

A STUDY OF THE NATURAL IMMUNITY OF THE LARCH SAWFLY
(PRISTIPHORA ERICHSONII (HTG.)) TO THE INTRODUCED
PARASITE MESOLEIUS TENTHREDINIS MORLEY, IN
MANITOBA AND SASKATCHEWAN, CANADA.

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TABLE OF CONTENTS

Page

I	STATEMENT OF THE PROBLEM	1
II	REVIEW OF THE LITERATURE ON MESOLEIUS TENTHREDINIS	3
	A. Classification	3
	B. Literature Review	3
III	LIFE HISTORY OF MESOLEIUS TENTHREDINIS	11
IV	NATURE OF THE IMMUNITY REACTION OBSERVED IN LARCH SAWFLY	13
	A. Historical	13
	B. Prevalence of the Immunity Factor in Manitoba and Saskatchewan	15
	C. Review of the Literature on the Immunity of Insects to Insect Parasites	19
V	STUDIES ON THE NATURAL IMMUNITY OF THE LARCH SAWFLY TO MESOLEIUS TENTHREDINIS	26
	A. The Host Stage Attacked and the Seasonal Period of Attack in Relation to the Effective Parasitism by <u>M. tenthredinis</u> ..	26
	B. Immunity of Host Material from British Columbia	36
	C. Viability of Encapsulated Eggs of <u>M.</u> <u>tenthredinis</u>	41
	1. Relation Between the Time Spent by <u>M. tenthredinis</u> Eggs in Sawfly Larvae and the Viability of These Eggs	43
	2. Relation Between the Time Required for the Eggs of <u>M. tenthredinis</u> to Hatch in Ringer's Solution and the Presence or Absence of Capsules Around These Eggs	59
	3. Unencapsulated Eggs	65
	4. Relation Between the Time Spent by <u>M. tenthredinis</u> Eggs in Larch Sawfly Larvae and the Time Required for These Eggs to Hatch in Ringer's Solution	67
	D. Health of the Larch Sawfly Larvae in Relation to Their Immunity to <u>M.</u> <u>tenthredinis</u>	70

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E. Relation Between the Number of Eggs Deposited in Individual Sawfly Larvae and the Hatch of These Eggs	72
F. Relation Between Temperature and the Immunity of the Larch Sawfly to <u>M. tenthredinis</u>	73
1. Field Studies	73
2. Laboratory Studies	79
G. The Possible Significance of the Melanin Formation in the Inner Layer of the Capsule Formed Around the <u>M. tenthredinis</u> Egg	80
H. Histology of the Capsule	84
I. Blood Count Studies on Larch Sawfly Larvae ..	87
J. Theoretical Considerations Arising out of and Pertaining to this Problem	91
VI SUMMARY	93
ACKNOWLEDGMENTS	98
REFERENCES	99

LIST OF FIGURES

Page

Figure 1. The Total Parasitism and Effective Parasitism by <u>M. tenthredinis</u> in Three Areas in Riding Mountain National Park, Manitoba, from 1945 to 1951	17
Figure 2. The Total Parasitism and Effective Parasitism by <u>M. tenthredinis</u> in Two Areas in Manitoba and One in Saskatchewan	18
Figure 3. Seasonal Trend of the Total and Effective Parasitism of the Larch Sawfly by <u>M. tenthredinis</u> in Swamp #1 "Prisoner of War Camp" Road, R.M.N.P., Manitoba, in 1949	29
Figure 4. Seasonal Trend of the Total and Effective Parasitism of the Larch Sawfly by <u>M. tenthredinis</u> in the Swamp at Mile 145 Dauphin Highway, R.M.N.P., Manitoba, in 1949	30
Figure 5. Seasonal Trend of the Total and Effective Parasitism of the Larch Sawfly by <u>M. tenthredinis</u> in the "Railroad" Swamp North of Prince Albert, Saskatchewan, in 1950	31
Figure 6. Seasonal Trend of the Total and Effective Parasitism of the Larch Sawfly by <u>M. tenthredinis</u> in the "Crutwell" Swamp, Saskatchewan, in 1950	32
Figure 7. The Relation Between the Rate of Hatch of 25 Encapsulated <u>M. tenthredinis</u> Eggs from which the Capsules were not Removed and 30 Eggs from some of which the Capsules were Removed	61
Figure 8. The Relation Between the Rate of Hatch of 11 Encapsulated <u>M. tenthredinis</u> Eggs from which the Capsules were not Removed and 12 Encapsulated Eggs from which the Capsules were Removed	61

Figure 9. The Relation Between the Rate of Hatch of 14 Encapsulated <u>M. tenthredinis</u> Eggs from which the Capsules were not Removed and 14 Encapsulated Eggs from which the Capsules were Removed	62
Figure 10. The Relation Between the Rate of Hatch of 69 Encapsulated <u>M. tenthredinis</u> Eggs from which the Capsules were not Removed and 74 Eggs from some of which the Capsules were Removed	62
Figure 11. The Relation Between the Rate of Hatch of 42 Encapsulated <u>M. tenthredinis</u> Eggs from which the Capsules were not Removed, 45 Encapsulated Eggs from which the Capsules were Removed and 46 Eggs which were Found to be Unencapsulated at Dissection	63
Figure 12. The Relation Between the Percent Hatch of <u>M. tenthredinis</u> Eggs and High Temperatures (arbitrarily chosen as the sum of those portions of the daily maximum temperatures that were over 80°F. from July 16 to Aug. 20 inclusive) at Five Locations in Manitoba and One in Saskatchewan from 1945 to 1951 inclusive	77
Figure 13. Section of a Capsule Showing the Fibrous Nature of the Inner Layer	84
Figure 14. <u>M. tenthredinis</u> Eggs Teased from their Capsules	84
Figure 15. Melanized and Non-Melanized Capsules	84

LIST OF TABLES

Page

Table I. Total Percent Parasitism by <u>M. tenthredinis</u> Found in Each Sawfly Larval Instar	34
Table II. Estimated Percent of Each Sawfly Instar in which <u>M. tenthredinis</u> Eggs were Deposited	35
Table III. Results of Dissections of Larch Sawfly Larvae from British Columbia Para- sitized by <u>M. tenthredinis</u> obtained from Different Sources	39
Table IV. Time Spent in Host in Relation to Viability for <u>M. tenthredinis</u> Eggs Deposited in Fourth-Instar Sawfly Larvae (Group #1)	46
Table V. Time Spent in Host in Relation to Viability for <u>M. tenthredinis</u> Eggs Deposited in Fourth-Instar Sawfly Larvae (Group #2)	47
Table VI. Time Spent in Host in Relation to Viability for <u>M. tenthredinis</u> Eggs Deposited in Fifth-Instar Sawfly Larvae (Group #3)	48
Table VII. Time Spent in Host in Relation to Viability for <u>M. tenthredinis</u> Eggs Deposited in Third-Instar Sawfly Larvae (Group #4)	49
Table VIII. Time Spent in Host in Relation to Viability for <u>M. tenthredinis</u> Eggs Deposited in Fifth-Instar Sawfly Larvae (Group #5)	50
Table IX. The Relationship Between the Time Spent by <u>M. tenthredinis</u> Eggs in Sawfly Larvae and the Viability of These Eggs. (Summary of data in Tables IV - VIII inclusive)	52
Table X. Encapsulation of <u>M. tenthredinis</u> Eggs Removed from Healthy Larch Sawfly Larvae Ten or More Days after Parasitization	53

100

.....

101

.....

102

.....

103

.....

104

.....

105

.....

106

.....

107

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108

.....

109

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Table XI. Relation Between the Time Required for the Eggs of <u>M. tenthredinis</u> to Hatch in Ringer's Solution and the Presence or Absence of Capsules Around These Eggs	64
Table XII. Relation Between Time Spent by <u>M. tenthredinis</u> Eggs in Larch Sawfly Larvae and Time Required for These Eggs to Hatch in Ringer's Solution	68
Table XIII. Hatch of <u>M. tenthredinis</u> Eggs in Relation to the Number of Eggs Deposited in Individual Sawfly Larvae	74
Table XIV. Comparison of the Hatch of <u>M. tenthredinis</u> Eggs Enveloped by White Capsules with the Hatch of <u>M. tenthredinis</u> Eggs Enveloped by Brown Capsules	84
Table XV. Relation Between Time Spent by Thorn Tips in Sawfly Larvae and the Blood Count of These Larvae	89
Table XVI. Relation Between Thickness of Capsule and Blood Count in Four Sawfly Larvae Examined Ten Days after the Introduction of Thorn Tips	90

THE HISTORY OF THE

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I STATEMENT OF THE PROBLEM

The larch sawfly, Pristiphora erichsonii (Hartig), is the most important pest of tamarack (Larix laricina) in North America. Entomologists differ as to whether this species is an introduction from Europe or a native of America. The available evidence appears to indicate that the insect was introduced from Europe and that it has probably been present in North America since about the beginning of the nineteenth century (2, 17, 19, 32, 34, 41). A number of devastating outbreaks of the insect have been recorded in North America since 1882 (27, 36). The most recent and continuing outbreak began in Manitoba about 1938 and now covers extensive areas in Saskatchewan, Manitoba, Ontario and the Lake States (47).

An important phase of the problem that has been studied intensively concerns the effectiveness of Mesoleius tenthredinis Morley, an introduced parasite of the larch sawfly. It will be shown in a succeeding section that in the past this parasite must have been an effective controlling factor in western and central Canada. Studies and observations undertaken since 1940 have revealed that the larch sawfly in Manitoba and Saskatchewan has evidently developed an effective immunity to the parasite. The author conducted an investigation of the nature of this immunity from 1949 to 1951 and this paper gives an account

of the results of this study. Research has been conducted in Riding Mountain National Park, The Whiteshell Forest Reserve, and Winnipeg, Manitoba and at Prince Albert, Saskatchewan.

Since M. tenthredinis has decreased in effectiveness in Manitoba and Saskatchewan in past years it is important to understand the reasons for this decrease in order to properly appraise the possibility of remedying the situation. In British Columbia M. tenthredinis is still an effective parasite of the larch sawfly and it is important to know what to watch for when sampling the larch sawfly population in British Columbia in the future in order to determine whether or not this parasite is maintaining its effectiveness in that province.

THE HISTORY OF THE

REPUBLIC OF THE UNITED STATES

OF AMERICA

1776	DECLARATION OF INDEPENDENCE	1
1787	ADOPTION OF THE CONSTITUTION	15
1791	ADOPTION OF THE BILL OF RIGHTS	30
1800	TRANSFER OF THE CAPITAL TO WASHINGTON	45
1820	ADMISSION OF MISSOURI AS A SLAVE STATE	60
1848	ACQUISITION OF CALIFORNIA	75
1861	SECESSION OF THE SOUTHERN STATES	90
1865	END OF THE CIVIL WAR	105
1877	RECONSTRUCTION AND THE 15TH AMENDMENT	120
1898	ACQUISITION OF HAWAII AND PHILIPPINES	135
1901	ADOPTION OF THE 17TH AMENDMENT	150
1913	ADOPTION OF THE 16TH AMENDMENT	165
1919	ADOPTION OF THE 18TH AMENDMENT	180
1920	ADOPTION OF THE 19TH AMENDMENT	195
1933	PROHIBITION OF ALCOHOL	210
1945	END OF WORLD WAR II	225
1954	SCOTTSBORO BOY CASE	240
1957	ROOSEVELT UNIVERSITY CASE	255
1960	ADMISSION OF MISSISSIPPI	270
1961	ADMISSION OF ALABAMA	285
1964	CIVIL RIGHTS ACT	300
1968	ADMISSION OF ARIZONA	315
1970	ADMISSION OF TEXAS	330
1975	ADMISSION OF NEW YORK	345
1980	ADMISSION OF IOWA	360
1985	ADMISSION OF KANSAS	375
1990	ADMISSION OF NEBRASKA	390
1995	ADMISSION OF NEVADA	405
2000	ADMISSION OF MONTANA	420
2005	ADMISSION OF WYOMING	435
2010	ADMISSION OF NORTH DAKOTA	450
2015	ADMISSION OF SOUTH DAKOTA	465
2020	ADMISSION OF NORTH CAROLINA	480
2025	ADMISSION OF SOUTH CAROLINA	495

APPENDIX

The following is a list of the names of the signers of the Declaration of Independence, the names of the authors of the Constitution, and the names of the signers of the Bill of Rights.

1776: John Adams, Thomas Jefferson, John Jay, Benjamin Franklin, Roger Sherman, John Hancock, William Livingston, Francis Pickens, John M. Smith, George Taylor, James Wilson, George Clinton, Lewis Morris, Robert R. Livingston, William Floyd, Philip Hone, John B. Cloyd, John De Witt, Francis Lewis, James Duane, John Fenwick, John M. Matine, James M. Smith, James Smith, Thomas T. Lee, George Tucker, John Witherspoon, George Wythe, and others.

1787: James Madison, Alexander Hamilton, John Jay, and others.

1791: James Madison, Alexander Hamilton, John Jay, and others.

near Ottawa and about 150 were liberated in the Algonquin National Park, Ontario. It is reported that this attempt at colonization was unsuccessful, probably due to the fact that the liberation sites were poorly chosen (31). In 1911, imported cocoons were distributed near Quebec City, St. Agathe des Monts and Point Platon in Quebec and in the Algonquin National Park, Ontario. A small lot of 957 cocoons was sent to R. H. Pettit in Michigan and he reported that M. tenthredinis parasitized 7 percent of this collection (34). Another lot of 202 cocoons retained at Ottawa for study showed a parasitism by M. tenthredinis of 12.5 percent (34). The liberations made in Quebec are reported as having been highly successful (31).

In 1912, ten seven-pound buscuit boxes of imported parasitized cocoons were released by Dr. Swaine in two larch swamps in the Riding Mountain National Park, Manitoba. This release was apparently successful since the larch sawfly did not become a serious problem in this area until 1940 when four areas of heavy attack by this insect were discovered in the Park (73). Further importations from England in 1913 were sent to Norman Criddle at Treesbank, Manitoba. This shipment consisted of eight cans of cocoons and these were placed out in a stand of larches growing in a bog situated in a bend of

the Assiniboine river. These larches, at the time, were heavily defoliated by larch sawfly. A check lot of these cocoons kept at Ottawa yielded a parasitism by M. tenthredinis of 51 percent (17).

Criddle (17) reports that in the spring of 1914 cocoons were collected from this swamp but no parasites were recovered from them. No further efforts were made to recover parasites until the spring of 1916 when several hundred sawfly cocoons collected were found to have a parasitism by M. tenthredinis of 19 percent. In 1917 the rate of parasitism by M. tenthredinis had risen to 22 percent, in 1919 to 40 percent, and in 1920 to 66 percent. After this year the larch sawfly became scarce and no further notes on the activities of the parasite were made until 1926, when a series of sawfly cocoons were gathered about ten miles from the locality where the parasites had originally been liberated. Of these, 66 percent were parasitized by M. tenthredinis. In 1927 the parasitism, in some places, ran as high as 88 percent, while it averaged 75 percent over the whole area covered by the Spruce Woods Forest Reserve.

In 1927 and 1928 Criddle assisted Mr. A. B. Baird to introduce M. tenthredinis into Eastern Canada. Parasitized larvae and cocoons were collected in Spruce Woods

and shipped to the parasite laboratory, then located at Chatham, Ontario, for emergence, whence the adult parasites were redistributed to Frederickton, N. B., and the St. Williams Forestry Station, Ontario. The parasite became established rapidly at St. Williams in the reforestation stands of larch that were then heavily infested by sawfly. The increase of the parasite was followed by a correspondingly rapid decline in the sawfly infestation. It was reported that no further injury to the larch trees in this area occurred (31).

From this recolonization at St. Williams, it was possible to secure parasites to establish a colony near North Bay, Ontario, in 1929. In 1929 it was found that M. tenthredinis had spread eastward from Treesbank, Man., inside of the Ontario border to Bustead, a distance of over 200 miles (31). Graham (30) reported parasitism of 30 percent at Glen Murray, Quebec, in 1929.

The larch sawfly was first noted in British Columbia in 1930. It was not brought to the attention of entomologists, however, until 1933. Cocoons were collected and the larvae dissected. No evidence of parasitism was found and arrangements were made to release parasites in the infested area (87). In July, 1934, a shipment of 673 M. tenthredinis was released

near Fernie, British Columbia. As the sawfly spread north and east, 2,196 M. tenthredinis were released in 1935 and 781 in 1936 in the newer areas of infestation. The parasite became established and spread with the sawfly. At no time since its initial establishment in British Columbia has the sawfly reached outbreak proportions except in isolated areas. The population in each of the heavily infested areas for which there are records became heavily parasitized by M. tenthredinis and subsided without serious injury to the trees. Further releases of 624 M. tenthredinis in 1941 and 702 in 1942 were made in British Columbia (87).

Dowden (21) reports that in 1917 a small lot of parasitized cocoons was sent from Canada for liberation in Michigan, and that small colonies of the parasite were sent from Canada to New England in 1929 and 1931 for liberation in New Hampshire and Massachusetts. Dowden (20) noted the recovery of this parasite in Montana, Michigan, Wisconsin and Minnesota and since then it has been recovered in Connecticut, New York and Pennsylvania (21).

Some forest entomologists are of the opinion that the larch sawfly is circumpolar, and has always been with us. Dowden (21) suggests that the wide-spread occurrence

of M. tenthredinis might be considered further proof of this. The remarkable early success of this parasite, however, in contrast to the low effectiveness of native parasites, would seem to indicate that M. tenthredinis was not present in this country prior to 1910 and also that the larch sawfly itself is an introduced species. Hewitt (34) points out that the history of the larch sawfly in North America is what one would expect of a pest insect introduced into a foreign country without its native parasites, i.e., a series of rapid and devastating outbreaks.

Surveys through south eastern Quebec in 1934 and 1935 disclosed that M. tenthredinis was well established as far east as the centre of the Gaspé peninsula and several places were found where collections could be made (31). From these collections and others made in New Brunswick, colonies of the parasite were distributed in 1938 in Nova Scotia, New Brunswick, Quebec, and Ontario. In 1939 and 1940 colonies were liberated in Nova Scotia, Quebec and Ontario and in 1940 liberations were also made in Newfoundland (1). It is reported that M. tenthredinis gave control both in the Maritimes and Newfoundland after establishment in these areas.

Sweetman (80), in a study of most of the numerous

attempts to control pest insects through the use of parasites and predators up to 1936, considered that only 25 of these attempts could be termed "unusually successful". The control of the larch sawfly by M. tenthredinis was one of these 25 cases.

In 1943 it was found that a relatively high rate of parasitism by M. tenthredinis prevailed in British Columbia and cocoons were collected there. In 1944, 5,362 adult parasites obtained from these cocoons were released in Newfoundland (1). In 1946 a great many cocoons were collected in B.C. for release of parasites in Newfoundland, Ontario and Manitoba. In 1947 a large collection of cocoons was not made in British Columbia. In 1948 an area was found with a parasitism by M. tenthredinis of approximately 68 percent and 105,000 cocoons were collected for parasite stock. In 1949 the rate of parasitism was found to average about 61 percent and 130,000 cocoons were collected. In 1950 there was a great reduction in the larch sawfly population in British Columbia. The scarcity of cocoons made it impossible to make collections for recovery of M. tenthredinis for release in central and eastern Canada. In that year a collection of 441 cocoons showed a parasitism by M. tenthredinis of 55 percent (87).

Most of the cocoons collected in British Columbia

in 1946, 1948, and 1949 were sent to Belleville, Ontario, for rearing. In the years 1947 to 1950 inclusive the M. tenthredinis adults recovered were redistributed and liberated as follows:

Newfoundland	-	1,450	
Ontario	-	36,058	(prior to 1947, 10,238 were released in Ontario).
Manitoba	-	23,045	(prior to 1947, an unknown number were released in 1912 and 1913).
Saskatchewan	-	7,054	(prior to 1947, none were released in Saskatchewan).

THE HISTORY OF THE UNITED STATES

The history of the United States is a story of growth and change. It begins with the first settlers who came to the shores of North America in search of a new life. These early pioneers, including the Pilgrims and the Puritans, established small communities that would eventually grow into the great cities and states we know today.

As the colonies grew, they began to assert their independence from British rule. The American Revolution was a turning point in the nation's history, leading to the signing of the Declaration of Independence in 1776. This document laid out the principles of self-governance and the rights of the individual, which would become the foundation of the new nation.

The years following the Revolution were a time of rapid expansion and development. The United States grew from a small collection of colonies to a vast, diverse nation. The discovery of gold in California and the opening of the West led to a period of great economic growth and innovation. The invention of the steam engine and the telegraph revolutionized transportation and communication, connecting distant parts of the country and the world.

However, the path of progress was not without its challenges. The Civil War, fought between 1861 and 1865, was a defining moment in American history. It was a struggle over the issue of slavery, which had long been a source of deep division and conflict. The war ultimately resulted in the preservation of the Union and the abolition of slavery, but it also left a legacy of hardship and loss that would take generations to heal.

In the decades following the Civil War, the United States continued to expand its influence and power. The industrial revolution brought about unprecedented economic growth and technological advancement. The United States emerged as a major world power, with its influence extending across the globe. The Spanish-American War of 1898 marked the beginning of the United States' role as a global superpower.

The 20th century was a time of great change and uncertainty. The First World War, fought between 1914 and 1918, was a global conflict that reshaped the world. The United States entered the war in 1917, and its military and economic power played a crucial role in the Allied victory. The war led to the emergence of the United States as a world superpower, with its influence extending across the globe.

The Second World War, fought between 1939 and 1945, was another defining moment in American history. The United States played a central role in the Allied victory over the Axis powers. The war led to the development of nuclear weapons and the beginning of the Cold War, a period of intense rivalry between the United States and the Soviet Union.

The 1960s were a time of social and political upheaval. The Civil Rights Movement, led by Martin Luther King Jr., fought for the rights of African Americans and brought about significant changes in the nation's laws and social structure. The Vietnam War, fought between 1955 and 1975, was a controversial conflict that led to a deepening of the nation's political and social divisions.

The 1970s and 1980s were a time of economic growth and technological advancement. The United States emerged as a global superpower, with its influence extending across the globe. The space race, a competition between the United States and the Soviet Union to be the first to land a man on the moon, was a defining moment in the history of the world.

The 1990s and 2000s were a time of global change and uncertainty. The end of the Cold War led to a period of relative peace and stability, but it also brought about new challenges and conflicts. The September 11 attacks in 2001 were a defining moment in American history, leading to a period of intense global conflict and a re-evaluation of the nation's role in the world.

The 21st century has been a time of rapid technological advancement and global change. The United States has emerged as a global superpower, with its influence extending across the globe. The challenges of the 21st century, including climate change, global terrorism, and economic inequality, are a testament to the power and influence of the United States in the world.

through July into the first, and sometimes the second, week of August. In both England and Canada it appears that the parasites first emerge at the time when the sawfly larvae are just beginning to appear on the larch trees. After mating, the female parasites search out the sawfly larvae and deposit eggs internally into the third-, fourth-, and fifth-instar larval stages. Although Criddle (17) states that all sizes of sawfly larvae are attacked, the author found that only in very rare cases are eggs deposited in second-instar larvae. No cases of the parasitism of first-instar larch sawfly larvae were found. The egg of M. tenthredinis normally hatches in seven to ten days and the small larva then feeds, grows and moults, until it enters the state of hibernation.

OBSERVED IN THE LARCH SAWFLY

A. Historical

In 1938 in Manitoba, an outbreak of the larch sawfly occurred in a larch swamp near the Assiniboine River about five miles northwest of Aweme. Dr. Hanford of the Entomological Laboratory, Brandon, estimated the defoliation to be 50 percent. From this area cocoons were collected as follows to determine parasitism; 1,531 in 1938, 7,850 in 1939, and 2,040 in 1940. The over-all parasitism of these 11,462 cocoons, based on rearings, was found to be only 0.017 percent and the parasitism was wholly by the Tachinid Bessa harveyi Tns. (73). M. tenthredinis was seemingly absent from this area in which it had been so prevalent only ten years previously.

In 1940, 1,250 cocoons were collected in Riding Mountain National Park, Manitoba. These cocoons were reared and it was recorded that three parasites emerged (1.14 percent) although the records did not name the species (73). In 1941 dissections of 100 cocoons from each of ~~these~~ four areas in R.M.N.P. gave the following figures for total parasitism by M. tenthredinis; 33%, 27%, 39% and 22% respectively.* It was found, however, that most of the sawfly larvae that harbored M. tenthredinis

* Unpublished data. Annual Technical Report, Forest Insect Laboratory, Winnipeg. 1941 pp. 256-257.

