Turfgrass Entomology

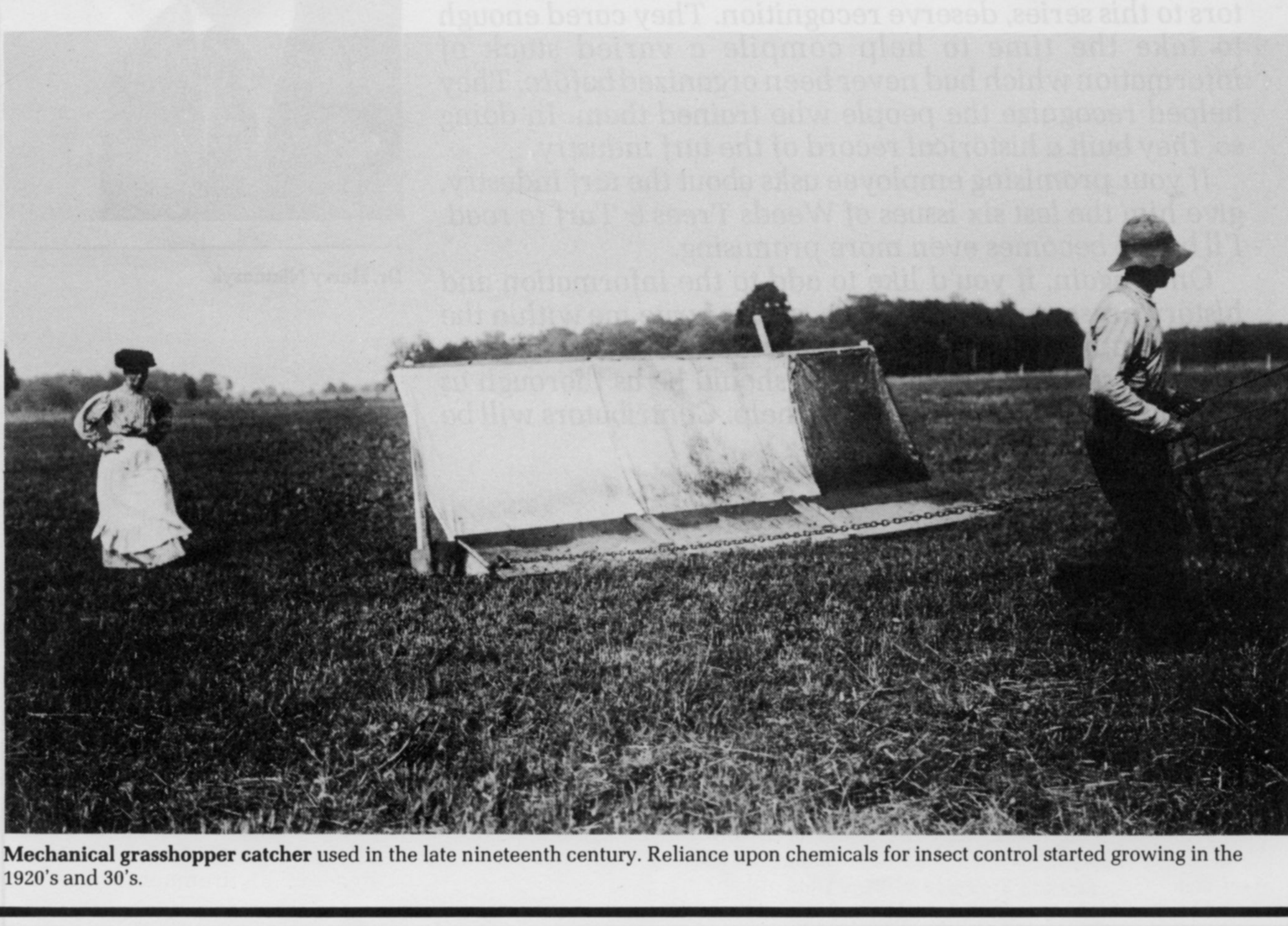
Past, Present & Future

Insects have been responsible for plagues, agricultural disasters, destruction of stored food and clothing, and a great deal of discomfort to man and his beasts. Insects and their arachnid relatives (spiders, mites) outnumber all other members of the animal kingdom and can dramatically increase in population under the right conditions. Only man and natural enemies of insects can prevent excess population problems.

Insects cause an estimated $20 billion in damage to forests, farms, and structures in the United States each year. Dr. James Reinert of the University of Florida Research Center, Ft. Lauderdale, determined that the mole cricket caused more than $100 million in damage to turf and pasture from 1976 to 1978 in the state of Florida alone. Professional turf managers spend more than $30 million per year for turf insecticides (WTT Survey 1980). Homeowners purchase large amounts of turf insecticides as well.

The need for control of damaging insect populations is evident. However, methods to achieve control are undergoing scrutiny due to heightened environmental awareness and resistance to some insecticides by target pests. Research on pesticide use, diminished by an overreliance on pesticides now cancelled or greatly restricted, needs to be restored. Only nine entomologists at U.S. universities and extension centers devote a majority of their time to turfgrass pests. The chemical companies are faced with extremely high product development costs. If many agricultural products could not be applied to turfgrass uses, a serious problem would exist. Even then, it takes specialized research to get agricultural labels expanded to turfgrass uses.

Shorter residual chemicals require more precise application and timing. Control efforts need to be directed specifically at times when the pest is most vulnerable. "Now, more than ever before, the applicator must have



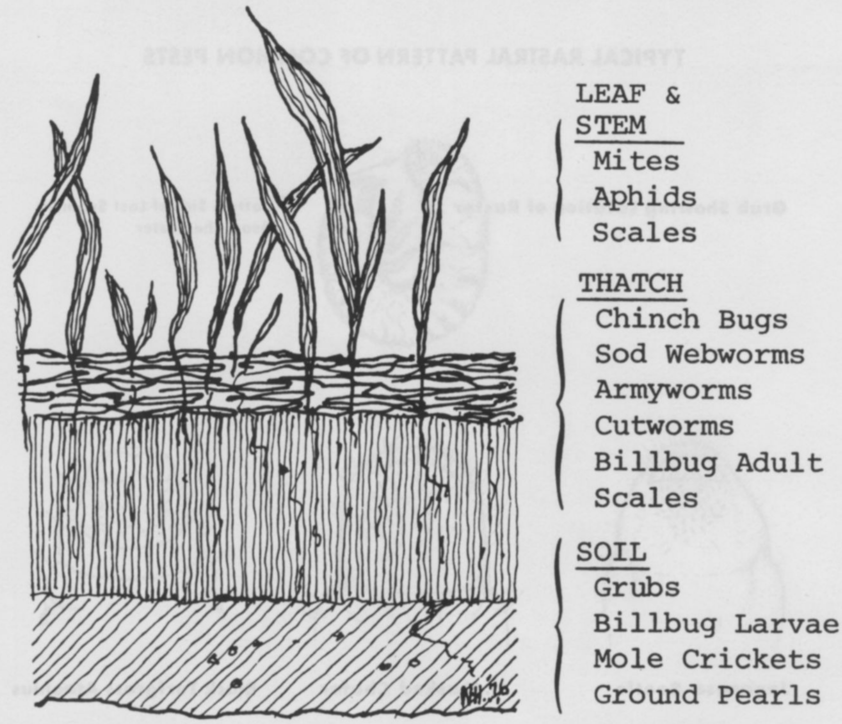
Mechanical grasshopper catcher used in the late nineteenth century. Reliance upon chemicals for insect control started growing in the 1920's and 30's.

knowledge of the target pest's life cycle," stresses Dr. Harry Niemczyk, professor of turfgrass entomology, Ohio Agricultural Research and Development Center, Wooster, Ohio. Additional training will be needed to apply turf pesticides in the future, Niemczyk suggests. "Virtually every segment of the turfgrass industry is in serious need of a basic foundation in the principles of dealing with today's insect problems."

The original insecticides included materials such as soap suds, turpentine, petroleum and fish oils, lime, sulfur, vinegar, pepper, tobacco, and wood ashes. Paris green, a copper/arsenic compound, was developed in 1867 and proved effective against chewing insects. Later in the century, arsenates of lead and calcium were developed and put to use. Plant derivatives such as pyrethrum, from the flowers of the genus *Chrysanthemum*; rotenone, from the roots of leguminous plants; and nicotine, from tobacco, have been used for centuries.

Early turf managers borrowed control measures from garden and agricultural sources. One source of pest control information for turf managers prior to World War I was a book still published, *Insect Pests of Farm, Garden and Orchard.* First written by E. Dwight Sanderson in 1912 and published by John Wiley and Sons, the book has since been revised by Leonard M. Peairs, R. H. Davidson, and W. F. Lyon. A Seventh Edition is now available, having been revised in 1979. Perhaps the longest continuously published book on the subject, it provides a good profile of economic entomology in the U.S. as it developed.

A great deal of the early literature on entomology was written in the mid- and late-30's. In a speech before the National Association of Greenskeepers of America in Cleveland in 1936, J. S. Houser, chief, Ohio Agricultural Experiment Station, Wooster, gave a thorough account of the description and control of sod webworms and chinch bugs. He reported on the severe outbreak of sod webworm in the summer of 1931 when, "the moths were so abundant on the windows of lighted rooms in the vicinity of grasslands that one could not place one's fingertip on the glass without disturbing one or more of the insects." Houser added, "It is of the utmost importance that an outbreak of sod webworm be detected in the early stages, because if checked in time, serious harm, particularly to greens, may be averted. At the outset, the taller grass of aprons and of other areas is more subject to damage, and if



Location of the pest at the time of control is absolutely necessary information.

the insect is not controlled it may spread to the greens. Moreover, the smaller, partly-grown larvae are more susceptible to the effect of treatment than are the larger, more nearly mature individuals."

For control Houser recommended lead arsenate dust brushed into the turf with stiff fiber brooms. One good indication of sod webworm is an abundance of grackles and starlings on greens, Houser added.

Lead arsenate dust, however, would not control the "hairy chinch bug" said Houser. The insect feeds on the sap of the grass plant giving it a desiccated appearance. It is most active on hot, sunny days. Houser reported nicotine-lime dust and commercial tobacco dust most effective when applied and the turf covered with canvas for five hours. Alternative controls were liquid sprays of nicotine sulfate and pine tar soap, a type of alcohol, or other penetrant. Certainly, covering a green for five hours was a severe interruption to play.

K. E. Maxwell, an entomologist at Cornell University, Ithaca, NY, reported in 1934 that nicotine sulfate (Black leaf 40) alone or combined with rosin fish oil soap or potassium cleate soap was effective against chinch bugs.

An extension release bulletin by R. H. Pettit of Michigan State College in 1932 gave these control recommendations:

Webworms—carbon disulfide emulsion, pyrethrum extract spray, or arsenate of lead.

June beetle grubs—arsenate of lead.

Wireworms—carbon disulphide or liming.

Ants—Paris green mixed with brown sugar.

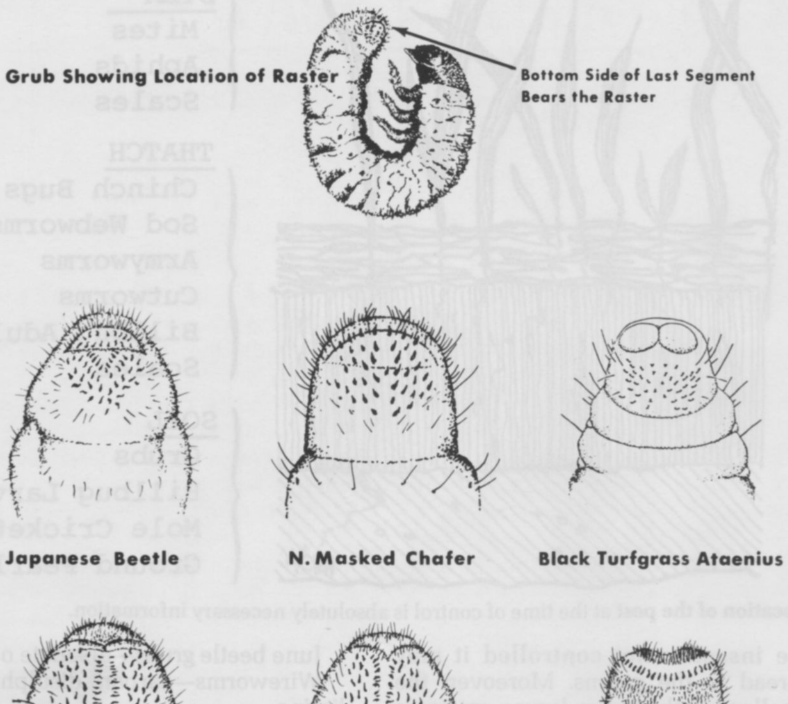
Earthworms—mercuric chloride or corrosive sublimate.

In general, arsenicals were used for chewing insects and nicotine was used for sucking insects. Carbon disulphide emulsion and pyrethrum were used as contact poisons.

Insect control became oversimplified after World War II with the development of the long residual DDT and the chlorinated cyclodiene insecticides (aldrin, dieldrin, heptachlor, chlordane, bandane). These materials lasted for years in the soil, providing almost timeless control. Chlordane received extra use as a herbicide for crabgrass. Today, years after applications, chlordane residues can be found in the soil of many fine turf areas. Insect resistance to these products has counteracted their residual life.

The simplicity was not to last. Environmental pressure was bought upon chemical companies and the United States Department of Agriculture primarily because the technology to find minute traces of chemicals in soil and water was discovered, the gas chromatograph. In the late 60's the pressure grew, and in 1972 a law stronger than the 1947 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was passed. This new act, the Federal Environmental Pesticide Control Act, created the Environmental Protection

TYPICAL RASTRAL PATTERN OF COMMON PESTS



Hair patterns on the last segment of a grub indicate the type of insect. Control measures may vary with the type of insect and there is no single control for all grubs.

Agency and took control of pesticide regulation away from USDA and the Department of the Interior. Revisions to the law in 1975 and 1978 have changed greatly the use of pesticides in the U.S.

One of these changes was the cancellation of all uses of DDT and many uses of the chlorinated cyclodiene insecticides. Substitutes had to be found. The chemical industry and the few turfgrass entomologists combined efforts to gain new use for a group of pesticides called organophosphates (diazinon, chlorpyrifos, and trichlorfon). Due to their lower mammalian toxicity, carbamates (carbaryl, propoxur, aldicarb, etc.) received favorable treatment by EPA.

These products remain the basis for turf insect control. Development of new products has not stopped completely. Research outside of the U.S. has produced a few promising candidates for this country. But the dominant source of new materials is the agricultural insecticides market. New uses for existing compounds may provide some relief in the future.

To understand insect control, one must have a basic knowledge of the vulnerability of the target pest. Control methods vary with the type of insect, rendering some controls useless against some insects.

In a sense, insects are made up of many container-like segments attached together. Support comes from the container walls and not from an internal skeleton like vertebrates. Openings in the walls, or the exoskeleton, permit toxic materials to enter and disrupt life processes. Some of these openings include the mouthparts and breathing holes called the spiracles. Some insecticides have the ability to penetrate the exoskeleton, but for the most part, toxins must enter the insect's body through ingestion.

The type of mouthparts largely determines the control method. Chewing mouthparts indicate the insect consumes the exposed leaf tissue of a plant. Pesticide placed on the plant surface will be ingested. Piercing-sucking mouthparts are used to feed on fluids inside the plant surface. Therefore, pesticides located on the plant surface will have little effect on the insect. Rasping-sucking mouthparts are similar to piercing-sucking except for the method of entry to the plant fluids. Siphoning mouthparts are used to draw in surface liquids as are sponging type. To control sucking insects the pesticide must be in the plant juices. These materials are termed systemics, since they must enter the plant through the leaves or roots and work their way into plant fluids.

The circulation system of an insect does not use arteries and veins. A heart-like structure forces the blood to circulate within the exoskeleton. Running through the body are tubes which are attached to the spiracles or breathing holes. Gases flow through these tubes into the body of the insect for direct absorption by the blood. Fumigants can enter the body through the respiratory system and thus into the blood.

Another factor of vulnerability is the life phase of the insect. The growth process of insects is termed metamorphosis. There are four stages: egg, larva, pupa, and adult. In some insects the larva and pupa stage are replaced with a nymph stage. Grubs are the larval stage. If an adult can be stopped from laying eggs, then a grub problem can be avoided. Often, however, the larva stage is more susceptible to pesticides than the adult. It is important to know when the insect is in each phase.

Location of the insect is the third vulnerability factor. Chewing insects located on exposed leaf surfaces are the easiest to control. However, some insects burrow deeply into the crown of the turfgrass plant or into the soil, greatly reducing their exposure to pesticides.

Reaching the insect in the soil necessitates getting the pesticide to the pest by thorough drenching. Often the active ingredients will get tied up to the thatch or to soil particles before reaching the target. Organophosphates are generally less effective as soil insecticides than the now-restricted chlorinated cyclodiene insecticides. They can be applied either in solutions or as granuals to the surface and soaked into the soil. If you consider that some grubs may be under the surface by more than a foot, the diluted insecticide has a long way to go and stay toxic. For this reason, more preventative adult control measures are being stressed. The reduction of insecticide effectiveness by thatch may be restrictive to control in some circumstances.

Perhaps a lesson learned by an overreliance on highly residual pesticides is the develoment of resistant insects. Insects have tremendous reproductive capacity. If a pesticide lasts for ten or more years in the soil, the few insects that weren't effected by the pesticide become the genetic base for future populations. This fluke resistance quickly becomes a widespread tolerance or resistance to the chemical. Hence no control. Repeat applications prove equally ineffective. Alternative insecticides then become necessary.

Similar adaptation by turfgrasses affords some hope for natural controls in the future. If researchers can identify turfgrasses which insects avoid, they can perhaps lower the dependence on chemicals for control. Dr. Jack Murray and Dr. Roger Ratcliffe at the USDA Research Center in Beltsville, MD, have detected aphid resistance in some cultivars of bluegrasses, fescues, and ryegrasses. Northrup King has been doing similar studies at its Minnesota research farm. Reinert in Florida has been checking resistance of warm season grasses to mealy bug, bermudagrass mite, and the mole cricket.

On the other hand, the Hyperodes weevil has a specific liking for *Poa annua*. Dr. Harue Tashiro of the New York State Agricultural Experiment Station in Geneva, has studied this insect closely. Confined mainly to the Long Island area, the insect has the potential to spread since *Poa annua* is common, although usually unwanted, on many eastern courses.

Major Turf Pests and Their Control

There are a dozen serious turf insect and mite pests in the U.S. with the potential for more. Following is an outline of the insect, current control methods, and potential solutions of problems.

Aphids

The only aphid of significance to turfgrass managers is the greenbug, *Schizaphis graminum*. It is a serious pest of grain crops and forage grasses. The first damage to Kentucky bluegrass was noticed by Dr. Roscoe Randall of the University of Illinois in 1970. No damage to other turfgrasses has been found.

Four stages of metamorphosis for the Black turfgrass ataenius.

The greenbug, in the process of sucking out plant fluids, injects fluids to break down cell walls within the plant. This fluid kills living tissues in the plant, resulting in a yellow and finally brown appearance to affected turf. The aphids commonly infect Kentucky bluegrass under the canopies of trees.

Agricultural experts on this pest previously thought the aphid could not overwinter north of Kentucky. However, Ohio's Niemczyk and his "Angels" have discovered reinfestations in the same locations in consecutive years. Niemczyk suggests the reinfestation is more than a coincidence of migrating adults from the South selecting the exact same location every year.

Lawn care companies are reporting increased incidence of the pest in the Midwest. Organophosphates have limited effectiveness upon this pest which can produce 20 generations in a single season. Special local needs labels in Ohio for Orthene from Chevron and Pirimor from ICI have given improved control. Randell reported good control with malathion in 1978.

Murray and Ratcliffe at USDA, Beltsville, are studying turfgrasses resistant to the sucking damage of the greenbug aphid.

Ataenius

The Black turfgrass ataenius, *Ataenius spretulus*, has appeared sporadically on turfgrass across the U.S. In 1932, larvae of the pest were discovered in damaged turf on a Minnesota golf course. Similar damage was found in New York in 1970. Since then the number and frequency of sitings have increased and entomologists are concerned.

The ataenius larvae feed on the roots of both bentgrass and Kentucky bluegrass. This feeding takes place after the eggs hatch in late May to mid-July. Ohio entomologists have noticed a second generation of larvae in late August and September. At the end of this period the larvae enter a short pupal stage and emerge as adults. These adults can begin laying eggs in July. The adults tend to leave the fairways for tall grassy fringe areas to overwinter.

Symptoms may be a drought appearance in June and July despite adequate irrigation. The greenbug has not been identified to warm-season turfgrass damage. Since the larva does not burrow too deeply into the soils, controls work relatively well. Prior to the expansion of the label interpretations in 1978, turf managers had a pest with no labelled control. Now, an applicator may use a pesticide against any pest not on the label if the application is to a crop, animal, or site specified on the label, unless the EPA specifically requires otherwise.

Ohio entomologists are encouraging preventative control of the ataenius adult before it has a chance to lay eggs. Timing becomes critical in preventative control and regional entomologists should be contacted for information on timing.

Adult hairy chinchbug. This pest may produce three generations in a single season.

Billbugs

There are three primary species of billbug affecting turf. The bluegrass billbug is the only cool-season billbug pest. The transition zone and warm-season zones are bothered by the zoysia billbug and the Phoenix billbug which attacks bermudagrass. A possible fourth species has been discovered in Denver, Colorado.

In May and June, adults begin laying eggs near the crown on the stems of the turfgrass plant. After hatching, the billbug larvae feed on the stems, moving downward to the crown and eventually to the roots. Larvae are most abundant in July and August. Damage by billbugs can be confirmed by examining the crown of dying plants. Excessive damage in this area and the presence of a white, sawdust-like material in the root zone are good clues.

Control centers around adults in April to May and larvae from June to August. Entomologists lean toward adult control. Since the larvae move downward from the stem, to the crown, into the thatch and finally into the soil, control must change with their location. For example, soaking insecticides into the soil may leach them out of the thatch where the larvae may be at the time.

Chinchbugs

Like billbugs, there are cool and warm-season chinchbugs. The hairy chinchbug attacks bluegrasses, fine fescues, and bentgrasses. The southern chinchbug feeds on bluegrasses, zoysiagrass, and especially St. Augustinegrass.

Like the greenbug, chinchbugs suck out plant juices and at the same time inject digestive juices into the plant which cause death of plant tissues. Nymphs inflict the same type of damage to the turf as the adult. The hairy chinchbug may produce three generations in one year whereas the southern chinchbug may produce seven or more.

Chinchbugs take special advantage of patches of turf under summer drought stress. Eggs are laid in the lower leaf sheaths of grasses. Southern chinchbug adults are active year-round, whereas chinchbug adults are active from late March to late September.

Chinchbugs are highly susceptible to a fungus disease called *Beauvaria*, especially when the turf is adequately irrigated. Proper fertilization can help the grasses resist a second or third generation.

This highly reproductive insect has exhibited some resistance to many insecticides. When resistance has been a factor, Baygon has served as a good replacment. Early treatment of the population to reduce the size of future generations is good policy.

Murray and Ratcliffe at USDA, Beltsville, have studied the resistance of Kentucky bluegrass and fescues to chinchbugs.

Cutworms and Armyworms

These are the larvae of moths. The adult moths are active primarily at night. Armyworms are a serious southern problem with some northern damage. The bronzed cutworm has been a problem in the Maryland area. The black cutworm is a northern problem.

Cutworm larvae become active in April, feeding during the night and retreating into the thatch and soil during the day. There is one generation per year. Materials applied to the plant surface during the day must remain effective to kill the chewing pests during the night. Solutions of pyrethrins or detergents can excite the larve to the surface.

The armyworm is very similar in habit to the cutworm except that it is known to migrate during the night and can produce three generations in a single year. Control measures are the same as for cutworms. Consult regional entomologists for application timing. Early generation control is most efficient. The fall armyworm, unlike the true armyworm, can migrate northward to inflict damage.

Grubs

Grubs are the larvae of many different beetles, including the Japanese beetle, the ataenius, May Beetle, European and masked chafers, and garden beetles. Not only do grubs damage turfgrass by feeding on roots, but they attract damage from moles, birds, and skunks feeding on them.

To identify the grub, the turf manager must examine the bottom side of the last body segment, the raster. The pattern of hairs on the raster determines which beetle the grub will be. This identification of the type of grub is neded to determine the timing of control measures and in the case of Milky Spore Disease, susceptible target Japanese beetles.

Grub damage is most evident in the spring and fall. Patches of dead or dying turf appear. Presence of moles or flocks of blackbirds provide a clue to grub infestation.

Diazinon, Dylox and Proxol are the chief controls. They remain active in the soil for only two weeks so timing is critical. pH is a limiting factor with Dylox and Proxol, since high pH will cause premature breakdown. Diazinon is attracted to organic matter in the soil, sometimes binding to thatch and other matèrial reaching the pest. Uniform distribution and penetration to the pest's location are very important. Post-treatment irrigation is almost essential to good distribution.

Milky Spore Disease is effective only against the Japanese beetle. Use on other grubs will be useless. Overreliance on the chlorinated cyclodiene insecticides encouraged development of resistant grubs. Organophosphates are the main replacement. MoBay is currently working toward a label for isofenphos which shows promise for grub control.

Control of grubs is still one of the most difficult problems to conquer. Control of 75 to 80 percent is as high as can be expected.

Ground Pearls

Ground pearls are a warm-season turfgrass pest. They feed on the roots of centipedegrass and other warm-season grasses. The tiny little yellow-white ball-shaped nymphs attach themselves to the roots with their piercing-sucking mouthparts. become adults and remain attached for two to three years. They secrete a substance which creates a hard shell around them. Turf attacked by the Ground Pearl turns yellowish-brown in irregular patterns.

Control is very difficult. This is another reason for study of effects of thatch on insecticides drenched into the soil.

Hyperodes weevil

The Hyperodes weevil is a chewing insect that has a taste for *Poa annua*. Turf areas dependent upon *Poa annua* in the Northeast must control this pest or renovate to other turfgrass types. Adults emerge from overwintering locations in the spring and do minor damage to the turf. The major problem is the way the adult inserts eggs between leaf sheaths. When the insect hatches, the larva feeds within the stem and works its way downward to the crown to inflict serious damage. The larvae enters the soil to pupate and emerges eight days later as an adult.

Damage becomes obvious in late May and early June. Organophosphates applied at the time provide good control. The target area for the larva is the thatch, so soaking is not recommended.

Dr. Harue Tashiro at Cornell is the national expert on this particular pest.

Mealy Bugs

Related to the Ground Pearl, the rhodesgrass mealy bug is a sucking insect which locates in masses at the crown or at the nodes of the grass stems. It secretes a shell for protection like the Ground Pearl. Reinert of Florida has studied the bermudagrass mealy bug and has trials for resistant turfgrass varieties.

Mites

There are two mites of importance to turfgrass. The winter grain mite feeds on plant juices just under the leaf surface in the late fall and winter when temperature permits. They have rasping-sucking mouthparts. Evidence of infestation is limited and sporadic, but control research may be necessary. The winter grain mite lays bright orange eggs in the thatch and soil beginning in March. The eggs do not hatch until fall when they begin to damage bluegrass and fescue.

The bermudagrass mite is a serious pest in the South where they furiously suck out the juices of bermudagrass plants. Stems die individually as they are damaged. Liquid applications tend to be more effective than granular insecticde formulations for control of mites. Organophosphates do well. A serious threat by mites is to grasses grown for seed in the Northwest.

Mole Crickets

Although mole crickets occur as far north as Ohio, they are basically a southeastern problem. All stages feed on the roots and can weaken turf by disturbing the root zone.

Adults burrow into the soil to deposit eggs in the spring. Two weeks later nymphs emerge to feed on roots. Rootzone disturbance may be a bigger problem than root feeding says Reinert of Florida. The disturbance can uproot plants and create ridges, like miniature mole tunnels. The crickets come to the surface at night. Reinert reports good control with dursban, Baygon, Scotts Nematicide/Insecticide (ethoprop) and malathion.

Webworms

There are more than 30 species of webworms. The tropical sod webworm creates a larger problem due to a greater number of generations per year. The adults are small, grayish-white moths which fly over the turf at dusk. Female moths drop eggs into the turf as they fly. Eggs hatch in less than two weeks as caterpillars. These larvae construct tunnels through the thatch which they line with silken webs. They feed on the grass blades nearest to their tunnels. The larva is the destructive stage, not the adult. Larvae can be irritated with pyrethrins and brought to the surface for examination.

Insecticides applied to leaf surfaces work well. One webworm, the cranberry girdler, has been found in Illinois and Michigan. It feeds in the crowns and roots and must be treated as a soil insect.