tion and has been semi-finalist in the Amateur Championships of 1905, 1907, 1914 and 1919. In the past twenty years he has qualified in all but four of the Amateur Championships, and in addition has been captain of the Walker Cup Team. Prior to his term as President, he served for two years as Vice-President of the Association, in 1924 and 1925.

Further Experiments in the Control of Japanese Beetle Grubs

By B. R. Leach, Riverton, N. J.

The results of five years of experimental work in grub, worm and weed control in fine turf by the use of arsenate of lead were announced to the members of the Green Section at Chicago in 1926. Since that time the method has been under test by many golf clubs in various sections of the country, and, judging from my correspondence and conversations with greenkeepers and officials of various clubs, it would appear that the method is producing the desired results in a measure even greater than was originally hoped for, and that it promises to become a valued part of the accepted turf-maintainance system.

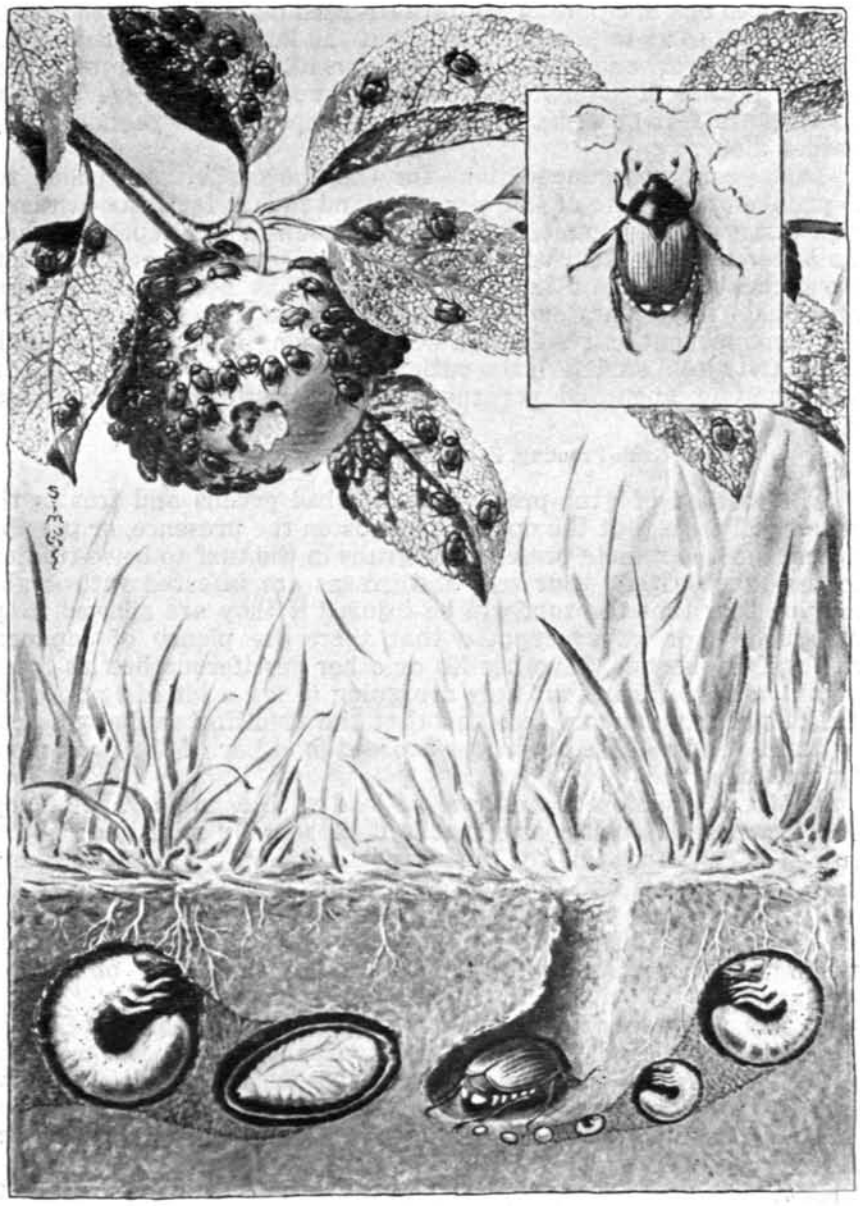
In view of the satisfactory reports on the use of arsenate of lead on fine turf during the past two years there need be no hesitancy in announcing the experimental results obtained during 1927, since they provide a basis for a decided simplification of the method with resulting reduction in the items of labor and cost of materials.

These latest results have been obtained in part by the continued maintainance and observation of the experimental plots at Riverton, N. J. In addition, however, much further information has been obtained as a result of very conservatively planned, extensive treatments of the turf of several golf courses in which all applications of arsenate of lead have been made under my personal supervision. I refer primarily to the Pine Valley Golf Club at Clementon, N. J., the Riverton Country Club, the Morris County Club at Convent, N. J., the Ashbourne Country Club, of Philadelphia, as well as various other clubs at which I have had the opportunity of observing the results of lead arsenate applications.

The most outstanding development, as a result of the years' work along the above lines, has been the gradual disclosure that decidedly less arsenate of lead is necessary to secure grub-proof turf than had previously been supposed; that, in fact, as little as 15 per cent of the amount of arsenate of lead formerly recommended is ample.

Grub-Proofing New Greens and Tees

Where it is desired to grub-proof greens and tees while in the process of construction and before the seed or stolons are sown, apply five pounds of arsenate of lead to each thousand square feet of soil surface and scratch in with a short-toothed rake to a depth of one-half inch. Do not work it in any deeper than one-half inch, otherwise you will lower the toxicity of the upper soil layer which is the only layer that counts in grub control. Do not apply the arsenate until all grading, smoothing and contouring is completed, otherwise you may bury the arsenate in spots with a layer of unpoisoned soil. In



JAPANESE BEETLE (*Popillia Japonica*)

The beetle deposits its eggs in the soil. The larvae, or grubs, hatching from them, feed on grass roots and decaying vegetable matter until autumn, when they become full grown. No feeding occurs during the winter, but in the spring the grubs feed for about a month before transforming to the tan-colored pupae. These change to the adults, or beetles, and emerge about the middle of June. The beetles cause damage by feeding on foliage and fruit. The grubs cause serious injury to sod lands through the damage which they inflict on the roots of grasses. Stages in soil, and inset, somewhat enlarged; beetles on foliage and fruit much reduced. (From U. S. Dept. of Agric. Cir. 363).

applying the arsenate to tees or greens in the process of construction it is best to mix the powder with a fair-sized bulk of moist (not wet) soil or sand, so as to prevent blowing of the fluffy powder, reduce the chances of error, and insure an even spread. It is easier to spread the five pounds of arsenate mixed with a bushel of soil over a thousand square feet of surface than it is to spread five pounds of the powder alone.

Last year's recommendations for the above operation called for 35 pounds of arsenate of lead per thousand square feet, as contrasted with this year's recommendation of five pounds, the depth to which the latter amount is to be worked into the soil being reduced from two inches to one-half inch. The change has been made because large scale treatments show the 5-pound dosage to be ample. The new recommendation results in a decided saving in the labor of application and also a saving in the outlay for arsenate of lead at 14 cents per pound of about $4 per thousand square feet of soil surface so treated.

Grub-Proofing Established Greens and Tees

The method of grub-proofing established greens and tees is the same in all cases, but the dosage depends on the presence, or possible presence or the remote presence, of grubs in the turf to be so treated. Let us suppose that your tees and greens are infested with grubs, and you fear that the turf will be injured if they are allowed to go undisturbed; or let us suppose that there are plenty of Japanese beetles, May beetles, June beetles or other pestiferous beetles flying around, and you fear that they are going to lay a lot of eggs in the turf of your greens and tees and that the resulting grubs will spoil the turf. Under these conditions proceed in either of the two following methods:

1. Mix 25 pounds of arsenate of lead with a cubic yard of topdressing material, being sure that it is thoroughly mixed and not all lumped in one portion of the topdressing, and apply it to 5,000 square feet of turf. This will give it a fairly smooth covering, but not too heavy. Work it in with a rake or broom. Do this when the grass is dry so that the topdressing works down through the grass without sticking, thereby avoiding even the slight possibility of surface burning.

2. Mix five pounds of arsenate of lead with a bushel of moist screened soil or sand, and scatter this over a thousand square feet of turf just as you would sow seed. This is the easier of the two methods, provided you have a man who can sow the bushel of poisoned soil evenly. Old-time farmers can do this to perfection, but the ordinary workman is a "dub" at this job.

It will be up to the greenkeeper to use his own judgment as to the best method of application. When No. 2 is followed it is important to apply the lead arsenate only when the grass is dry, otherwise the arsenate may stick to the blades of grass and cause a temporary burn—nothing of a lasting nature, but enough to spoil the color for a few days.

When the above dosage, which is relatively heavy when put on in one application and only recommended on fine turf when facing an emergency, is applied, worked in and watered, the arsenate of lead penetrates into the soil to a certain extent, and if you watch

the grubs present in the turf, you will note during the course of a week to ten days that they are beginning to succumb to the poison. Bear in mind also that they cease eating the roots for some time before they die, due to the arsenic making them sick. So much for high-speed grub-proofing.

Let us suppose, on the other hand, that no grubs are present in the tees or greens, but that the Japanese beetle is working your way, or that your turf has been spoiled in the past by native grubs and that you wish to have your turf grub-proof so as to play safe. In this event mix five pounds of arsenate of lead with a cubic yard of topdressing and apply it to 3,000 square feet of turf. Repeat this with the next four topdressings. This will give you a grub-proof turf in the course of four or five months, depending on how frequently you topdress. If you prefer to mix the arsenate with a little soil or sand and sow it over the green as you would seed, well and good; only be sure it is sown evenly.

Maintaining the Grub-Proofed Green or Tee

After the green or tee has been grub-proofed by either the heavy or light applications described above, you can not topdress repeatedly with unpoisoned soil from then on. If you do this, you will gradually bury the layer of poisoned soil and the grub-proof condition of the turf will be lost. As you apply topdressing to the surface of a grub-proofed green or tee you must apply arsenate of lead in proportion so as to poison the layer of soil so applied in grub-proof condition also. For every application of topdressing one-half pound of arsenate of lead should be applied to each thousand square feet of turf, assuming that you put the topdressing on at the rate of one cubic yard to 5,000 square feet of turf; or, in other words, that you apply it in a layer one-sixteenth of an inch thick. You can put on three or four unpoisoned topdressings and then apply all the lead arsenate that should have gone with them at one time, that is, one and one-half or two pounds per thousand square feet as the case may be. Ammonium sulfate and lead arsenate may be mixed with the topdressing and the mixture applied with safety, thereby resulting in a saving of labor.

Poisoned Barrier Around Greens and Tees

I have repeatedly advised against the prevailing tendency among greenkeepers and green committeemen to stop short with all treatments at the edge of the green or tee. Let me again reiterate that all approaches and an area at least ten feet wide around greens and tees should be poisoned regularly. Poisoning the turf immediately adjacent to the green or tee is very important in keeping the latter free from pests. There are plenty of grubs, worms and weeds in this area just outside the green or tee, and they will constantly invade the latter unless they get a dose of the poison before they reach the edge. Where June beetles are plentiful, a strip 50 feet wide around the green or tee will be necessary in order to keep them out.

Steep banks or tees and greens are a problem in grub-proofing, inasmuch as the surface soil has a tendency to wash badly, carrying the poison with it. It will be necessary to watch these steep banks closely and apply arsenate of lead more frequently where washing occurs.

Grub-Proofing Fairways

Fairways, due to the acreage involved and their infrequent top-dressing, are best grub-proofed by methods differing somewhat from those employed in the case of greens and tees.

Arsenate of lead, 250 to 300 pounds per acre, when properly applied, controls grubs and worms in fairways and gives an appreciable weed control. The method of application is optional with the greenkeeper and depends to a certain extent upon his course and equipment. To date I have found that the best method is to mix the arsenate of lead with fine soil, or sand, and apply it to the turf with a lime spreader. Hang burlap bags on the front and back of the box so that they touch the ground, thereby preventing as much as possible the arsenate of lead from blowing when it is dropping to the ground from the feeders. If the machine tends to drop the arsenate in drills, steps should be taken to break up each stream before it reaches the soil surface, the idea being to get the poison on evenly all over the turf rather than in streaks. Use enough soil or sand to give enough bulk so the machine will cover an acre while you are putting on 250 to 300 pounds of the arsenate, the amount of soil filler depending, of course, on the type of machine employed. I have not as yet tried cottonseed meal as a filler, but have an idea that it would prove very satisfactory. Follow the spreader immediately with a spike or spring-tooth alfalfa harrow so as to lightly scratch in as much of the arsenate as possible. It is also a good plan to harrow both ways across the field.

How long this system and dosage will insure grub-proof fairways can not be stated at this time. On relatively level areas I believe it will insure grub control for at least two years and that the fairway turf can be maintained in that condition by the annual application of 100 pounds of arsenate of lead per acre. Sloping fairways where washing occurs is, of course, a problem, and I do not have much data as yet along this line.

Everything considered, the treatment of fairways by this method is sound. It is a very cheap method of grub and worm control, costing as it does from $35 to $40 per acre for the chemical and with a relatively low labor cost for applying it to the turf.

At the present time I am supervising the grub-proofing of 60 acres of fairway at one of the Philadelphia golf clubs, the fairways having been badly damaged by Japanese beetle grubs together with an infestation of June beetles in spots. Two-thirds of the grass was dead when we began applying the arsenate of lead in late October. Within ten days after the application of the lead a large number of the grubs were in that characteristic "flabby" condition, which is the first indication that the grubs are beginning to feel the effects of the poison. A normal, healthy grub is always tightly curled up with the head and tail close together, and the flesh is firm to the touch, whereas grubs that are beginning to feel the effects of the poison are not tightly curled and the flesh is soft and flabby. When grubs reach this stage of arsenate poisoning they eat very little, hence while they hang on to life for a little while longer, turf injury is checked.

How small a quantity of arsenate of lead is necessary to grub-proof turf can not be stated definitely at this time. In this connec-

tion, however, at a certain club in the Philadelphia district early last summer, all the creeping bent greens but one were given one application of ten pounds of arsenate of lead (about two pounds per thousand square feet). No additional arsenate of lead was applied. These greens today are firmly turfed and in splendid condition, except along the edges where the grubs have crept in and chewed up the turf to some extent. The one unpoisoned green is cut to pieces with grubs, and the turf can be rolled up with the hands—all this in the presence of one of the heaviest Japanese beetle infestations in my experience, for the fairways were simply teeming with grubs. This experience is given merely as an indication of the value of arsenate of lead as a grub-control measure and not as a dosage recommendation. It does not seem advisable to be stingy as regards the amount of arsenate of lead applied to turf, since the chemical is relatively cheap and an absolutely grub-proof condition is the object of the treatment.

Time for Treating a Fairway

If grubs are not present in the fairways, but an infestation is feared, apply the entire amount of arsenate of lead at one time before the first of June. This will insure its being on the turf before the beetles begin laying eggs. If grubs are present in the turf and injury is feared, apply the arsenate of lead at once, regardless of the season, provided the ground is not frozen or muddy.

In conclusion it seems advisable to issue a word of warning regarding the grade of lead arsenate used in poisoning the soil for control of the Japanese beetle where turf grass is to be grown. As the demand for the poison increases it is not inconceivable that a lower grade of material may be put on the market which might be more or less injurious when applied to the fine turf grasses. As a safeguard, therefore, the purchaser of lead arsenate should always demand a grade similar to that used for insecticidal purposes.

An Unusual Golf Course Pest

A recent letter from Mr. L. W. Kephart, who has spent several months in plant exploration in East Africa for the United States Department of Agriculture, tells of a problem that greenkeepers encounter in some parts of that country, but with which they are never likely to be confronted in the United States. In speaking of the golf course at Jinja on the north shore of Lake Victoria in the Province of Uganda, he says:

"In the evening Bill and I took a stroll out across the beautiful little golf course that has been built along the hillside overlooking the lake and the falls. The Jinja golf course is, undoubtedly, distinguished from all other golf courses on earth, by reason of the fact that one of the chief difficulties of its manager is to keep the hippopotamuses off the greens. I have no doubt that many an inebriated American golfer has seen green crocodiles and purple hippos in his sleep, but here they are a sure enough hazard. One evening, not long ago, a dance was held at the golf club. During an intermission two couples went out for a stroll across the grass in the moonlight. Coming to a nice shady mound they sat down to enjoy the moonlight, when the mound with an enormous grunt rose up beneath them, scattered the couples wildly in all directions and moved off. Since