broom. Repeat the dressings at intervals of about six weeks throughout the growing season. The final application in the autumn, and the first one in

following spring, could be increased to one ton compost: 15lb. sulphate of ammonia and 8lb. sulphate of iron.

Frequent use of a spike roller, and one or two dressings of charcoal or fine breeze given during winter months, will keep the surface open and porous.

The value of these substances for improving the mechanical condition of soils cannot be overestimated. A fine surface with the right amount of give in it, results from their use.

While sufficient phosphates and potash will probably be supplied through the medium of compost. It may become necessary to use a fertiliser containing these foods, especially if the grasses show signs of not responding to the nitrogenous fertilisers, sulphate of iron and sulphate of ammonia.

To guard against the soil becoming alkaline and too fertile, it should be tested from time to time. Particulars of a soil-testing outfit, and comments on acid and alkaline conditions, are given in reply to question 6.

Another great asset in maintaining all turf in good condition is an adequate supply of water. Unless the ground is thoroughly soaked during spells of drought, the grasses burn out and are superseded by other plants. Moreover, water acts as a solvent and transporting agent for conveying food materials to the roots.

The generous use of a spike roller and the watering-in of fertilisers and compost is a good method of treatment. It will be noticed that I have not made any suggestion as to what ingredients should constitute the compost. The following would probably prove suitable (it will need to be prepared some months before use):—Three parts loam soil (acid in reaction), one part good quality leaf mould, one part well-rotted horse manure, and half part sand (acid).

If sterilisation is adopted, I think horse manure will be the best humus ingredient for composts. It contains the three principal plant foods, and is not so sticky as either cow or pig manure. Being unable to procure good leaf mould, I use seaweed, horse dung, topsoil, and sand, and find they make a very good compost.

Question 3.

On a naturally retentive type of soil, the following is a satisfactory method of constructing a winter teeing ground:—The site is first marked out, care being taken to see that it faces correct line of play. Turf and top spit are then removed. The subsoil is dug out to a depth of 18 inches, and the space created filled with cinders and flint stones. These ensure a firm, porous foundation, over which there is little chance of hollows forming. To assist drainage, the tee is raised 1ft. above ground level. The material used for this purpose consists of one part topsoil, one part sand, and one part breeze. When this has been firmly trampled into position, a surface layer of prepared compost completes the building process. Good seed mixtures are obtainable for teeing grounds, but, personally, I prefer old turf, providing it is reasonably clean. Lolium Perenne and Poa Trivialis, as well as the fescues and bents, form a suitable herbage.

A muddy surface is the cause of a lot of trouble on tees. Worms are mainly responsible, and they should be eradicated. If plenty of gritty material, such as sand and breeze, is frequently worked into the turf, a firm surface will be ensured.

Mats saturated with sand are used on some courses, and, undoubtedly, provide the condition for a firm stance. I think the adoption of materials other than turf for the surfacing of teeing grounds would tend to create too much of an artificial appearance. It is quite true that players do find tees rather slippery during very bad weather, and while every effort should be made to prevent this occurring, there always will be some golfers who make a "slip" on the tee. After all, the elements of chance is the spice of golf.

Question 4.

LEATHERJACKETS.

The worst pests that greenkeepers have to contend with are undoubtedly leatherjackets. They include a variety of species, the most prominent of which is Tipula Olaracia. Its habits, life history, and the nature of injuries it causes, are too well known to need comment.

I have tried numerous preparations for eradicating the grubs. I find that one application of any of them is seldom sufficient, and the continuous use of strong insecticides soon does more harm than good. Such remedies are not only detrimental to the growth of fine grasses, some of them are poisonous, and kill birds which devour the grubs. However, I have found each of the following to be successful in bringing grubs to the surface :— Paris Green, 1lb. to 50 gallons water; Jeyes' Fluid, 1 pint to 100 gallons water; copper sulphate, dissolved as advised, for worms.

Tarbol and Helicide are useful proprietary remedies. The best preparations I have yet tried is Premex Soil Fumigant; the price and sample bottles can be obtained from Pattisson's, Stanmore. The natural enemies of the leatherjacket include starlings, plovers, rooks, pheasants, and wasps. Starlings deserve special comment. I have no hesitation in saying that these little workers have prevented many golf courses from being completely eaten out by pests.

A problem in connection with the eradication of leatherjackets is that attacks are not confined to greens alone; the pests exist in both rough and fairways. Often, when greens are treated and the grubs disposed of, the pupa on the surrounding ground mature, the flies lay their eggs on the greens, and the whole expensive programme of eradication has to be repeated. In view of this, I think the trouble with leatherjackets will not be overcome until a really efficient and economical remedy is discovered for either preventing the female fly from depositing eggs on greens, or by destroying the eggs so that grubs do not appear.

By experimenting on a small lawn which has been subjected to yearly attacks of the pest, I have found the following to be effective (I cannot, however, vouchsafe for its complete success, until it has been tried out on a larger scale) :—As soon as flies begin to emerge from pupa cases, and during such time as they are on the wing, dress turf weekly with powdered napthalene, about 2oz. per square yard. Tie together three or four sacks that have been treated with paraffin until they are damp; drag these over the affected area once each day. The paraffin odour permeates the grass leaves, and together with napthalene, makes conditions disagreeable for egg-laying. It is claimed that arsenate of lead applied frequently, at ½oz. per square yard, is a good preventive. The substance is a potent poison, and I have not tried it.

COCKCHAFERS.

Cockchafers or white grubs do considerable damage to grass and other crops. The female beetle burrows into the ground and deposits as many as 70 eggs. After about six weeks the larva hatches out, and lives as long as four years in the soil, eating away at the roots of the plants. During the summer of the fourth year the grub becomes a pupa, and about the following May the beetles appear above the ground. They fly at dusk each day for about half-an-hour, and can be recognised by the booming noise made during flight. They swarm on bracken and trees, usually isolated trees, outside of woods. I am told that, in France, cloths are placed under trees, the beetles are shaken down and collected by the sackful. A scoop and box apparatus was devised a few years ago in Yorkshire for collecting beetles that had swarmed on young bracken.

I have not had to contend with the cockchafer nuisance on golf courses, but have experienced the trouble in both agriculture and gardening.

Napthalene, broadcast at the rate of 2 cwt. per acre, was beneficial. In gardens I have trappd the grubs by placing pieces of turf face downwards. They have a habit of collecting beneath heaps of turf and dung. The natural enemies of the cockchafer are rooks, starlings, gulls, moles, and bats.

ANTS.

Previous to the war, while farming with my father in Lincolnshire I had a good deal of experience in the management of pasture and meadow lands. We had one or two fields with anthills dotted all over. The ants were diminished by first piercing and loosening each hill with a fork; a small quantity of petrol was then poured over the top and ignited. Subsequent ploughing up of hills and harrowing down completed the work. I have, at various times, had several remedies given to me for the destruction of ants. I have had no occasion to employ them in greenkeeping, but I repeat them, as they may be worth a trial, if any greenkeeper has to combat with the nuisance :—

(1) Search out the nests, dig up and dress with air-slaked lime;

(2) Fumigate by applying a preparation made from 1lb. napthalene dissolved in a gallon of paraffin;

(3) Dress the tops of the hills with a strong solution of nitrate of soda and water;

(4) Dissolve 2oz. of carbon bisulphide and apply in the same manner as (3).

A few years ago, together with other members of the Greenkeepers' Association, it was my pleasure to visit the Belfrairs golf course, at Southend-on-Sea. Here we were shown a species of ant known as the horse ant, or hill ant (Formica Rufa). These insects infested the course and caused considerable trouble. I am indebted to Mr. A. A. Keeling, F.R.H.S., Parks Superintendent, Southend, for the following information concerning them.

The ant is usually found in the greatest abundance in pine woods, where it constructs its nest heaps, making use, in many cases, of rotted tree stumps, and also building under brushwood, with decayed twigs and similar débris gathered from the floor of the woods.

The method of eradication that was recommended was :—That all nests should be located, and a shallow tunnel, the width of a spade, made

round each nest, and the channel filled with powdered quicklime to a depth of about one inch. The lime should be watered thoroughly to produce a semi-fluid condition, thus forming an effectual barrier against the egress of the ants. The nest is then loosened up, and carbon bisulphide, about one quart to a nest, poured carefully over the top. On this a piece of sackcloth is placed. The carbon-bisulphide forms a gas which is heavier than air, and, therefore, will gravitate down to the bottom of the nest, and so dispose of the ants. This method was tried and found to be very laborious, and a method of burning with petrol was resorted to, and this has the effect of keeping the ants down. Having mentioned napthalene as an insecticide suitable for use against leatherjackets, cockchafers, and ants, the following information concerning it may be of interest :—

To the chemist, the substance is a hydro-carbon. It is largely sold, in tablets and balls, for the prevention of moths in clothing.

It is a tar distillate, obtained as a by-product in the making of gas. It evaporates slowly when exposed to air, and in the refined state is white in colour.

The substance is harmless to plants, and readily dissolves in paraffin and other oils. It throws off a vapour which destroys pests.

Question 5.

In answering the question, *Should a newly-made green be turfed or sown?* certain circumstances have to be taken into consideration.

If good turf from a nursery is available, consisting mainly of the desirable bents and fescues, I would prefer it to seeds. Owing to the care that had been expended on it, it should be free from weed and pest troubles. There would be very little risk attached to its use, and the green would be ready for play almost immediately. If, however, coarse grasses, weeds, and pests were likely to be introduced by using inferior turf, then I would prefer seeds, because a lot of money would have to be spent subsequently on renovation work.

Some purchased turf appears to contain nothing but desirable grasses, but when it comes under the influence of a modern mowing machine weed seeds, lying tucked away, commence to grow, and soon cause trouble. Therefore, no turf should be laid on a putting green unless it has been subjected to close cutting for some time previous.

Cumberland turf has made many fine bowling and putting greens, and if I was situated in a vicinity where it was easily obtainable, other things being equal, I would prefer it to seeds. Turf costs more to purchase than seeds, and this, too, has to be taken into consideration.

A system of propagating turf by cutting up and distributing stolons of creeping grasses is practised in America. Trials are also being carried out in this country.

Some time ago I experimented on a small plot with some stolons of Agrostis and Hard Fescue seed. The ground was carefully prepared, the stolons cut and distributed, and the seed sown at the same time. The combination formed good turf.

I cannot, however, see how the propagation of turf by stolons is going to be any more economical and satisfactory than the sowing of seeds or the cultivation of a turf nursery. Planting the stolons, maintaining the beds, collecting, and cutting into small pieces for distribution, would entail a good

deal of labour and expense. Another objection is that there are very few species suitable, and if these fail there is no stand-by.

Against the argument that stolon grasses only are more suitable for golf, is the fact that the leading golfers of to-day continue to hole putts, and do scores of anything between 60 and 70 on turf propagated from seeds of a variety of grasses.

Question 6.

Soil, the product of decayed vegetation and rocks, is the source of all life. Nobody could live without it. Although science has shown us the origin, distribution, and, to some extent, the composition of soil, investigations into its fertility or the state of productiveness by which plants thrive, still go on. Constant efforts are being made at colleges and research stations to ascertain how this substance of tiny organisms and mineral matter can best be treated so that it will systematically produce and uphold the particular plants that man requires. Soil acidity has been the subject of a number of theories and counter-theories. However, as a direct answer to this question I favour a soil neutral in reaction for greens, tees, and fairways, because I think such a soil is just about sufficiently fertile to grow the desired species of grass, under average conditions. Providing humus is present, an alkaline soil is generally very fertile, a rank growth and mixed herbage mark its trail.

If a course is situated on moorland or heath, and the soil is naturally acid and a success, there would be nothing gained by endeavouring to make it neutral. It must, necessarily, take a long time to prove freedom from disease and economy in upkeep of greens, teeing grounds, and fairways that have been made acid by the application of chemicals. I understand that the Board of Greenkeeping Research are investigating this matter.

I am told that the disease known as "Brown Patch" fungus has increased in America since acidifying methods were adopted. I know, from farming experience, that if a soil is sour, if it is exhausted by continuous cropping, or if the land is addicted to fungi diseases, it is a recognised practice to use lime. But what is suitable in agriculture is not necessarily suitable in greenkeeping. Science, with the help of time, may prove an acid soil to be the best, and may also find quicker and more economical methods of rendering alkaline soils acid.

In connection with such investigations, one fact is outstanding, and that is that research into greenkeeping problems is research into soil and plant problems, and, as such, will greatly assist both the farmer and gardener.

A very useful apparatus for testing the acidity or alkalinity of soils is the B.D.H. (British Drug Houses) soil testing outfit. It consists of a liquid indicator, a small porcelain boat, and spatula. When a little soil is mixed with a few drops of the liquid, a colour is produced which denotes the acidity or alkalinity of the soil. Full instructions are supplied with each set, together with particulars of P.H. (Power of Hydrogen-ion) values corresponding to the various colours. Very accurate determinations of the P.H. of soils are arrived at by means of a capillator. The small outfit, however, is quite useful for ordinary testing purposes.

Here it is necessary to bring this essay to a close. I believe that the exchange of ideas by greenkeepers through the medium of an essay competition encourages "hard thinking," which tends to promote efficiency, and, therefore, generally uplifts the standard of greenkeeping. For this reason it has been a great pleasure to take part in the competition.