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A STUDY OF THE STYLET-BEARING NEMATODES ASSOCIATED WITH CRANBERRIES IN MASSACHUSETTS

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Introduction

In the United States, the cultivated cranberry, Vaccinium macrocarpon Ait. is grown commercially in only five states, Massachusetts, New Jersey, Wisconsin, Washington, and Oregon. In 1958 Massachusetts was the most important cranberry producing area with 54% of the production. New Jersey accounted for 8%, Wisconsin 30%, and the remaining 8% was produced in Oregon and Washington. United States cranberry production has increased since 1900 but this increase is due to improved cultural practices rather than increased acreage (20).

High in importance among these improved practices is the control of cranberry pests. The relationships of fungi, viruses and insects to the cranberry have been extensively studied. The nematode relationships have not been studied up to this time. Information is lacking on the extent of nematode damage on other crops in Massachusetts as well. Work on specific crops other than cranberries has shown the importance of nematodes on these crops.

Much of the experimental work connected with this thesis was carried out while the author was employed at the Cranberry Experiment Station, East Wareham, Mass. The author was privileged to work at the experiment station during the summer of 1958, at

which time a project on the biology and control of nematodes was started. The initial stages of this project consisted of sampling soil and plant roots from various crop areas of the state, extracting nematodes and identifying them. Since cranberries are a highly important, intensively cultivated crop in Massachusetts and information on the nematode parasites is so completely lacking, the author undertook this study.

Scope of the Work

Since this work was in a new area, it was essentially an exploratory survey rather than a detailed study of the life history or control of a single species or group. It was aimed at pointing up problem areas for future study. During the course of the work soil and root samples were collected from cranberry producing and other crop producing areas of the state (Appendix). Emphasis was placed on cranberry-bog soils but as part of the station project and to provide background and depth for this study, samples from areas producing field crops, cover crops, ornamentals, shade trees, and forest trees were processed. The nematodes were extracted from these samples and the plant parasites identified to genus and where possible to species. One hundred and twelve such samples were processed and the data recorded on cross-index cards of a hand sort type made by the Royal McBee Corporation. An overall picture has been obtained of the plant-parasitic nematodes which inhabit the cranberry-bog soils of the state and many areas for future exploration have

been delineated.

Summary of Literature about Nematodes Associated with Cranberries

Cobb (5) in 1913 described the nematode Atylenchus decal-incatus Cobb from cranberries in New Jersey. This is a rare nematode and it was not reported again until 1957 when Chitwood and Tarjan (4) redescribed the species from New Jersey cranberry-bog soil. These are the only references to nematodes on cranberries up to the time of this study according to the U.S.D.A. nematode host index file. A comprehensive host index of plant-parasitic nematodes published by Goodey and Franklin (10) in 1956 does not list any reports of nematodes associated with the genus Vaccinium. However Cohoon and Brown (7), in sampling soil from blueberry fields report Tetylenchus spp. in many samples and six other plant-parasitic genera in lesser numbers. The large numbers of Tetylenchus spp. in some samples were believed to be suggestive of possible pathogenicity. Good (9) gives an estimate of what may be expected when he states that an acre of farm land may contain several billion nematodes, although not all are plant parasites. However he stated that enough are parasites so that the plant that escapes nematode attack is exceptional.

Methods and Techniques

Seventy-one soil samples were taken from 48 different cranberry bogs located throughout the cranberry growing area of southeastern Massachusetts. This area centers about Plymouth county and

included sections of Norfolk, Bristol, and Barnstable counties. Different bogs as defined here are those which are separated geographically or by dikes. Bog pieces separated by dikes are subjected to different cultural practices and are treated as separate management units by the cranberry grower. However it should be pointed out that many bogs are constructed of soil from the same source and receive sand from the same pit. Not only adjacent bogs but also quite distant ones may receive water from the same source. Thus their nematode problems may be expected to be closely related.

Individual bogs are separated into sections and these sections divided by ditches. Many sections of certain bogs were sampled where evident differences justified it. The State Bog, a ten acre experimental bog located at the Cranberry Experiment Station, East Wareham, was the most intensively examined.

Since it was desirable to have plant-parasitic nematodes at once, areas were selected which appeared to offer promise of such nematodes. In most of the cranberry bogs sampled, not only at first, but throughout the survey certain areas were noted to have thin vines or bare spots. Usually there was no known explanation for these "poor areas" and it was thought that nematodes might be related to the condition.

Soil together with associated roots was taken from several spots around the outside of each "poor area" until about a pint had been

gathered. This was placed in a plastic freezer bag and kept under refrigeration until ready to be processed. Roots were placed in water in petri dishes and later examined for emerged nematodes. Nematodes were extracted from the soil by a standard method outlined in the U.S.D.A. manual (25). This method consists of running soil samples through sieves of 30, 60, and 270 mesh and using the Baermann Funnel technique to process the soil further. For examination of the nematodes thus extracted, a few drops of water were drawn off the funnel into a watchglass. Nematodes were individually transferred to a drop of TAF[1] on a microscope slide by means of a pulp canal file. Twenty or more nematodes were picked up at random and placed on each slide. By microscopic manipulation the nematodes were grouped near the center of the TAF drop. Several strands of glass wool were arranged around the nematodes to support the cover slip which was then dropped into place. ZUT[2] slide ringing compound was used to seal the slide. The nematodes were then ready for microscopic examination. They were first tentatively identified by the use of keys in the U.S.D.A. manual (25). Some identifications were checked by Dr. A. L. Taylor of the Plant Nematology Section, U.S.D.A. and others by Dr. W. R. Jenkins of the University of Maryland. In time the author was able to identify the more common plant parasites. All nematodes which had any form of stylet were considered to be possible plant parasites. No efforts were made to identify the non-parasitic types. Data were later entered on

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1. Triethanolamine 2 ml., formaldehyde 7 ml., water 91 ml.

2. From Bennett's, 65 West First South St. Salt Lake City, Utah

the cross-index cards following a procedure already in use at the experiment station. Population counts were not made at this time.

Results of the Survey

Fifteen genera of stylet-bearing nematodes were found in 71 soil samples from 48 different cranberry bogs (Table 1.). Nearly all of these samples yielded more than one stylet-bearing genus as well as many types of non-parasites.

Eight of the genera from the cranberry bogs were widespread, occurring in 10% or more of the bogs sampled. These were Dorylaimus, Helicotylenchus, Hemicycliophora, Tatylenchus, Trichodorus, Tylencholaimus, Tylenchorhynchus, and Tylenchus. Dorylaimus, Tylenchorhynchus, and Tylenchus were also widespread in the non-cranberry samples while Trichodorus, Tatylenchus, and Tylencholaimus were rarely in non-cranberry samples. Hemicycliophora was found in one non-cranberry sample (from a field growing blueberry plants, also genus Vaccinium), and Helicotylenchus was found only in cranberry-bog soil. These eight genera were selected for greater attention because of their widespread occurrence in cranberry-bog soil, large numbers in many samples, or known pathogenicity to other crops. The seven remaining genera were less common and occurred in smaller numbers.

The water-soaked roots yielded nematodes of the same groups. There was no evidence of root knot on any of the roots examined. None of the endoparasitic nematodes appeared to be of importance to cranberry.

Table I. Stylet-bearing nematodes recovered from cranberry bogs during the summer of 1958

Genus or Species	No. of Bogs from which recovered	% of Bogs from which recovered	
Aphelenchoides spp.	3	6	
Criconemoides spp.	1	2	
Dorylaimus spp.	31	65	
Helicotylenchus spp.	6	13	
Hemicycliophora spp.	14	29	
Hemicycliophora similis	3	6	45
Hemicycliophora uniformis	5	10	
Hoplolaimus spp.	3	6	
Nothotylenchus spp.	1	2	
Pratylenchus spp.	2	4	
Psilenchus spp.	1	2	
Rotylenchus spp.	1	2	
Tetylenchus spp.	5	10	
Trichodorus spp.	14	29	
Trichodorus christiei	3	6	35
Tylencholaimus spp.	5	10	
Tylenchorhynchus spp.	6	13	
Tylenchorhynchus claytoni	4	8	21
Tylenchus spp.	16	33	
Tylenchus agricola	2	4	37

Total number of Bogs: 48

Total number of samples: 71

Table 2. Stylet-bearing Nematodes Recovered from soils with Crops Other than Cranberry during the summer of 1958

Host	Nematode												Total No. of Samples
	Aphelenchus spp.	Aphelenchoides spp.	Criconemella spp.	Dityienchus spp.	Dorylaimus spp.	Hemicycliophora spp.	Honolaimus spp.	Meloidogyne spp.	Paratylenchus spp.	Tylenchus spp.	Trichodorus spp.	Tylenchorhynchus spp.	Tylenchulus spp.	Xiphinema americanum	
	No. of samples from which recovered														
Blueberry	1	1		2	1			2		1		1	1		6
Strawberry				1		1	6		1		1				6
White Pine	2			2					1		1	1			2
Red Pine	1	2		6						5	2	2			7
Yew				1							1				1
Elm				1						1		1			1
Red Maple	1	1		1			1				1				2
Sugar Maple		1		3		1		2		1		3			4
Norway Maple	1			1							1				1
Box Elder	1	1	1	1				1	1						1
Willow							1								1
Ash	1			1				1			1				1
Potato	1														1
Lettuce		1					1	1							1
Misc.		1					1	1							5

The non-cranberry samples yielded 15 genera of stylet-bearing nematodes. In addition, stylet-bearing nematodes of the family NeOtylenchidae were found but were not identified further. Many types of non-parasites were found. Of the stylet-bearing genera, 12 were found also in cranberry-bog soil and many represented a wide host range (Table 2.).

Analytic Discussion of Survey Data

Although no attempt has been made in this study to investigate the pathogenicity of the various nematodes found associated with cranberries, other workers have established pathogenicity for members of many of the same genera on other hosts. Even where pathogenicity has not been established, the presence of large numbers of stylet-bearing nematodes in the cranberry-bog soils indicates possible dangers and points out areas for further study.

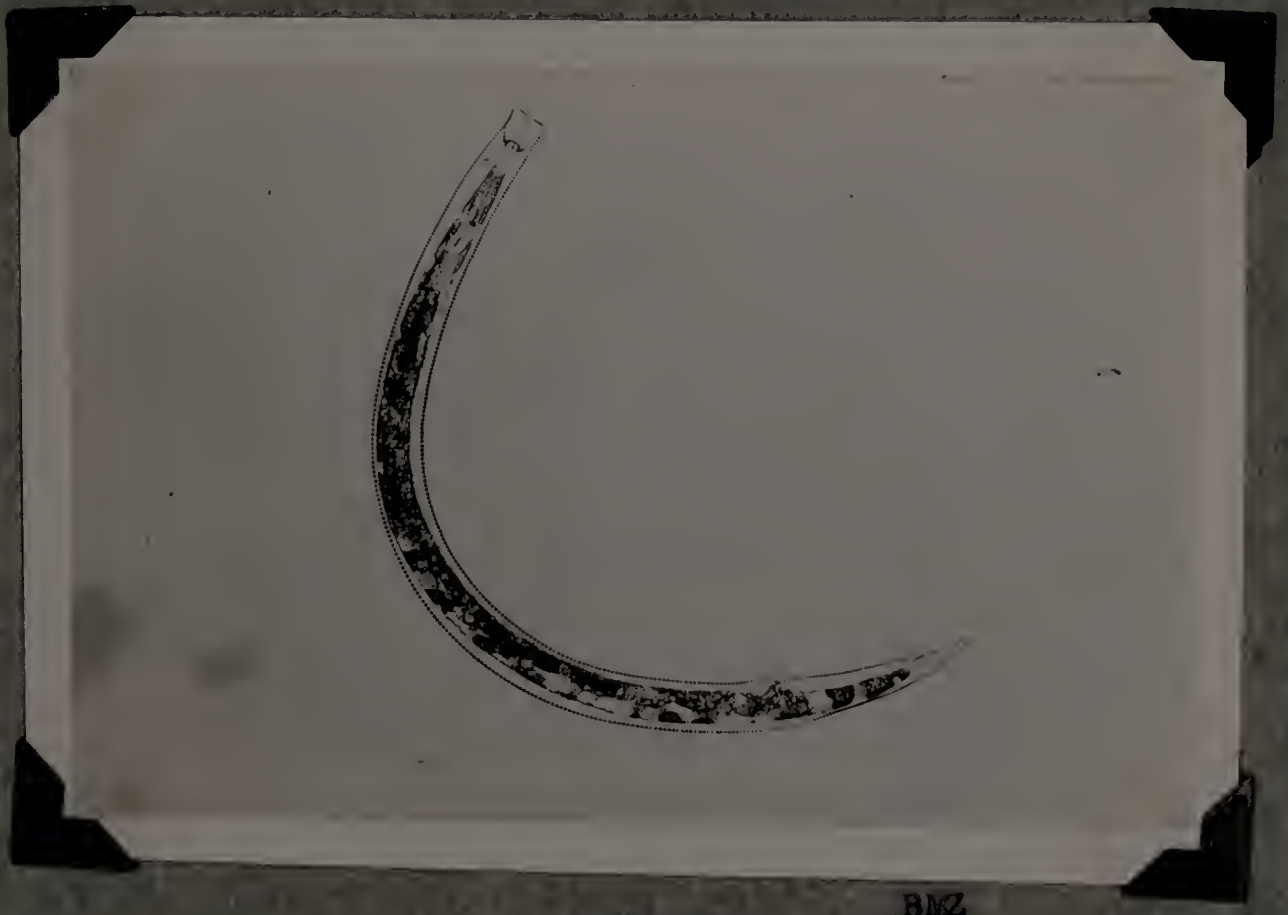
a. Hemicycliophora

The genus Hemicycliophora (Figs. 1-4) was especially prominent in this study. It occurred in 45% of the bogs sampled, usually as the principal stylet-bearing form and usually in large numbers. Members of this genus were also found in a blueberry field that had once been a cranberry bog.

Representative specimens of Hemicycliophora taken from cranberry-bog soils were sent to taxonomists for identification to species. H. uniformis Thorne was identified from seven different samples. However the identification was tentative since several points of variance from Thorne's description (24) indicated that a closely related undescribed species might be involved. Four samples yielded

BMZ

Fig. 1. A nematode of the genus Hemicycliophora. Appearance of molting is characteristic of this genus.



BMZ

Fig. 2. A nematode of the genus Hemicycliophora, showing the genital and anal openings, structures useful in identification.

BMZ

Fig. 3. View of the head of a member of the genus Hemicycliophora showing the stylet which is inserted in plant tissues for feeding.

BMZ

Fig. 4. Head of a member of the genus Hemicycliophora showing the stylet retracted and showing a variation of the double-skin appearance in this genus.

specimens that were identified tentatively as H. similis Thorne but here again there were points of difference.

Work on cranberry-soil inhabiting nematodes from the fall of 1958 to the spring of 1959 (27) has shown the importance of this genus. In further soil samples the genus Hemicycliophora was recovered from 71% of the bogs sampled. Hemicycliophora spp. ranged from 1% to 83% of the nematodes recovered from the State Bog while adjacent drier areas growing pitch pine, Pinus rigida Mill., did not yield any specimens of this genus. Hemicycliophora were also found associated with blueberry plants in two more locations and with strawberry plants in another location. The two blueberry samples were from fields subject to flooding from a nearby cranberry bog. The strawberry sample was taken from a planting adjacent to a cranberry bog. This survey did not disclose any occurrences of Hemicycliophora spp. that were not in some way associated with cranberry. Due to the prevalence of this genus in the majority of the bogs sampled, particular attention was given to the 26 bogs that yielded samples from which the genus was not recovered. Further sampling showed Hemicycliophora spp. to be present on six of these bogs. Fourteen other bogs were adjacent to bogs yielding Hemicycliophora. The remaining six were in areas surrounded by bogs yielding Hemicycliophora. There was no reason to believe that this genus was not present in all the cranberry bogs of the area although less abundent in some places.

Identifications from additional specimens of Hemicycliophora sent to taxonomists have shed more light on the cranberry-

soil-inhabiting members of this genus (27). A sample yielding specimens tentatively identified as H. similis Thorne contained a single male. Males are at present unknown in this species. Another sample yielded specimens tentatively identified as H. pigus Thorne and six other samples yielded specimens identified as H. gracilis Thorne. An additional male specimen was found among these nematodes. It is apparent that a taxonomic problem exists here.

Occurrences of members of the genus Hemicycliophora associated with other hosts are reported by various workers. Steiner (19) reports that Hemicycliophora spp. attack roots of slash pine seedlings, Pinus caribaea Morlet, in Florida. Thorne (24) found H. obtusa Thorne around the roots of sugar beets in Utah and H. similis from alfalfa, peaches, and roses. H. penetrans Thorne is reported from rice and corn in Java and H. conida Thorne from sugar beets in Ireland (24). None of these is reported in large numbers although Ruehle and Christie (17) reported large numbers of Hemicycliophora spp. occurring commonly in Florida. These infestations are reported to occur in small areas, often extending only a few feet. Members of this genus are well equipped to attack plants (Figs. 3 and 4) and are proven plant parasites. Tarjan (21) found that H. parvana Tarjan reproduced on celery, Apium graveolens, under greenhouse conditions. Ruehle and Christie (17) reported that H. parvana fed readily on corn, Zea mays L., and bean, Phaseolus vulgaris L., in the laboratory but that the feeding "did not cause

necrotic lesions during the experiment", nor were other symptoms of pathogenicity noted. Van Gundy (26) describes the feeding of H. arenaria Raski on rough lemon, Citrus limonia Osbeck, and on tomato roots. Further work is needed to show the pathogenicity of Hemicycliophora spp. on cranberry.

b. Trichodorus

The large numbers of Trichodorus spp. from a large percentage of the cranberry bog samples together with the known pathogenicity of members of this genus on other hosts gives Trichodorus an important position. In a contemporary study (27), Trichodorus spp. have been successfully grown on cranberries in pure culture, but symptoms associated with feeding on this host have not yet been demonstrated. Representative specimens taken from cranberry-bog soil were sent to taxonomists for identification to species. T. christiei Allen and T. nannus Allen were identified. The work of Rohde and Jenkins (16) indicates a wide host range for this parasitic genus, as Trichodorus spp. were able to feed and reproduce on the roots of plants from 42 plant families under greenhouse conditions.

c. Tylenchorhynchus

In soil samples from cranberry bogs, Tylenchorhynchus spp. (Fig.5) sometimes occur in large numbers. Occasionally they are the principal parasitic forms. Representative specimens from cranberry-bog

Fig. 8. Tylenchorhynchus claytoni Steiner. A specimen found in soil from a cranberry bog.

soil were identified as T. claytoni Steiner. Later (27) T. dubius (Bütschli) Filipjev was identified from a cranberry bog. Of the two T. claytoni is by far the more common. This genus contains many species of proven pathogenicity. Atkins, Fielding, and Hollis (2) reported an undescribed species of Tylenchorhynchus from rice fields. Atkins and Fielding (1) reported this nematode as T. martini Fielding, the predominant parasitic nematode present in extensive samples from Texas rice fields. Boyle (3) stated that the most important root parasite of peanuts, Arachis hypogaea L., in Georgia was T. claytoni. T. claytoni is also known as "the tobacco stunt nematode" and occurs generally in tobacco (Nicotiana tabacum L.) fields in eastern South Carolina where it was present in 67% of 175 soil samples from stunted tobacco (12). Large populations of this species have been found in Louisiana where Horn and Martin (13) showed that it propagated readily on strawberry in the greenhouse. In this case severe root damage by this species was not demonstrated. They were able to demonstrate increased growth and yield in one test where soil heavily infested with T. claytoni was treated with ethylene dibromide. Reynolds and Evans (15) report T. dubius as a root parasite of economic importance in the southwest. Although they consider this nematode less devastating to the roots of plants than other ectoparasitic nematodes, nevertheless they demonstrated moderate stunting of growth under both greenhouse and field conditions. Jenkins et al (14) report that Tylenchorhynchus seems to be a pest of importance second only to Pratylenchus in Maryland. The presence of so important a plant parasite in Massachusetts cranberry soils points out the need for further work, especially when the local abundance of this nematode

is considered.

d. Tylenchus

Although Tylenchus spp. are widespread in the cranberry bogs, their importance as plant parasites is unknown. While they occasionally occurred in large numbers they were never the principal stylet-bearing nematodes in the sample. Most of the specimens were identified only to genus but specimens of T. agricola de Man were found in the State Bog. This genus was not restricted to cranberry bogs but was quite widely associated with other hosts. Other studies have also shown it to have a wide host range (14).

e. Tetylenchus

No specimens of Tetylenchus spp. were identified to species in this study. However further work on cranberry-bog soils (27) has shown the presence of T. productus Thorne and T. loctus Thorne. No references were found which show Tetylenchus spp. to be of proven pathogenic nature although the close taxonomic relationship with Tylenchorhynchus suggests that they are. Goheen and Braun (7) in reporting large numbers of Tetylenchus spp. from blueberry fields suggest that they may be pathogenic on that host. Taylor and Schindler (23) report Tetylenchus spp. associated with corn and barley.

f. Tylencholaimus

Although Tylencholaimus spp. were commonly found they were

always associated with other stylet-bearing forms and usually in small numbers. In further work (27) T. proximus Thorne was identified from cranberry bogs. The pathogenicity of Tylencholaimus is as yet unknown.

g. Helicotylenchus

Specimens of Helicotylenchus were found only in cranberry bogs. They were rarely found in large numbers. H. erythrinae (Zimmerman) Golden and H. nannus Steiner were identified from cranberries. Members of this genus have been reported as parasites on boxwood, Buxus sempervirens L. (8). Jenkins et al (14) found them associated with numerous field crops in Maryland where they regard them as serious plant parasites. The pathogenicity of Helicotylenchus has been shown by Steiner (19) who pictures members of this genus feeding on the roots of sweet clover, Melilotus sp.

h. Dorylaimus

The genus Dorylaimus was not limited to cranberry bogs but appeared in samples from strawberry, blueberry, and bean fields. It was also found in 16 of the 20 soil samples taken from the vicinity of tree roots. Large populations of this nematode were rarely observed. Dorylaimus spp. are usually regarded as free living rather than as plant parasitic forms. However the possession of a stylet and their association with plant roots makes them suspect. Foster (6) mentions them as having been found in "wormy" nurseries in Germany and absent from soil of adjacent areas supporting healthy

plants. He reports Dorylaimus spp. as having been found in nurseries containing root rot in Mississippi and as having been observed feeding on pine roots. The true relationship of these nematodes to plants is still obscure.

i. Other Genera

Even though many of the seven additional genera of nematodes recovered from cranberry bogs are important parasites on other crops, these nematodes were always recovered in such small numbers that it seems unlikely that they are significant parasites on cranberries.

j. General Discussion

It should be realized that most of the nematode genera are somewhat more widespread than the survey indicates. Many samples are needed from an area to give a proper impression of the nematodes present. Since a pint of soil is a very small amount when compared with the volume in a cranberry bog, the nematodes that are present in small numbers or unevenly distributed are less likely to be picked up in a given sample. Nevertheless many of these less common or unevenly distributed nematodes are picked up by the random sampling.

Taylor (22) states that nematodes are carried from field to field by drainage water. Since cranberry culture requires movement of water from one area to another and since water for many bogs is drawn from and drained into the same ponds and streams, it is probable that nematodes are spread from bog to bog by water. In addition

many cranberry growers operate bogs in widely separate areas and transfer equipment, soil, and plants from bog to bog. It would seem that bogs having common sources of water and those having the same ownership would have the same nematode populations and that isolated bogs might be noticeably different. However the data thus far gathered do not show this. There are differences between samples from different areas but these differences are no more than can be demonstrated in samples from adjacent areas of the State Bog.

The injury to cranberry roots which is associated with nematode feeding is as yet unknown. Nematodes were suspected of being agents in causing certain dying areas found in many bogs. Although soil samples taken from the edge of such areas yielded large numbers of stylet-bearing nematodes, such nematodes were found also from areas in which all plants seemed healthy.

Even though no symptoms of damage have been recognized, the injury may be considerable. Steiner (18) states that the loss caused by nematodes is primarily one of reduction of yield. Plants so afflicted show reduced growth and slow decline. Massachusetts, in spite of its leadership in number of acres in cranberry bog and amount of cranberries produced, produces less than the average number of barrels per acre that is produced in Wisconsin, Oregon, and Washington. Not only is there a considerable difference in yield between Massachusetts and the west but there is also a considerable production difference between individual bogs in Massachusetts. Many factors such as age of bog, cultural and harvesting treatment, variety of cranberry and insect pests are no doubt important in

these differences. Nevertheless it may well be that nematodes are playing a highly important role in those bogs where production is low. Until work is done on the nematodes inhabiting the cranberry-bog soils of other areas and the effects on cranberry growth brought about by nematodes, their role must remain obscure.

Additional Work on Cranberry Nematodes

The nematode survey at the Cranberry Station in East Wareham has been carried on in the absence of the author during the fall, winter, and spring of 1958-1959. The complete results of this work will soon be available (27). A total of 303 soil samples from 145 Massachusetts cranberry bogs shows the same nematode genera to be the principal forms. Here representatives of nine genera of known or suspected plant parasitic nematodes were recovered from at least 10% of the bogs investigated.

Table 3. Partial List of Nematodes Recovered from Cranberry-Bog Soils in Massachusetts. Sept. 1958-Sept. 1959 (27)

Genus	% of Bogs from which Recovered
Aphelenchoides spp.	19.3
Dorylaimus spp.	62.7
Helicotylenchus spp.	13.1
Hemicycliophora spp.	71.9
Tetylenchus spp.	22.1
Trichodorus spp.	41.4
Tylencholaimus spp.	22.1
Tylenchorhynchus spp.	16.5
Tylenchus spp.	73.8

In these data the genus Aphelenchoides assumes a place of importance in addition to the eight genera previously reported. Although widespread, nematodes of this genus rarely appeared in large numbers. They were always associated with other stylet-bearing forms. None of the specimens recovered from cranberry bogs were identified to species. Aphelenchoides is one of many genera in need of revision with identification to species exceedingly difficult. Members of this genus have a wide range of feeding habits, some being obligate parasites, others living as commensals with insects and yet others living on decaying plant materials (12). No conclusions can be drawn as to their possible effect on cranberries.

Specimens representing nine other genera of stylet-bearing nematodes, the species Atylenchus decalineatus Cobb, and the family Neotylenchidae were also found. None of these were in large numbers or in more than 5% of the bogs sampled.

In these additional data many genera are represented in a larger percentage of the bogs sampled, since many bogs have been sampled several times during population or other studies. Earlier sampling sometimes failed to find certain less abundant forms which showed up after repeated sampling. For example, 64 samples were taken from the State Bog before specimens of Atylenchus decalineatus were recovered.

During the summer of 1959 the author assisted in population studies on the State Bog. It was shown experimentally, during these

studies, that the technique used to process the soil samples (the sieving-Baermann funnel technique) allowed a considerable variation in numbers of nematodes recovered. A variation of 200% in samples of the same soil was shown. However the data obtained in the study give an estimate of the numbers in which nematodes may occur in the cranberry bogs. The average number of nematodes recovered from 13 adjacent plots was 648 per 200 grams of soil on April 29th, 806 on July 8th, and 1339 on August 5th. All of the 39 samples showed a high proportion of Hemicycliophora spp., averaging 50% of those nematodes recovered on April 29th, 73% on July 8th, and 70% on August 5th.

Summary and Conclusions

This paper reports on the first study of plant parasitic nematodes associated with cranberries. Massachusetts cranberry bogs were sampled for possible nematode parasites during the summer of 1958. Soil from sixteen other plant sites was also sampled. Eight genera of plant parasitic or suspected plant parasitic nematodes were widespread or occurred in large numbers in cranberry bogs. Seven other genera were less commonly found. All of the principal forms were ectoparasitic in nature. No evidence of root knot was seen nor were the root knot or any other endoparasitic nematodes found to be of importance. Three genera, Hemicycliophora, Trichodorus, and Tylenchorhynchus are especially important in cranberry bogs. One or more undescribed species of Hemicycliophora may be present.

Nematodes of the genus Hemicycliophora are probably present throughout the Massachusetts cranberry bogs and are present in large numbers, often as the principal parasitic form. Although the effect of these nematodes and other stylet-bearing nematodes on cranberry is as yet unknown, the large numbers in the bogs and the known pathogenicity of members of the same genera or even of the same species to other plants indicate need for further work.

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Appendix

Samples were taken from soil where the following plants were growing;

Common Name	Latin Name	No. of Samples
Cranberry	Vaccinium macrocarpon Ait.	71
Blueberry	Vaccinium corymbosum L.	6
Strawberry	Fragaria virginiana Duch.	6
White Pine	Pinus strobus L.	2
Red Pine	Pinus resinosa Ait.	7
Yew	Taxus canadensis Marsh.	1
Elm	Ulmus americana L.	1
Red Maple	Acer rubrum L.	2
Sugar Maple	Acer saccharum Marsh.	4
Norway Maple	Acer platanoides L.	1
Box Elder	Acer negundo L.	1
Willow	Salix sp.	1
Bean	Phaseolus vulgaris L.	1
Potato	Solanum tuberosum L.	1
Lettuce	Lactuca sp.	1
Misc.		5

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