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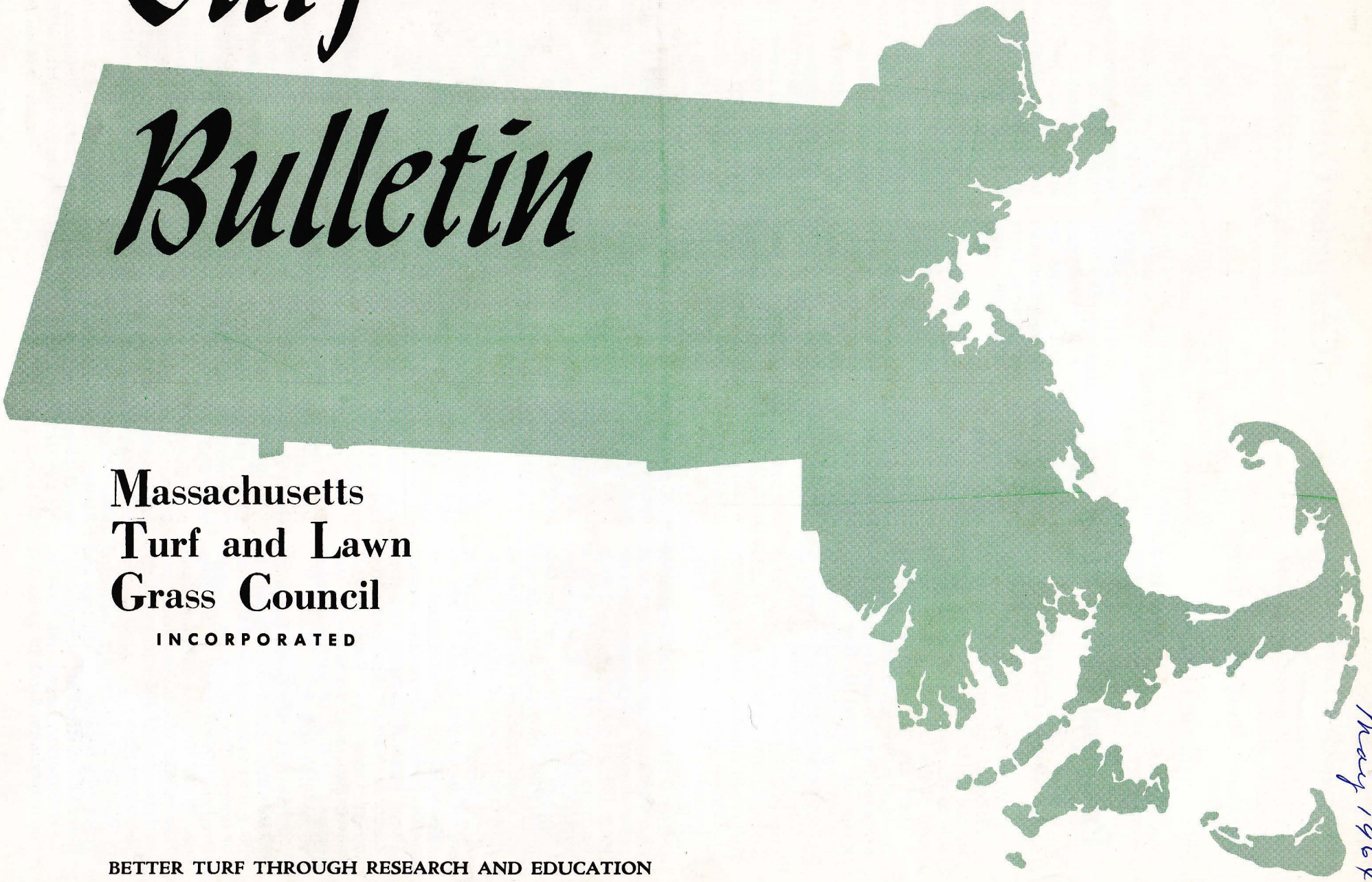
Turf Bulletin



Massachusetts Turf and Lawn Grass Council

INCORPORATED

BETTER TURF THROUGH RESEARCH AND EDUCATION

May 1964

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TURF BULLETIN

Vol. 2, No. 6 May, 1964

Principal Lakes of U.S. Described

A "WHO'S WHO" for all principal lakes of the United States of 10 square miles or more is now available to the public from the Department of the Interior.

They are listed in a 22-page Geological Survey publication and are described in non-technical language by Conrad D. Bue of Survey's Water Resources Division. A selected bibliography is provided.

The circular describes about 250 principal United States fresh-water lakes, located in 23 states. Nearly 100 are in Alaska. Another 100 are scattered throughout Minnesota, Wisconsin, Michigan, New York, and Maine.

The author, a hydraulic engineer, also tabulates the largest artificial reservoirs of 10 square miles or more (39) in each state. Largest is Garrison in North Dakota, with a surface area of 610 square miles, although Lake Mead, on the Colorado River in Arizona-Nevada, can store half again as much water as Garrison because of its great depth.

"Although the amount of water stored in natural lakes — even exclusive of the Great Lakes — is much greater than the amount stored in artificial reservoirs, their economic value, stemming from power, irrigation, flood control, navigation, and recreation, is surpassed by that of artificial reservoirs," Bue said.

Exclusive of the Great Lakes, 34 fresh-water lakes are known to have maximum depths of 250 feet or more. Twenty are in Alaska. Oregon's Crater Lake is the deepest (1,832 feet), and Minnesota's Lake of the Woods has the largest surface area (1,485 square miles), the report shows.

The Great Lakes are tabulated separately because of their size and described in effect as "inland seas." Lake Superior, largest and deepest, has a maximum depth of 1,302 feet and a surface area of 31,820 square miles.

The report also covers United States saline lakes, listing 27 principal salt lakes, most of them in the Great Basin area.

Largest is Great Salt Lake in Utah, saltier than the ocean, a "remnant" of ancient Lake Bonneville, which at its highest level covered an area of about 20,000 square miles. Present area of Great Salt Lake is about 1,000 square miles.

Geological Survey Circular No. 476, "Principal Lakes of the United States," may be obtained free from the Geological Survey, Department of the Interior, Washington 25, D. C.

Crabgrass Control

Joseph Troll, John Zak, and Donald Waddington
University of Massachusetts

Crabgrass is a perennial problem in most lawns and turf areas in the Northeast. Crabgrass plants detract from the beauty of a lawn and make mowing more difficult.

The two species of crabgrass most commonly found in turf areas are smooth crabgrass *(Digitaria ischaenum)* and hairy crabgrass *(Digitaria sanguinalis)*. Both are annuals and develop from seed each year. Smooth crabgrass is more prostrate in growth habit than hairy crabgrass.

HOW CRABGRASS GROWS

A crabgrass plant may produce thousands of tiny seeds which are dormant during the winter and cool spring. Germination begins in early May when soil temperature rises. The two-leaf seedling looks almost like other wide-leafed grasses and is not usually recognized by the average person. During the summer, the plants develop long stems which tend to grow close to the ground and send down roots at the joints. The growth of crabgrass is so rapid and dense that the basic turf grasses are choked out. Finger-like seedheads appear in August and September. Although frost kills the crabgrass in the fall, the seeds remain at the soil surface and are the source of the next year's infestation.

CULTURAL CONTROL OF CRABGRASS

Good management practices, including mowing, liming, fertilizing, and watering, will increase the vigor and density of turf grasses and minimize the infestation of crabgrass. Hence, it is important to fertilize turf areas heavily in the spring and fall to develop a dense turf. During the summer months, fertilize lightly or not at all. Lawn grasses are primarily cool season plants and do not respond to summer fertilization. Adjust the mower to cut at a height of 1½ inches to 2 inches. Most lawn grasses cut at this height will compete more effectively with crabgrass seedlings for light, moisture, and nutrients.

Turf grasses should be watered when they show pronounced effects of dry weather. Apply sufficient water to soak the root zone. Frequent and light watering encourages crabgrass germination.

CHEMICAL CONTROL

Where good cultural practices have failed to control crabgrass, the use of either pre-emergence or post-emergence chemical controls may be necessary. These materials may be applied in either dry or liquid form, depending upon the formulation of the manufacturer. In most cases the commonly used fertilizer spreaders and knapsack sprayers will handle these materials.

Pre-emergence chemicals, which are applied in early spring, kill crabgrass seeds just prior to or at the time of germination. Post-emergence chemicals are applied after the crabgrass seed has germinated and kill the young growing plants. In either case, herbicides may temporarily injure turf. It must be understood that chemicals react differently on various grass species, and also under varying soil and climatic conditions.

WARNING!

Most pesticides are poisonous. Read and follow all directions and safety precautions on labels. Handle carefully and store out of reach of children, pets and livestock.

TESTS RESULTS

Pre-emergence crabgrass herbicides have been tested at the University of Massachusetts Agricultural Experiment Station since 1960. As new materials have been made available for testing, they have been included in the testing program. Herbicides were applied to turf consisting of Kentucky blue

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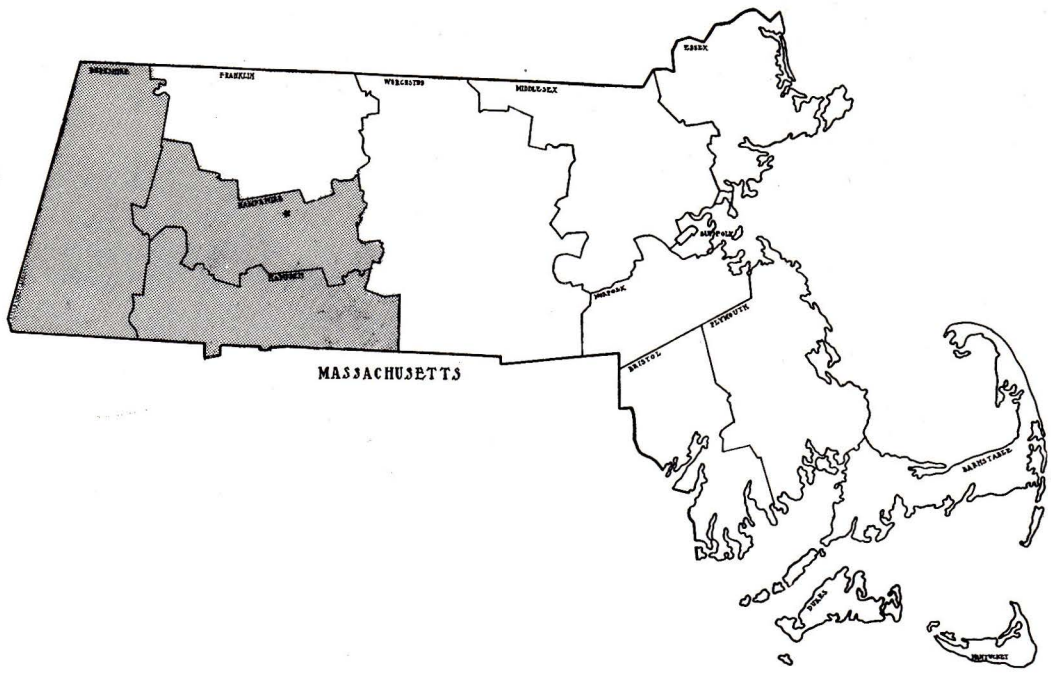

Golf Courses and Driving Ranges in Western Massachusetts

JOHN H. FOSTER
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In the summer of 1962, a census was taken of all private outdoor recreation operations in Berkshire, Hampshire, and Hampden Counties in Western Massachusetts. In this census, information was obtained from 37 golf courses and ten driving ranges. This is believed to be the total number of operating courses and ranges in the three counties at the time the information was obtained. Managers or other personnel of these operations provided the following information about the golf industry in these three counties.

Golf Courses

The 36 courses in operation in 1961 reported a total of more than 2.8 million hours of play in that year, including about 100,000 hours of other activities such as tennis, picnicking, and swimming (Table 1). About 700,000 individual visits were reported. The estimated gross income from fees and dues amounted to almost $1.5 million based on an estimated average charge per round of golf of $2.25. This is probably a conservative estimate. The 28 courses reporting their membership had a total of 5,849 members. Hampden County courses accounted for about half of all hours of play reported.

TABLE 1
HOURS OF PLAY AND ESTIMATED GROSS INCOME FROM PLAYERS' DUES AND FEES, BY COUNTIES, 36† GOLF COURSES IN WESTERN MASSACHUSETTS, 1961

County	Number of courses	Hours of play	Estimated gross income from dues and fees‡
Berkshire	14†	1,021,100	$ 519,100
Hampshire	6	327,250	174,400
Hampden	16	1,475,600	795,100
Total	36	2,823,950	$1,488,600

† One course in Berkshire County started in 1962 so had no use or income data for 1961.

‡ Estimated on the basis of $2.25 per round of golf.

Resources of Golf Courses:

The 37 golf courses reported a total of 5,565 acres of land of which 5,172 acres were available for recreation activities. Almost three-fourths of the land was open and one-fourth was wooded.

Eighteen courses had nine holes and 17 had 18 holes. One had 12 and one 15 holes. Several of the 9-hole courses had plans to expand to 18 holes. Eleven courses had facilities for other outdoor recreation activities in addition to golf. Tennis courts were a common added facility but swimming pools, picnic areas, skiing areas, and sport fields, were each reported by several courses.

History of Golf Courses:

The founding dates of golf courses operating in 1962 are fairly evenly distributed over the last 60 or more years, except for the 1940-49 decade (Table 67). Seven of the 37 courses were founded before 1900.

(Continued on Next Page)

TABLE 67
FOUNDING DATES AT PRESENT LOCATION, BY DECADES, 37 GOLF COURSES OPERATING IN 1962, WESTERN MASSACHUSETTS

Decade	Number of courses	Percent of courses
Before 1900	7	19
1900-09	6	16
1910-19	5	13
1920-29	5	13
1930-39	4	11
1940-49	1	3
1950-59	7	19
1960-	1	3
No answer	1	3
Total	37	100

The survey indicated a general expansion of the golf industry since 1950. Nine courses have added land, usually for the purpose of expanding from 9 to 18 holes. Thirty-two courses have made additional investment in facilities and 28 reported increased use in the period.

Ten of the 37 courses reported that potential patrons had been turned away in 1961 because facilities were being used to capacity. This was usually necessary only at periods of peak usage and weekends.

Residence of Users:

Nearly all the users of the 36 courses reporting use lived within 15 to 20 miles of the courses (Table 2). Only in Berkshire County was there significant use by out-of-county residents. Most of this use was probably by summer residents of the county.

TABLE 2
HOURS OF PLAY AND ESTIMATED GROSS INCOME FROM FEES AND DUES BY RESIDENCE OF PLAYERS, 36 GOLF COURSES WESTERN MASSACHUSETTS, 1961

Residence of players	Hours of play		Estimated† income from dues and fees	
	Number	Percent	Number	Percent
Within 15-20 miles of course	2,643,100	93	1,384,300	93
Rest of county	75,200	3	44,400	3
Rest of state	1,200	*	700	*
Out of state	104,300	4	59,200	4
Total	2,823,900	100	1,488,600	100

* Less than 0.5 per cent.
† Estimated on the basis of $2.25 per round of golf.

Business Organization and Financial Objectives:

The golf courses were evenly divided between non-profit courses and those with a profit objective (Table 3). The profit courses were again divided equally between those providing the major source of income and those operated as a source of supplementary income.

Five courses operated for supplementary income were associated with restaurants and bars. At each of these courses, golf provided less than 25 per cent of the income. Income from other courses supplemented the owner's income from other businesses or a job.

(Continued on Next Page)

TABLE 3
BUSINESS ORGANIZATION AND FINANCIAL OBJECTIVE, 37 GOLF COURSES IN WESTERN MASSACHUSETTS, 1962

Type of ownership	Source of principal income	Source of supplementary income	Non-profit	Total
Sole owner	2	5	—	7
Partnership	—	1	—	1
Corporation	7	3	19	28
Total	9	9	19	37

Characteristics of Courses:

The courses averaged 135 acres available for recreation activities. They averaged 10 acres per hole, but half of the courses had seven or fewer acres per hole. Six courses listing small land area as a major problem average 4.4 acres per hole.

The courses averaged 78,400 hours of play and 19,460 rounds of golf per course in 1961. The largest number of rounds reported by a single course was 50,000.

The courses averaged 546 hours of play per acre available for recreation activities (Table 4). At the 18 courses reporting that they were operating at or above capacity of their land, hours per acre were only moderately higher than the average for all courses. Contrary to most other types of recreation operations, land at the non-profit courses was much more heavily used than land at the profit courses. Average hours of golf per acre at six courses reporting small land area as a major problem was almost three times greater than for all courses.

Most courses were incorporated. The use of word "club" in the name of the course, however, signified little about the organization of the course. Some sole-owner courses were called clubs.

TABLE 4
HOURS OF GOLF PER ACRE, 36 GOLF COURSES IN WESTERN MASSACHUSETTS, 1961

Type of courses	Number of courses	Average hours of playing per acre
All courses	36	554
Courses at or above land capacity	18	610
All profit courses	17	437
All non-progt courses	19	661
Courses listing small land area as a major problem	6	1,431

Fees and dues charged varied widely among the courses. Nearly all courses had a schedule of charges, depending on the time of the week for fees and on the type or age of the member for dues. Dues ranged from $10 per year for junior membership at two courses to $700 for a family membership at one course. At five courses, family membership dues were $300 or higher. These courses tended to be the limited membership clubs. A major portion of the courses had dues of less than $100 for most types of membership.

Fees for guests and at non-membership courses varied from $1.00 to $7.50 per round. They were typically about $2.50 on week days and $3.50 to $4.00 on weekends. There was little difference among fees and dues at profit and non-profit courses, although the courses with the highest charges were non-profit while those with the lowest charges were profit courses.

The non-profit clubs with a total of 5,071 members at 19 clubs, averaged 267 members per club. The nine profit clubs reporting their membership had a total of 1,778 members, an average of 198 members per club.

Income of Profit Courses:

About 40 per cent of the operators of profit courses were satisfied with their net taxable income. Half of the 16 who answered the question would recommend golf course operation to others who were primarily interested in income. Relative to alternative investments and use of time, six operators reported their golf course income as low, seven as medium, and two as high. One reported a negative income.

Only three of the 18 profit courses reported their net income. The three figures had a range of $325,000 from the largest loss reported in the survey to the highest income reported. No conclusions can be drawn from this fragmentary and diverse information.

Management Problems of Golf Courses:

A total of 47 of the 60 problems listed in the questionnaire were checked by at least one course manager. Problems checked by 10 or more managers included crowded conditions, weather, and long hours. Those with 8 or 9 mentions included decisions about new facilities, trespass and vandalism, insect control, and the high cost of labor and supplies.

Golf Driving Ranges

The facilities at most of the ten driving ranges in the study were limited to a driving range. Some had facilities for miniature and short golf. One also had an archery range and picnic area. Operations with only miniature or short golf were considered to be amusement parks and, as such, were omitted from the survey.

A total of about 55,000 hours of use was reported by the nine ranges giving 1961 use information (Table 5). Nearly half this amount was reported by the five ranges in Hampden County. Total 1961 income from users' fees at the nine ranges was about $14,000.

A total of 101,000 visits was reported by the nine ranges, indicating that the average length of visit was about 35 minutes, much the shortest average visit of the types of operations studied.

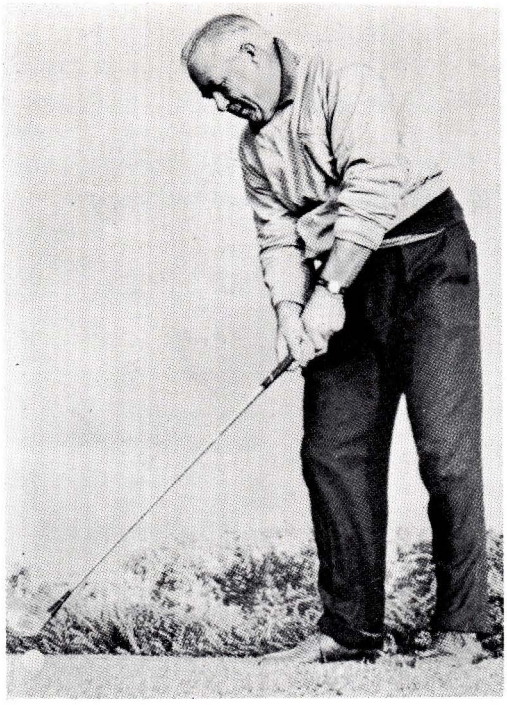


TABLE 5
HOURS OF USE AND GROSS INCOME FROM PLAYERS' FEES, BY COUNTIES, NINE† GOLF DRIVING RANGES, WESTERN MASSACHUSETTS, 1961

County	Number of ranges	Hours of use	Gross income from user fees
Berkshire	2	12,875	18,900
Hampshire	4	17,796	21,200
Hampden	3†	24,367	23,700
Total	9†	55,038	63,800

† Information not available from the other range in Hampden County.

Resources of Driving Ranges:

The ten ranges had a total of 320 acres, of which 132 acres were available for recreational uses. Only the operation with several other activities in addition to the driving range reported woodland. The other 10 ranges had open land only, another major difference from most other types of recreation operations.

A total of 215 driving positions were reported at the ten ranges.

History of Driving Ranges:

Two of the ten ranges were started prior to World War II, but most were started since 1950 (Table 6). Whether this represented a substantial increase in ranges since 1950, or whether others went out of business during this period cannot be determined from survey information.

Most of the ranges did not change acreage since 1950 or since they were started if started since 1950. One had lost land to a new road and had lost business as a result. Five had invested in additional facilities and nine of the ten had an increase in use in this period.

One of the ten turned patrons away in 1961 because of overcrowded conditions.

TABLE 6
FOUNDING DATES AT PRESENT LOCATION, BY DECADES, TEN GOLF DRIVING RANGES OPERATING IN 1962 WESTERN MASSACHUSETTS

Decade	Number of ranges	Percent of ranges
1930-39	2	20
1940-49	1	10
1950-59	7	70
1960-	—	—
Total	10	100

Residence of Users:

Most of the users of driving range facilities lived within 15 to 20 miles of the range (Table 7). The only important use by out-of county residents was reported by Berkshire County ranges. This use was probably by summer residents of the county.

Business Organization and Financial Objective:

The ten driving ranges all had profit objectives (Table 8). They were about equally divided between those supplementing other sources in income and those providing a principal source of income. The majority were sole ownerships.

Characteristics of Golf Driving Ranges:

The driving ranges had from 14 to 42 driving positions and averaged 21 positions. Use varied from 2,000 to 9,000 hours, with an average of about 6,115 per range. The number of visits ranged from 2,000 to 20,000 and averaged about 11,000. These figures include time and visits reported spent at miniature golf and other facilities in addition to the driving range.

Including only visits and time spent at the driving ranges, the ranges had an average of 335 visits and 211 hours per position. Visits per position ranged from 80 to 1,110 and hours spent per position varied from 80 to 450.

Time spent in all recreation activity average 417 hours per acre at all ranges (Table 9). At those ranges reporting present operation at or above land capacity, the figure was 490 hours per acre. At the range which had lost 30 percent of its land by eminent domain proceedings and reported loss of 45 percent of its business, the figure was 514 hours per acre.

Estimated gross income from users' fees averaged about $7,100 per range. It varied from $4,700 to $14,000.

Fees charged were usually based on the number of golf balls provided to the patron. The fee for a small bucket of balls ranged from $.25 to $.50 and for a large one from $.50 to $1.00.

TABLE 7
RESIDENCE OF USERS

Residence of users	Hours of use		Gross income from users	
	Number	Percent	Amount	Percent
Within 15-20 miles of range	42,211	77	$46,200	72
Rest of county	3,283	6	4,200	7
Rest of state	5,098	9	7,100	11
Out of state	4,446	8	6,300	10
Total	55,038	100	$63,800	100

TABLE 8
BUSINESS ORGANIZATION AND FINANCIAL OBJECTIVE, TEN GOLF DRIVING RANGES IN WESTERN MASSACHUSETTS, 1962

Type of ownership	Financial objective			
	Source of principal income	Source of supplementary income	Non-profit	Total
Sole owner	3	4	—	7
Partnership	—	1	—	1
Corporation	2	—	—	2
Total	5	5	—	10

TABLE 9
HOURS OF USE PER ACRE, NINE GOLF DRIVING RANGES IN WESTERN MASSACHUSETTS, 1962

Type of range	Number of ranges	Hours of use per acre
All ranges	9	417
Ranges now at or above land capacity	5	490

Income of Golf Driving Ranges:

Four of the 10 operators were satisfied with their net income and seven would recommend a driving range to others whose main motivation was income. Six considered their rate of return on capital invested and their own labor as medium, and the remaining felt they obtained a low rate of return.

The operator of one of the ten ranges reported a net taxable income of about $2,500. The estimated gross income of this range was $13,500. Several other operators gave gross income figures but were unable to provide a net income figure.

Management Problems of Golf Driving Ranges:

The three major management problems listed by range operators were weather, stealing, and long hours. Rapid destruction of equipment, vandalism, littering, undesirable patrons and wide day-to-day variation in use were each mentioned by three or more operators.

This dagger nematode, with its spear plunged into the center of a root, is feeding on Chewing's fescue. These nematodes, which future research may prove to be the most destructive pests in the country, are widely distributed in root areas of most trees, flowers, and other plants.

NEMATODES

Biology, Host Range, and Life Cycle

Nematodes are among the most abundant groups of animals. They are found wherever life exists and probably are best known to us as parasites of plants and animals. Man himself is a choice food supply for more than 32 types of nematodes.

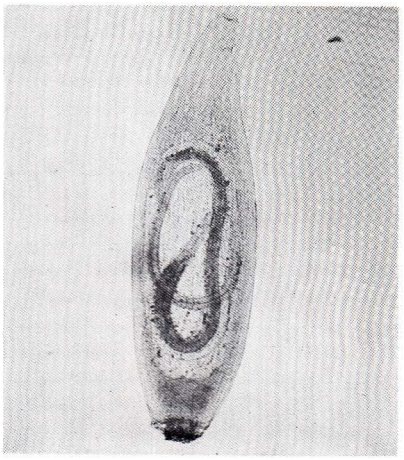
Only a few of the vast numbers which inhabit seas, lakes, streams, and soil are known to science. Researchers estimate that there are 300 to 600 million nematodes per acre a foot deep in the soil. A single gall of infected wheat contains 90,000. Nearly 1,000 were counted in a small dog, and more than 5,000 pin worms have been found in a man.

Sometimes nematodes are called "eelworms" — probably a more satisfactory term as it describes their shape and movement. Most nematodes move in a snake-like fashion but some scarcely move at all. Some depart from the conventional eel-like shape to resemble miniature beans, lemons, and pears. The vast majority are so small that microscopes are necessary to see them. A few can be seen without magnification. The largest one known to science — found in the placenta of a whale — is reported to be 25 feet long. Most nematodes have a size range of 1/50th to 1/5th of an inch.

Active life for most nematodes begins with jelly-bean shaped eggs, though others are born as active young — in either case they are called larvae. Eggs produced by a single female vary from a few for some species to several thousand for others. Eggs are deposited within the host plant or animal or in soil or water. Larvae generally resemble their parents except they are much smaller and lack some adult structures such as reproductive organs. In order to complete their development, most forms undergo a type of metamorphosis which involves a series of four moults and four larval stages. A complete life cycle from egg to egg may last only a short time — 3 to 5 days for some species — but others reach the ripe old age of a year or more.

Though nematodes are small in size, they are complex in structure, possessing essential mechanisms necessary for development, survival, and reproduction. While most nematodes are blind (except numerous marine forms) and possess no known circulatory or respiratory organs, they do have well developed digestive, excretory, muscular, nervous, and reproductive systems. Their exterior covering, which furnishes great protection, is called the cuticle. Adverse conditions such as high or low temperatures and excessive or limited moisture are easily tolerated by many species.

Though nematodes have been intensively studied as parasites, their contributions to nature's general plan have been overlooked. They provide food for higher animals and plants and also help with the breakdown of decaying organic materials. As parasites of various insects and other forms of animal life they help maintain a balance in nature.



SEED NEMATODES

Anguina agrostis

The most important seed nematode is *Anguina agrostis,* the grass seed nematode. This pest continually harasses grass seed industry by causing serious damage to Chewing's fescue and bentgrasses. A second species may be involved, since natural or artificial infections do not occur between the two principal hosts.

Host Range. Astoria Bentgrass, *Agrostis tenuis* Sibth.; Seaside Bentgrass, *Agrostis palustris* Huds.; Highland Bentgrass, *Agrostis tenuis* Sibth.; Chewing's Fescue, *Festuca rubra v. cummutata,* Gawd.; Creeping Red Fescue, *Festuca rubra* L.

Life Cycle and Biology. Galls containing thousands of larvae usually fall to the ground about harvest time. They remain in stubble until fall and winter rains soften the hardened exterior and free young nematodes. Larvae move about in the film of moisture on surfaces of soil and existing vegetation. Eventually some larvae make their way into stems and growth tissues of host plants. A few find their way to sites of developing flowers where they remain until future seeds start to develop in the boot stage. Then they crawl into open ends of young seeds and begin to feed. As they feed, young seeds develop into galls instead of normal seeds. When flowers emerge from the boot stage nematodes are usually adults. As host plants mature, nematodes continue to feed, mature, mate, and produce thousands of eggs during gall development. Then as flowers mature for harvest, eggs hatch and release thousands of new larvae coiled within the gall and ready to begin another cycle.

Usually one male and one female — sometimes several — are recovered from each gall after panicles have emerged from the boot stage. If only one sex invades a developing ovule, galls will be smaller than usual. Seed hulls will be enlarged like those of an average gall.

Ability of second-stage larvae to survive in dried galls for 10 to 15 years following harvest is an amazing example of nematode survival in extremely adverse conditions. All food for this inactive period, as well as for first and second stage development, is provided in the egg. Survival in galls accidentally included in seed used as planting stock makes this nematode a constant threat to bentgrass prduction.

FOLIAR NEMATODES

Foliar nematodes of the genus *Aphelenchoides* are pests of greenhouse and outdoor ornamental plantings. They are the "spring dwarf" or "crimp" nematode, *Aphelenchoides fragarie;* and the "chrysanthemum leaf" nematode, *A. ritzema-bosi.*

Aphelenchoides fragarie

This foliar or leaf pest has several common names in addition to those mentioned. Two of the most common terms are "bud and leaf" nematode (Easter lilies) and "spring dwarf" nematode (strawberries). Easter lily growers are occasionally concerned over possible spread of this pest from sword fern to lilies. Neither field observations nor laboratory tests indicate this is possible.

Host Range. Bellingham Hybrid Lily, Easter (Croft) Lily, Strawberry, Sword Fern.

Aphelenchoides ritzema-bosi

"Chrysanthemum leaf" nematodes are common greenhouse pests, though outdoor plantings are occasionally affected. The green-

house host range includes many plants — African violet, Bird's nest fern, and Pepperomia — which usually make up the home owner's collection. The life-cycle is very similar to other species of the genus.

Host Range. Chrysanthemum, Begonia, Gloxinia, Phlox.

Life Cycle and Biology. Most researchers conclude that a life cycle from egg to egg can be completed in a minimum of 14 days. Poor conditions such as temperature, moisture, development of host plant, and so forth, may prolong time in which a life cycle is completed.

Foliar nematodes tend to establish both endo- and ecto-parasitic relationships with host plants. As endo-parasites—inside the plant—they usually enter host plant tissue through stomata — small natural openings — although direct penetration can be made through the cuticle. As ecto-parasites — outside the plant — they usually travel on surfaces of host plants in a film of moisture. They are easily spread from one host plant to another during an ecto-parasitic relationship. Once nematodes are established, it is possible to find eggs, larvae, and adults in tissue next to stomata.

Aphelenchoides are active, frequently moving so fast that they remain near the surface of water in an examining dish. They also become inactive and survive in dried leaf tissue and other infected plant debris for 3 to 5 years. Their ability to live as ecto-parasites and to survive for years in infected host tissue necessitates certain horticultural sanitation practices.

BULB OR STEM NEMATODES

These nematodes usually attack bulb or stem portions of plants, though flowers and leaves also are injured occasionally. Two species of this group (of the genus *Ditylenchus*) are *Ditylenchus destructor* ("potato-rot" nematode), found only on bulbous iris and dahlia, and *Ditylenchus dispsaci* ("bulb or stem" nematode). Many researchers believe this species is a composite of several related nematodes. This may be, since several instances exist where a population from one host will fail to produce symptoms or survive on another reported host plant.

Ditylenchus dipsaci

Commonly known as the "bulb or stem" nematode, "teasel" nematode, or "alfalfa stem" nematode, occurs in several crops and weed costs. Evidence of damage or injury is most noticeable in spring.

Host Range. Alfalfa, Alpine Carnation, Clover (Red), Daffodil, Garlic, Phlox, Primrose, Strawberry, Teasel, plus many more too numerous to list.

Weed Hosts. Cow Poison, Larkspur, *Delphinium trolliifolium* ray; Hairy Cat's Ear, *Hypochoeris radicta* L.; English Plantain, *Plantago maritima* L.; Silver Weed, *Potentilla anserina* L.; Sand Strawberry, *Frageria chilensis* (L.) Duch, etc.

Life Cycle and Biology. Time to complete a life cycle from egg to egg has not been determined, although some researchers have estimated 21-30 days for best conditions. Poor conditions may extend this period many times. Considerable overlap exists in various developmental stages since there is no spontaneous sequence from one generation to another. This is evident by observing eggs, larvae, and adults in diseased tissue.

Bulb and stem nematodes usually are parasites of stem tissue, though leaves and flowers also are damaged. Although above ground plant symptoms are conspicuous and easy to see, bulbs or infected underground portions require examination. Invasion of the host plant usually takes place through natural openings, but these nematodes also provide their own avenue of entry. Once established, pests move through tissues of host plants, break down cell walls, and feed on cell contents.

Sometimes bulb or stem nematodes gather together in tight clusters which resemble tufts of cotton and are called "nematode wool." This frequently occurs on outsides of daffodil bulbs near the basal plate. Nematodes in these situations will withstand highly adverse conditions, such as dryness, long exposure to hot water, and subzero temperatures. Like many plant parasites these nematodes can remain alive in infected plant tissue for at least nine years. Infected plant tissue must remain dry or activity is resumed.

Ditylenchus destructor

Until 1945 this nematode was regarded as a "potato strain" of *Ditylenchus dipsaci.* New research shows that nematodes in potatoes and iris are identical. Though this nematode once attacked iris, recent reports of its occurrence have not been received. *D. destructor* was found recently in major dahlia plantings.

Host Range. Several varieties of dahlias and iris.

Life History and Biology. Biology of this pest is similar to that of bulb or stem nematodes. Potato-rot nematodes are most active during late fall and early winter when symptoms are most apparent on dahlias and iris. During winter months, when these crops are in storage, larvae, eggs, and adults can be found in infected tissue. Thus generations tends to overlap. In mushrooms, activity is continuous.

ROOT-LESION NEMATODES

Other common names for this group are "meadow" and "migratory" nematodes. The most injurious nematodes belong to this group. Only three *(Pratylenchus penetrans, P. pratensis,* and *P. vulnus)* are regarded as major pests. Most serious is *P. penetrans,* a constant threat to the nursery and ornamental industry.

Root-lesion nematodes produce dead spots or lesions on roots. Injury is probably most severe on small feeder roots which may be completely girdled. These pests injure their host plants . . .

- By direct feeding which deprives plants of water and food.
- By producing lesions which cause partial or complete loss of plant tructures and impair vital functions necessary for growth.
- By producing wounds or lesions through which other organisms may enter plant tissue.
- By migrating ahead of rotting tissue and spreading other organisms into healthy tissues.

Root lesions caused by these nematodes are also invaded by secondary organisms. Root-lesion nematodes are seldom found in large numbers in tissues occupied by secondary fungi and bacteria but tend to migrate to marginal areas of lesions — hence the common name "migratory." Root-lesion nematodes frequently travel from one area to another in the same root, from root to root, or from plant to plant.

These nematodes can survive in soil, without a host plant, longer than a year. In plant tissue, usually roots, they can survive most storage and transportation conditions. Once established in host tissue, they withstand some of the most adverse conditions devised by man. Thus far no treatment of infected plants by heat or chemicals has been developed which will eliminate these nematodes without injuring plants.

ROOT-KNOT NEMATODES

Knot-like swellings or "galls" on roots of various crops are familiar to most agriculturalists: Root-knot nematodes, one of the first groups of nematodes recognized, belong to the genus *Meloidogyne*. Nine species and six varieties of root-knot nematodes are now recognized. Three of these are *Meliodogyne hapla, M. incognita,* var. *acrita,* and *M. arenaria,* var. *thamesi.*

Meloidogyne hapla

This nematode is the most common root-knot species. Host range includes many common forage, greenhouse, ornamental, and vegetable plants. These pests are widely distributed over most cultivated areas.

Host Range. Carrot, Celery, Clematis (Greenhouse and Nursery), Clover (Alsike), Clover (Red), Coleus (Greenhouse), Cyclamen (Greenhouse), Gladiolus, Lettuce (Miners), Pansy, Parsnip, Peony, Peppermint, Potato, Snapdragon (Greenhouse), Spearmint, Strawberries, Tomato (Greenhouse), Tomato, Violet, African (Greenhouse).

Meloidogyne incognita var. **acrita**

This nematode is most common east of the Cascade Mountains but occasionally is found in western Oregon. In most respects it resembles and has the same life history as others in the genus.

Host Range. Clover (Ladino), Dandelion, Potato, Tomato (Greenhouse), Violet, African (Greenhouse).

Meloidogyne arenaria var. **thamesi**

Little information is available regarding distribution of this nematode. It has been found in dandelion roots and potato tubers in some areas.

Life History and Biology. Root-knot nematodes are similar in structure and behavior. Once they are established in a field, sources of subsequent infection include established and volunteer biennial or perennial crops or weeds and infested soil. Two full generations and a partial third per year occur in most outdoor plantings. Development in greenhouse plantings is continuous. Nematodes are most active during warm weather and least active during cold months.

Recent research shows that first-stage larvae, formerly thought of as the infective stage, develop and remain in eggs. Thus root-knot nematodes enter host plants as second-stage larvae. These larvae enter host plants near root tips. Heads usually are perpendicular to central portion of roots. When feeding begins both invaded tissues and nematodes expand and swell. Maturing nematodes go through three stages — from eel-shaped second-stage larvae to sausage-shaped third-stage, and finally to pear-shaped adult females. Males are not as abundant as females. Male development is somewhat different in that they regain their original eel-like shape as adults.

Each female may produce 300-600 eggs. These are deposited in a gelatinous egg mass. Nematode posteriors usually protrude through the surface of galls so egg masses can be deposited outside of roots. Exceptions include dahlia roots and potato tubers where egg masses are usually found far beneath the surface. There may be one or more egg masses on exterior surfaces of host tissue depending on numbers of females in a gall. Galls result from giant cell formation. Small galls may contain only one female while large galls contain several. Some galls may contain nematodes in various stages of development.

Males tend to be rare in some varieties of nematodes which attack tomatoes but common in those which attack strawberries. When males are rare these nematodes can produce subsequent generations without fertilization of eggs.

Time required to complete a life cycle is variable and dependent on temperature, moisture, and development of host plants. Under optimum conditions (semi-tropical) a life cycle may be completed in 21 days. With cold, wet, heavy soils and a slow-growing host plant, only one generation may develop in a year. Damage sustained by many host plants is seasonal. During fall, winter, and early spring, the environment is usually unfavorable for rapid development of nematodes and of many host plants. A greenhouse usually provides these pests with optimum conditions and serious plant injury may occur anytime.

CYST NEMATODES

Heterodera or cyst-forming nematodes are so named because the lemon shaped bodies of dead females become a protective container for eggs and larvae. This phenomenon increases difficulty of control. The protective cyst-like containers enable eggs and larvae to withstand long periods of adverse conditions such as rotation, summer fallow, cold weather, and transit of plants.

Several species of *Heterodera* injure agricultural crops. Distribution of some species is limited while others are found the world over. Golden nematodes *(Heterodera rostochiensis),* common pests of potatoes, belong to this group.

Heterodera schachtii

This nematode is one of the most destructive pests of sugar beets, and can be blamed for the rise and decline of the sugar beet industry in Germany between 1830 and 1890. Since then, these pests have threatened the industry in western United States — especially in the intermountain region where vast acreages of sugar beets have been lost.

Biology and Life History. Some larvae may emerge, periodically, from the same cyst for as long as eight years. First generation of a season usually emerges as soil warms up in spring and as host plants become active.

Like most parasitic nematodes, this species passes through four larval stages before reaching adulthood. First stage larvae and first moults occur within eggs. Second stage larvae (the infective stage) hatch from eggs. Once larvae emerge from cysts they are attracted to root areas of a developing host plant. Penetration usually is made just behind the root cap. Shortly after penetration, larvae establish themselves in tissues and begin to feed. As nematodes continue to develop, they lose their worm-like shape, become greatly enlarged, and resemble miniature sausages. This association with the host plant usually results in conspicuously swollen areas of invaded roots. Larvae continue their development and pass through necessary moults and larval states— a total of four each — to become adults.

Development of males differs from that of females. Males (not known for *Heterodera trifolii*) regain their slender shape during the fourth moult, leave root tissue, but remain near roots in search of females. Female larvae continue to expand while developing. As their size increases they break through the root cortex but remain attached to roots by their head and neck region. As females rach maturity a gelatinous mass may be deposited about the posterior. Females deposit a number of eggs — which soon become active larvae — into this mass. Not all eggs, however, are deposited in this mass. Most are retained within bodies of females. After death, the lemon-shaped body of each female be-

comes a cyst which changes from white to dark brown.

Although *Heterodera trifolii* has has been repeatedly recovered from soil samples, little information exists about injury to crops. Partial crop failure has been observed in stands of Ladino clover. Host range of this pest includes other legumes such as hairy vetch.

Biology of this pest is similar to the sugar beet nematode but has one exception. Males have not been found, and larvae hatch from unfertilized eggs. This species is found in nonculticated areas.

Ladino clover and hairy vetch are known host plants for this pest, but future investigations probably will reveal more hosts among legumes. Clover-root nematodes have been found.

ECTO-PARASITIC NEMATODES

Ecto-parasitic nematodes do not enter root tissue but still cause unsatisfactory plant growth.

Root systems of infected plants usually are poorly developed and show various evidences of deterioration such as lack of small feeder roots, short, thickened root remnants, and conspicuous discolored areas or lesions. These symptoms are described as a "stubby root" condition. This poor root development is often associated with nonspecific above ground conditions such as stunting, chlorotic foliage, and a tendency of affected plants to wilt on hot days. Like other nematodes living in soil, ecto-parasites are usually distributed so that plant injury occurs in target-spot areas in fields.

Ecto-parasitic nematodes remain in soil near roots, where they use a well-developed spear to feed on tissues beneath the surface. Each time a nematode feeds, it makes separate minute punctures which open the way for invasion by bacteria, fungi, and other nematodes. Ecto-parasites also act as carriers for certain virus diseases.

Diagnosis of these pests is more complicated than that of endo-parasites because they rarely are found attached to host plants. Evidence of parasitism depends on removal of pests from soil surrounding infected plants and duplication of symptoms under controlled conditions. The following genera of ecto-parasitic nematodes have been found in soils where crop production was inferior: *Helicotylenchus, Hemicycliophora, Longidorus, Paratylenchus, Rotylenchus, Tylenchorhynchus, Trichodorus,* and *Xiphinema.*

Spiral Nematodes—
Helicotylenchus spp.

Enormous population of *H. nannus* occasionally are associated with various ornamental plants showing symptoms of stunting. This pest recently was associated with a general decline in a greenhouse planting of gardenias. Microscopic observations frequently reveal nematodes partly embedded in the root bark. Sometimes colonies of nematodes in all stages of development occur beneath sloughing cortex. Males have not been observed. Very little information is available concerning the ecology of this pest. Formation of a coil or spiral figuration in death is a characteristic feature of this and closely related genera.

Sheath Nematodes—
Hemicycliophora spp.

Distribution of this genus in the Northwest is confined to a single genus *H. gracilis* found in enormous numbers in gladiolus fields. Their association with poorly developed root systems of dwarfed plants in zone-like areas in the field indicates a potential disease problem. A well developed spear and the double cuticle are characteristic features of this genus. Males have not been found.

Mint Nematode—
Longidorus menthasolanus

This particular nematode, the largest plant parasitic species, is a common pest of mint in flood areas. It can be seen without a microscope because of its large size. Mint nematodes are easily found in spring when they usually congregate in large numbers on or around roots of host plants. Preliminary observations have revealed a few additional host plants such as table beet, Merion bluegrass, and tomato. Populations of this pest seem to attain their highest level in June. After harvest or during dry weather, mint nematodes become inactive and tend to coil like small springs singly or in clusters. Populations of this pest are largely composed of females and larvae. Males are found rarely. The long spear and large size are prominent features of the genus.

Pin Nematodes—
Paratylenchus spp.

These nematodes are rather small but possess exceptionally large spears. They are so widely distributed that most soil samples contain a few specimens of at least one of the several species found. Large populations of pin nematodes often are found in samples obtained from root zones of plants making poor growth. Though root systems are favorite targets of these pests, they also have been seen in leaf and stem tissue of mint rhizomes. Untreated greenhouse soils may contain large numbers of these pests. For example, 7,000 pin nematodes were recovered from a single pint of soil in a bench bed where snapdragons were severely stunted and failed to bloom.

Spiral Nematodes—Rotylencus spp. and **Stunt Nematodes—**
Tylenchorhynchus spp.

Although these genera are considered plant pests elsewhere, they are not known to cause serious crop losses. Data from hundreds of soil samples indicate several species from each genus are widespread here. Stunt nematodes are found in most soil samples and are most abundant in soil used for ornamental crops (azaleas and rhododendrons). Enormous populations of this group also are found in greenhouse beds, vegetable areas (onion), and in sagebrush areas

Spiral nematodes belonging to the genus *Rotylenchus* are more restricted in their distribution and are largely confined to nursery and greenhouse soils.

Stubby Root Nematodes—
Trichodorus christiei

Stubby root nematodes were first among ecto-parasites proved to be plant pests. They belong to a genus having abnormally thickened cuticles which become wrinkled as the nematodes move about, and they also possess a peculiar feeding apparatus found in no other group.

Dagger Nematodes—
Xiphinema spp.

Dagger nematodes are closely related to *Longidorus* and possess well developed spears. Since ecology of dagger nematodes has not been adequately studied, there is little information concerning the biology of this group. The principal species generally distributed in soils is *Xiphinema americanum,* but at least one other species is present though sporadically distributed.

Dagger nematodes recently became major plant pests when one species was discovered to cause galls or tumor-like growths on rose roots, and another proved to be the long sought carrier of the virus responsible for "fan leaf" disease of grapes.

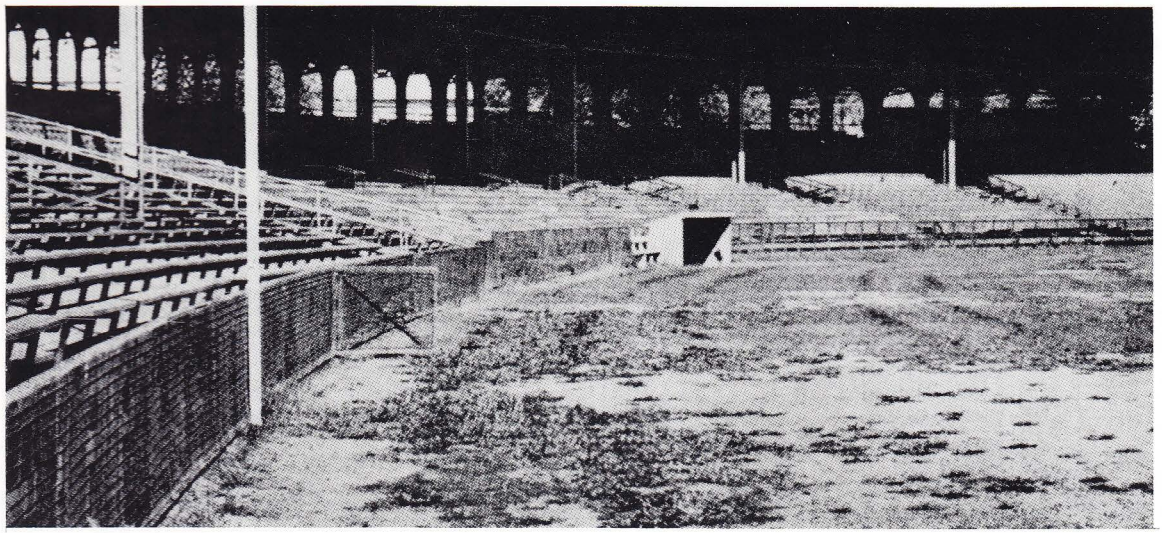
Above information courtesy Harold J. Jensen, Agricultural Experiment Station, Oregon State University, Corvallis.

Chinch Bug and Its Control

JOHN C. SCHREAD

Entomologist

Connecticut Agricultural Experiment Station



Looking back over the past nineteen years we become acutely conscious of the rapid advances made in combatting insect pests. Greater strides were made in the development of pesticides during this time than in all of the years prior to 1945. Many of the newy-developed insecticides have actually revolutionized many fields of agriculture, including control of insect pests in grass.

Perhaps in our enthusiasm we may have proceeded a little too fast with some of the chemicals merely skimming the surface, hence overlooking important fundamental questions involved. Notwithstanding, we now produce more abundant insect free crops including turf over a greater area of the world than ever in the past.

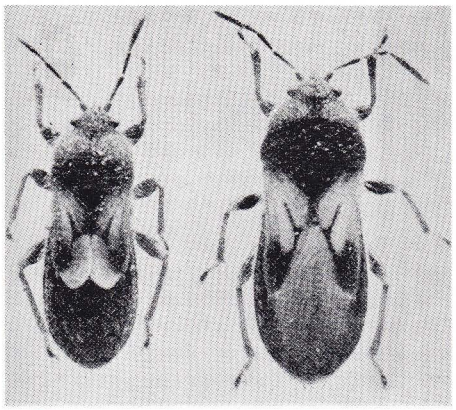
Of the many insect pests attacking and injuring turf one of the most important offenders in recent years is the hairy Chinch bug. It has during recent dry years become a major pest of turf in golf courses, house lawns, parks, cemeteries, etc.

Conditions favoring the spread of this piercing sucking insect are warm, dry weather in late spring and early summer when the first annual generation is active and again in the late summer and early fall when the second generation is developing. Under such conditions the chinch bug multiplies rapidly; frequently injuring bent and blue grasses in addition to fescues, before its presence is discovered. Wet weather in early or late summer when the young chinch bugs are developing reduces the population materially. Under such conditions, chinch bug fungus may play a major role in destroying the population. Injured turf shows reddish-brown areas of irregular size. They usually become more abundant as the season advances until finally the entire turf area is involved with dead grass leaving nothing but crabgrass, weeds and clover. Sun-drenched turf, especially in protected areas, will be injured sooner than grass growing in shaded or semi-shaded areas.

The presence of the insect may be detected by examining the turf at or near the surface of the ground. The fast moving adults and young will be seen scurrying through the grass quite often by the hundreds. They are always more noticeable at the margin of the injured spots where they enlarge the damaged areas as their members increase. Very few chinch bugs will be found towards the centers of the dead grass areas.

When chinch bug infestation is suspected the affected areas may be flooded with warm water and cvered with a piece of white cloth. If the insects are present they will crawl to the underside of the cloth where they may be easily seen.

The adults are 1/5 to 1/6 inch in length, black in color with white wings. There is a small, triangular black spot on the outer edge of each wing. The much smaller immature young vary in color from orange through brick-red to gray. There is a conspicuous transverse white line behind the head.



The overwintering adults become active in the spring when temperatures reach about 70°F. Mating and egg laying continue for about six weeks. Several hundred eggs are deposited per female. They hatch in 2 weeks and the nymphs feed for 4 to 6 weeks before they reach maturity. Adults of the second generation hibernate in hedge rows, accumulated litter, clods of heavy sod and dense thatch. Winter mortality may occur when moisture gathers where the chinch bugs are hibernating.

The hairy chinch bug has been controlled in the past with nicotine in various forms, sabadilla, and rotenone. Newer materials such as DDT, chlordane and dieldrin give excellent results for a number of years. More recently, however, the insects have become resistant to them.

(Continued on Page 15)

(Continued on Page 2)

with small amounts of bentgrasses and the fine-leafed fescues intermixed. The chemicals used and the results obtained in the 1963 tests are shown in Table 1.

TABLE 1.
Crabgrass Control with Pre-emergence Chemicals — 1963

Herbicide	*Lbs. Active Ingredient/A**	*Rating*
Azar, granular	10.0	Excellent
Azar, wettable powder	10.0	Fair
Bandane, granular	40.0	Poor
Bandane, emulsion	40.0	Fair
Calcium arsenate	413.0	Poor
Chlordane	80.0	Poor
Dacthal	10.0	Excellent
Dacthal + 10-5-5 fertilizer	11.2	Excellent
Diphenatrile	28.4	Poor
Stauffer, emulsion	15.0	Excellent
Trifluralin, granular	1.25	Fair
Trifluralin, liquid	2.0	Good
Zytron, granular	15.0	Excellent
Zytron, emulsion M2025	17.0	Excellent
Zytron + 10-6-4 fertilizer	15.2	Excellent

* *Applied at manufacturer's suggested rates on April 22, 1963.*

PRE-EMERGENCE HERBICIDES

Azar

Based on one year's results (1963), the granular form appears to give better control than the wettable powder. Further testing is necessary before concrete conclusions can be made; however, these materials show promise.

Bandane

Both the dry and liquid applications gave unsatisfactory control in the 1963 trials; however, some stations have reported good to excellent control.

Calcium Arsenate

This material has given erratic control. Control was poor in 1963; however, in previous years it has been rated as high as excellent.

Chlordane

This material also has given variable control over the years in the tests at University of Massachusetts. These findings are in agreement with those of other investigators.

Dacthal

Excellent control has been obtained in every year of testing. Dacthal has been incorporated into turfgrass fertilizers and the control was the same.

Diphenatrile

Diphenatrile had given good to excellent control in previous tests but control was poor in 1963.

Stauffer Emulsion

Still in the experimental stages, this product shows promise as a pre-emergence crabgrass control chemical.

Trifluralin

This material gave fair to good control. It appears that higher rates may give more satisfactory control. More testing is needed.

Zytron

Zytron, like dacthal, has given excellent control over the years of our testing. Equally good results have been obtained from the dry and liquid applications and from zytron incorporated in a turfgrass fertilizer.

POST-EMERGENCE HERBICIDES

Arsenicals

Post-emergence chemicals D.M.A. (disodium methyl arsonate) and A.M.A. (ammonium monomethyl arsonate), when applied according to labeled directions, gave reasonably safe and good control of crabgrass. Best results were obtained when the crabgrass was in the two- or three-leaf stage.

Phenyl Mercuric Acetate (PMA)

This chemical has shown good control of crabgrass seedlings. It should not be used on Merion Kentucky bluegrass.

Both the post-emergence arsenicals and PMA may require repeated applications for best control.

(Continued from Page 13)

Experiments were carried on during 1962 using new insecticides for chinch bug control. Sevin, diazinon and ethion are the ones that gave best results. They are registered and labelled for chinch bug control and should be used as directed on the label of each package of insecticide whether it is granular, emulsion or wettable powder. All formulation should give equally good control of the pest.

Mid-spring treatment may control chinch bug throughout the growing season. Notwithstanding, however, treatments may be necessary during the time each of the two generations are active. This can be determined only by keeping a close watch on potentially infested areas for signs of outbreak.

Turf Students' Trip

On the morning of February 10, 1964, fifty Turf Management students left Stockbridge School of Agriculture, U. of Mass., headed for Philadelphia, Pa., the site of the 35th International G.C.S.A.A. Conference. Upon arrival in mid-afternoon, we checked in at the Y.M.C.A., where prior arrangements had been made for lodging the students. Fortunately, the Y.M.C.A. was conveniently located within the heart of "The City of Brotherly Love," close to all points of interest. Since this was our first experience at an International G.C.S.A.A. Conference, we were deeply impressed by the genuine professional attitude of its members and the cordiality extended.

The educational program was conducted by an exceptionally qualified list of informative speakers, which included Professor Troll's topic on "Superintendents" 2-Year Training Course. Mr. Troll historically traced its origin at the U. of Mass., and in addition, pointed out its success as well as its need today. I might add that all the turf majors are grateful to Professor Troll is helping make this trip possible.

Several lecturers increased our knowledge of effective administrative practices, while Roy Blaser, J. R. Love, and Marvin Ferguson have broadened our outlook on fertilizer behavior in the soil. There were more than one hundred exhibitors present in the Sheraton Exhibit Hall. These representatives introduced a fine array of products and machinery relating to the turf world.

Throughout the conference, there were ample bus tours available for those students who wanted to visit such places as the Betsy Ross House, Independence Hall, and the Liberty Bell. Also, the entire class was given a tour of the American Pulley Company, manufacturers of the Hardie Sprayer. We found this quite interesting since we were given the opportunity to see the complete process of the manufacturing of a Hardie Sprayer.

We sincerely believe that the conference was very successful and we would like to thank everyone who made it possible for us to have a very informative and memorable experience, one the class of 1964 can look back on with fond memories.

Robert F. Coffey
Turf Management
Class of '64

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TROLLING

Suggested Reading

1. *The Quiet Crisis* by Stewart L. Udall, Secretary of the Interior, traces the use o fthe land in America, and describes the role that resources have played in the development of our affluent society. Its purpose is not to construct a comprehensive historical account, but rather to provide background for understanding our present environmental problems, defined by Secretary Udall in his foreword:

   "America today stands poised on a pinnacle of wealth and power, yet we live in a land of vanishing beauty, of increasing ugliness, of shrinking open space, and of an over-all environment that is diminished daily by pollution and noise and blight. This, in brief, is the quiet conservation crisis of the 1960's."

   Secretary Udall concludes with an eloquent plea for individual and community effort towards the development of a land ethic for tomorrow. Holt, Rinehart and Winston, 1963. Price $5.00.

2. *God's Own Junkyard: The Planned Deterioration of the American Landscape,* by Peter Blake, takes a more direct and dramatic approach to the question of environmental disfigurement and resource despoilation. Mr. Blake, an architect and Managing Editor of Architectural Forum, states in his introduction that this book is written not in anger, but in white fury, and his short but effective text is supported with a series of black and white photos depicting the best and the worst in the American landscape. Holt, Rinehart and Winston, 1963. Price $4.50, Paperback $2.95.

3. *Cluster Development,* by William H. Whyte, Jr., is a non-academic, straightforward account of this new approach to suburban land development. Complete with site plans, photographs, model ordinances and deed forms, this report shows how communities and developers in various parts of the country are attempting to adopt the cluster concept to their own needs. This practical and objective work fills an important need. It contains materials and ideas which will be useful for members of Planning Boards and Conservation Commissions, as well as private land developers, consulting planners, and concerned citizens. American Conservation Association, 30 Rockefeller Plaza, New York, New York, 1964. Price $3.00.