R. Brust

PROCEEDINGS OF THE

ENTOMOLOGICAL SOCIETY OF MANITOBA

VOLUME 46 1990

Proceedings of the

Entomological Society of

Manitoba.

VOLUME 46

1990.

A.P. Wiens,

Editor

Winnipeg, Manitoba.

CONTENTS

SUBMITTED PAPER ABSTRACTS:

RESEARCH PAPER:

Minutes of the 46th Annual Business Meeting of the Entomological Society of Manitoba

13:30 h, 2 November 1990

Freshwater Institute
Winnipeg, Manitoba

The President, Dr. R.J. Lamb, presided. A quorum being present, the President called the meeting to order and asked the Secretary, Dr. N.D.G. White, to take minutes of the meeting.

ATTENDANCE

Executive:	Dr. R.J. Lamb, President	
	Dr. R. Westwood, President-Elect	
	Dr. P. Fields, Member-at-Large	
Executive Staff:	Dr. N.D.G. White, Secretary	
	Dr. P. Pachagounder, Treasurer	
	A. Wiens, Editor - Proceedings	
	B. Galka, Editor - Newsletter	
Members:	B. Deneka	S.C. Jay
	P.A. MacKay	R.A. Brust
	R.E. Roughley	R.M. Gadawski
	Li Yunrui	B. Gallaway
	L. Grenkow	I. Wise
	B. Fingler	A.G. Robinson
	W.B. Preston	J.E. Guthrie
	T.D. Galloway	W.J. Turnock
	L. Manaigre	M. Smith

1. **Agenda** (Appendix A)

Motion: T. Galloway/Wise. That the proposed agenda be adopted. CARRIED

2. **Minutes of the 45th Annual Meeting**

Motion: MacKay/Roughley. That the minutes of the 45th Annual Business Meeting of the Entomological Society of Manitoba, held 3 November 1989 and published in Volume 45 of the Proceedings of the E.S.M., be accepted. CARRIED

3. **Business Arising from Previous Minutes**: None.

4. **Executive Reports**

a. President (Appendix B). **Motion**: MacKay/Guthrie. That the President report be received.

CARRIED

b. Treasurer (Appendix C - Financial Statements). **Motion**: Brust/Fingler. That the Financial Statements be received.

CARRIED

c. Editor - Proceedings of the E.S.M. (Appendix D). **Motion**: Westwood/MacKay. That the Editor's report be received.

CARRIED

d. Regional Director the Entomological Society of Canada (Appendix E).

Dr. R.E. Roughley, as acting Regional Director to E.S.C. highlighted several aspects of his report, especially that E.S.C. will now only cover travel expenses of regional directors to Annual Meetings. Per diem and lodging expenses should be covered by the regional societies. Requests for full funding by the E.S.C. can be made by regional society Executives. **Motion**: Galloway/Brust. That the Regional Director's report be received.

CARRIED

- Business for consideration by the Executive: Define policy re partial funding for the Regional Director to the E.S.C. for consideration at the next annual meeting.

e. Endowment Fund Board (Appendix F).

It was noted that our investments will shortly exceed $30,000. **Motion**: Roughley/Gadawski. That the Endowment Fund Board report to be received.

CARRIED

Motion: Turnock/Brust. That the maximum of the principal amount of the Endowment Fund be raised to $35,000.

CARRIED

Business for consideration by the Executive: Consider the uses of funds in excess of the $30,000 currently invested.

5. **Committee Reports**

a. Finance Committee (Appendix G).

b. Newsletter and Publicity (Appendix H).

c. Social:

L. Manaigre reported that two luncheons were held, each with 40-50 people, at the Norlander Hotel. Guest speakers were R. Westwood and J. Joyce. The New Member's Social was held at the Royal Crown and 40 people attended.

The Annual Meeting banquet was held at the Radisson Hotel and 36 people attended.

d. Youth Encouragement and Public Education (Appendix I).

e. Insect Common Names (Appendix J).

f. Archivist (Appendix K).

g. Manitoba Environmental Council (Appendix L).

h. E.S.M.-E.S.C. Honourary Members: No members were sponsored to be honourary members in the past year.

i. Student Awards Committee (Appendix M). Randall Brant received the Student Achievement Award and Rhéal Lafernière received the SWAT Student Award.

j. E.S.M. Scholarship Committee (Appendix N). Stephen Pernal received the E.S.M. scholarship.

k. E.S.C. Scholarship Awards (Appendix O).

l. Scientific Program Committee (Appendix P). **Motion:** Jay/Preston. That the Society extend thanks to R.N. Sinha for organizing an excellent program.
CARRIED

The motion was followed by applause.

m. E.S.M. Membership Committee (Appendix Q).

n. E.S.C. Membership Committee: no report.

o. Fund Raising Committee: R. Westwood reported that about $500 has been received from various sponsors.

Motion: Westwood/Galloway. That the Committee reports be received.
CARRIED

6. **Election Results for the 1991 Executive**

A.G. Robinson reported for the scrutineer committee.

President-Elect: N. White
Member-at-Large: L. Manaigre
Regional Director: P. Fields

Motion: Robinson/Fingler. That the ballots be destroyed.
CARRIED

The President, on behalf of the Executive and the Society, thanked all participants in the election for allowing their names to stand for office.

7. **Transfer of Office**

R. Lamb called upon R. Westwood to assume the office of President.

8. **Other Business**

a. R. Westwood thanked the outgoing Executive and the Committees for their contributions to the Society.

b. Appointment of Auditors

Motion: Pachagounder/Wiens. That D. Nicholson and Co. be appointed auditors for the Society in the coming year.
CARRIED

9. **Adjournment**. (15:10 h)

APPENDIX A

ENTOMOLOGICAL SOCIETY OF MANITOBA
46TH ANNUAL BUSINESS MEETING

November 2, 1990

AGENDA

1. Appointment of Secretary to record proceedings of the Annual Business Meeting.

2. Acceptance of Agenda.

3. Minutes of last Annual Meeting (Nov. 3, 1989).

4. Business arising from the minutes.

5. Reports · Executive, Trustees

a.	President	R.J. Lamb
b.	Treasurer (Auditor)	P. Pachagounder
c.	Editor of the Proceedings	A. Wiens
d.	Acting Regional Director to E.S.C.	R. Roughley
e.	Endowment Fund Board	B. Fingler

6. Reports - Committees

a.	Finance Committee	B. Fingler
b.	Publicity, Newsletter	B. Galka
c.	Social	L. Manaigre
d.	Education and Youth Encouragement	B. Deneka
e.	E.S.C. Insect Common Names	A.G. Robinson
f.	Archivist	A.G. Robinson
g.	Manitoba Environmental Council	I. Wise
h.	Honourary Members (E.S.C.)	W. Turnock
i.	Student Awards (E.S.M.)	B. Gallaway
j.	E.S.C. Scholarship Committee	J. Conroy
k.	E.S.M. Scholarship Committee	J. Conroy

l.	Scientific Program and Annual Meeting Local Arrangements	R. Sinha
m.	Membership Committee (E.S.M.)	R. Ellis
n.	Membership Committee (E.S.C.)	G. Gerber
o.	Fund Raising Committee	R. Westwood

7. 1990-1991 Election Results

   Scrutineer Committee — A.G. Robinson

8. Transfer of Office

9. Other Business

   Appointment of Auditors

10. Adjournment

APPENDIX B

PRESIDENT'S REPORT

The Entomological Society of Manitoba was 46 years old this year, and continued to play a strong role in the scientific community of Manitoba. Our membership is currently 135, up five from last year, but down from the 167 recorded members in 1984.

During the past year, the affairs of the Society have run smoothly due primarily to the efforts of the many members who have contributed as officers in the Society or in the various committees. These activities are summarized in the reports that follow. The system of committee guidelines and budgeting procedures developed over the past few years continues to be of value in guiding the committees and assuring that the Society operates with a minimum of direction from the Executive.

The Executive itself has had relatively little new business to attend to this year. A new Committee, Endangered Species, was formed with Bill Preston agreeing to act as chair. Bill also serves on the companion committee of the Entomological Society of Canada. A letter and follow-up letter were sent to the Minister of Agriculture, Manitoba, on behalf of the Society, in support of the filling of a vacant entomology position in Manitoba Agriculture. The outcome of this lobbying effort is not yet known. On the request of the City of Winnipeg, the Executive proposed Paul Fields be named to sit on the City of Winnipeg Pesticide Review. The City named Society member, Ozzie Morris, to that Committee. An advertising policy for the Proceedings was established.

On behalf of the Society, I would like to thank the officers and committee members who have volunteered their time and energy to serve the Society. In particular, Noel White, Secretary deserves special thanks. He is completing his ninth and final year as secretary, and has made a major contribution to the Society over this period. Al Wiens took over this year as Editor of the Proceedings and oversaw the incorporation of paid advertisements and the inclusion of a refereed publication, the first in some years. Lynne Manaigre managed the Social Committee effectively with the result that we had very enjoyable luncheons and a New Members' Social, with a stimulating array of guest speakers. Swamy Pachagounder took over the time-consuming job of Treasurer for this one year and handled all his duties effectively. Brian Galka and Gene Fortney took over production of the Newsletter this year and produced four interesting issues. Barb Deneka served as chair of the Youth Encouragement and Public Education Committee and continued the tradition of arranging for our members to introduce entomology to a substantial number of groups of children. All these members and many others deserve the Society's thanks for their contributions.

The final and most important event in our 46th year is the annual meeting, chaired by Ron Sinha. This year our meeting highlights stored product entomology, a sub-discipline that has been particularly active in Manitoba. The Society is fortunate to have two outstanding guests, Dr. F. Dunkel, Montana State University, and Dr. J. Arnason, University of Ottawa, participating with our own members.

I look forward to the coming year and working with the new President, Richard Westwood, and his Executive.

Robert J. Lamb
President, 1989-90

AUDITOR'S REPORT APPENDIX C

To the Directors of the
Entomological Society of Manitoba Inc.

I have examined the balance sheet of the Entomological Society of Manitoba Inc. as of August 31, 1990 and the statement of income for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests and other procedures as I consider necessary in the circumstances.

In common with may non-profit organizations, the organization derives some cash revenue, the completeness of which is not susceptible to conclusive audit verification. Accordingly, I am unable to determine whether any adjustments for unrecorded receipts from these sources might be necessary to income or surplus balances.

In my opinion these financial statements present fairly the financial position of the company as at August 31, 1990 and the results of its operations and the changes in its financial position for the year ended in accordance with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Winnipeg, Canada
September 27, 1990

Original signed by Doug Nicholson
Certified General Accountant

ENTOMOLOGICAL SOCIETY OF MANITOBA INC.
BALANCE SHEET
AUGUST 31, 1990

ASSETS

	1990	1989
Cash advances (note 2)	$350	$550
Cash in bank (note 3)	6,441	10,316
Investments (note 4)	27,006	25,000
	$33,797	$35,866

LIABILITIES

nil

SURPLUS

Surplus	$33,797	$35,866

APPROVED BY THE BOARD

_____ Director

_____ Director

The accompanying notes form an integral part of these financial statements.

ENTOMOLOGICAL SOCIETY OF MANITOBA INC.
STATEMENT OF INCOME AND EXPENSES
YEAR ENDED AUGUST 31, 1990

	1990	1989
REVENUE (note 1)		
Annual meetings	$1,513	$2,315
Donations	200	750
Fundraising Committee	60	651
Heritage	300	---
Interest income	2,976	2,998
Members fees	1,609	1,615
Social Committee	225	180
Subscriptions	514	94
Student Awards	100	100
Youth encouragement and public education	$ 3	200
	7,500	8,903
EXPENSES (note 1)		
Awards and scholarships	1,208	1,207
Donations	---	500
Fundraising Committee	---	36
General	769	734
Heritage	2,959	---
Meetings	3,195	2,094
Newsletter	112	489
Other Committees	33	221
Proceedings	860	274
Social Committee	433	319
	9,569	5,874
EXCESS (DEFICIT) OF INCOME OVER EXPENSES	$(2,069)	$3,029
Surplus, beginning of the year	35,866	32,837
SURPLUS, END OF THE YEAR	$33,797	$35,866

The accompanying notes form an integral part of these financial statements.

ENTOMOLOGICAL SOCIETY OF MANITOBA INC.
NOTES TO THE FINANCIAL STATEMENTS
AUGUST 31, 1990

1. SIGNIFICANT ACCOUNTING POLICIES

Income and expenses are recorded on the cash basis of accounting. There are no accruals of receivables or payables at the year end. Fixed assets are written off when acquired and therefore, there are no annual depreciation allowances.

2. STANDING ADVANCES

Treasurer	P. Pachagounder	$ 25.00
Secretary	Dr. N. White	100.00
Editor	A. Wiens	25.00
Newsletter	B. Galka	200.00
		$ 350.00

3. CASH IN BANK

Savings account	$ 3,129.00
Current account	3,312.00
	$ 6,441.00

4. INVESTMENT CERTIFICATES

8421072	$ 1,775.67
7053706	3,024.33
7058513	2,000.00
7058436	3,000.00
7053871	7,200.00
7053893	2,006.48
7053937	2,000.00
7053939	2,000.00
7053805	2,000.00
12007930	2,000.00
	$27,006.48

ENTOMOLOGICAL SOCIETY OF MANITOBA INC.
STATEMENT OF RECEIPTS AND DISBURSEMENTS
YEAR ENDING AUGUST 31, 1990

RECEIPTS	ACTUAL	BUDGET
Membership Dues	$1,609.41	$1,450.00
Proceedings	514.01	650.00
Social Committee	225.00	150.00
Youth Encouragement and Public Education Committee	3.00	200.00
Student Awards and Scholarship	100.00	100.00
Meetings	1,513.00	2,265.00
Fund Raising Committee	260.00	500.00
Heritage Committee	300.00	300.00
Investment Income	2,975.69	2,900.00
	$7,500.11	$ 8,515.00
DISBURSEMENTS		
General Society Expenses	$768.93	$775.00
Proceedings	860.31	2,400.00
Newsletter	111.55	535.00
Social Committee	432.98	400.00
Student Awards and Scholarship	1,208.35	1,300.00
Meeting	3,195.00	2,709.00
Fund Raising Committee	0.00	75.00
Heritage Committee	2,958.54	2,958.54
Other Committees (Youth/Education)	0.00	400.00
(Profiles of Entomologists Committee)	33.12	0.00
	$9,568.78	$11,552.54
NET LOSS For Year Ending August 31, 1990	$2,068.67	

ENTOMOLOGICAL SOCIETY OF MANITOBA INC.
BALANCE SHEET
YEAR ENDING AUGUST 31, 1990

ASSETS		
Current Account Balance		$3,128.74
Savings Account Balance		3,312.33
Investments:		
012007930	$2,000.00	
007053871	7,200.00	
007058436	3,000.00	
007053706	3,024.33	
008421072	1,775.67	
007053959	2,000.00	
007053805	2,000.00	
007058513	2,000.00	
007053893	2,006.48	
007053937	2,000.00	
		$27,006.48
Standing Advances:		
Treasurer (P. Pachagounder)		25.00
Secretary (N. White)		100.00
Editor (A. Wiens)		25.00
Newsletter (B. Galka)		200.00
		$33,797.55
LIABILITIES AND SURPLUS		
Liabilities	nil	
Surplus Account:		
Balance at August 31, 1989	35,866.22	
Net Loss for Period	$ 2,068.67	$33,797.55

APPENDIX D

REPORT OF THE PROCEEDINGS EDITOR - 1990

After a long absence, a scientific paper has appeared in the Proceedings of the Entomological Society of Manitoba. This was "**A list of the ants of Manitoba**" by G.C. Wheeler, J. Wheeler, T.D. Galloway, and G.L. Ayre. The manuscript was externally reviewed, and represents an important contribution to this field. Combined with the abstracts of papers presented at the annual meeting, it will help to raise the scientific profile of the Proceedings.

The following is a list of the individuals/institutions to whom the annual Proceedings are sent:

Society Members	140
Journal Exchanges/Gifts to Libraries	59
Subscribers	48
Archival/Legal Deposit copies	3
Complimentary copies to advertisers	2
Total	252

The number of subscribers continues to decline, but not as rapidly as feared. Subscribers are important to the Society as they have in the past contributed more than 75% of the costs of publication for the Proceedings. Their present contribution is now about 65% of publication costs, and any improvement in the scientific content of the Proceedings is likely to lessen the number of cancellations, or even reverse the trend.

The past years' volume (No. 45) also marked the first year that paid advertisements appeared in the Proceedings. Two advertisers submitted copy, and it is hoped that the quality of the ads will encourage others as well.

Due to the introduction of more efficient printing techniques, Rinella Printers Inc. was able this year to offer us the same number of Proceedings copies as last year (270) for almost $100 less ($592.21). As the publication has almost 50% more pages, this reduction is significant, and Rinella Printers continues to be the printing firm of choice.

Allen P. Wiens, Editor
October 31, 1990

APPENDIX E

REPORT OF THE REGIONAL DIRECTOR TO E.S.C.

The Annual Meetings of the Governing Board of the Entomological Society of Canada were held on October 6th and 10th in Banff, Alberta. Many items of business were covered during these meetings. Those of greatest relevance to E.S.M. are discussed below.

The Board reminded the E.S.M that (1) a list of officers and their years of tenure, and (2) the E.S.M. Newsletter should be sent to the Bulletin Editor. Also, the Public Awareness Committee of E.S.C. has grants of $200.00/year which are available to regional societies. Apparently E.S.M. did not apply last year.

News from E.S.C. Committees

The Governing Board considered a report from the Finance Committee concerned with the expenses of having the Governing Board attend the Annual Meetings. It was decided that, in the future, expenses will be paid only for the cost of transportation of the members of the Governing Board (e.g. Regional Directors) to the Annual Meeting. However, requests for financial assistance for per diem and lodging expenses will be considered by the Executive of E.S.C. if submitted before the relevant meeting.

E.S.C. has purchased a new building for society business. The new address is 393 Winston Avenue, Ottawa, Ont., K2A 1Y8. A new committee was struck for management of these facilities.

The Endangered Species Committee of E.S.C. is now set up and operational. The representative for E.S.M. is Dr. Bill Preston, Manitoba Museum of Man and Nature.

The Common Names and Cultures Committee has been encouraged to develop and publish a full, bilingual list of common names of insects in Canada. It was suggested that this would consist of an updated version of Benoit's *Nomenclatura Insectorum Canadensum*.

The book project, *Diseases and Insect Pests of Vegetable Crops in Canada*, being developed jointly with the Canadian Phytopathological Society is making good progress. The book will be published in 1991.

News about E.S.C. Trustees

The Bulletin Editor, Dr. Ron Aiken, tendered is resignation effective Dec. 31st, 1990. Dr. Fiona Hunter, Brandon University, has accepted the duties as of Jan. 1st, 1991.

The Treasurer, Dr. Don Bright, tendered his resignation effective Dec. 31st, 1990. Dr. Bob Foottit, Biosystematics Research Centre, Agriculture Canada, Ottawa, has accepted the duties as of Jan. 1st, 1991.

The duties of Editor of The Canadian Entomologist were lightened by the creation of the new trustee position of Editor of the Memoirs of the Entomological Society of Canada. Dr. Valerie Behan-Pelletier, Biosystematics Research Centre, Agriculture Canada, Ottawa, has agreed to accept the duties of this position.

The 41st Annual General Meeting of E.S.C. will be held in conjunction with the Ent. Soc. Québec which is scheduled for 21st-23rd of October, 1991 in Montréal.

Respectfully submitted:

R.E. Roughley,
(Acting) Regional Director, Ent. Soc. Manitoba

APPENDIX F

ANNUAL REPORT OF THE ENDOWMENT FUND BOARD

The Endowment Fund continues to be a major source of revenue for the Society. It provides a basis for funding the Student Scholarship, the publication of the Proceedings and the promotion of publication of scientific papers in the Proceedings. In total, the Endowment Fund is committed to approximately $2,100.00 annually.

In the 1989-90 fiscal year, $2,975.69 of investment income (which includes some bank interest from savings) were generated from a principle amount of $27,006.48. A similar amount of revenue will be generated through the Fund in the 1990-91 fiscal year.

It is anticipated that the principle amount of the Endowment Fund will be increased to its current maximum of $30,000.00 in 1990-91, with an investment of approximately $3,000.00

It is therefore appropriate for the membership of the Society to consider either raising the Endowment Fund's principle amount to $35,000.00 or committing additional funding to new or current Society programs or events.

A description of the current Endowment Fund investments is provided below.

Guaranteed Investment Certificates with Royal Trust

Cert. No.	Amount ($)	Interest Rate (%)	Maturity Date	Annual Int. ($)
7053937	2,000.00	10.500	Oct. 2, 1991	210.00
7053959	2,000.00	9.250	Feb. 19, 1992	185.00
7053706	3,024.33	10.750	Dec. 15, 1992	325.12
8421072	1,775.67	10.750	Jan. 26, 1993	190.88
7058513	2,000.00	10.500	June 3, 1993	210.00
7058436	3,000.00	10.750	Dec. 13, 1993	322.50
7053805	2,000.00	11.250	Apr. 5, 1994	225.00
12007930	2,000.00	10.750	Oct. 11, 1994	215.00
7053871	7,200.00	10.75	Nov. 14, 1994	774.00
7053893	2,006.48	11.500	Aug. 28, 1995	230.75
Total	**27,006.48**	**10.695**		**2,888.25**

October 23, 1990
Randy Gadawski
Palaniswamy Pachagounder
Barry Fingler, Chairperson

APPENDIX G

ANNUAL REPORT OF THE FINANCE COMMITTEE

The Finance Committee met on October 17 to review the Society's financial situation. It was determined that in 1989-90, expenses exceeded revenues by $2,068.67. This can be attributed to the costs associated with publishing the "Entomologists of Manitoba". (Note: $2,700.00 was received for this venture in 1986-87 fiscal year).

The Financial Committee received notification from the Social Committee which indicated that based upon current budgetary guidelines, it would be extremely difficult to properly hold the New Member's Social in future years.

The Finance Committee recommends that the Society consider:

a. allowing the Social Committee's budget to reflect a net deficit of $400.00 (i.e. $150.00 more than budgeted in 1989-90) to permit the Committee more latitude to adequately plan and carry out the New Member's Social; or

b. allowing the Social Committee to increase the admission charges to the New Member's Social from the current level of $5.00 for regular members and $3.00 for student members to prices which are necessary to fully finance the cost of holding the social; or

c. a proportional combination of options 1 and 2.

The Finance Committee had the responsibility of reviewing each of the Committee budgets and prepared an overall budget for the Society. An accounting of the revenue and expenses for 1989-90 and projections for the next two fiscal years is appended.

ENTOMOLOGICAL SOCIETY OF MANITOBA

Budget Items	1989-90[1] Actual	1990-91 Actual & Projected	1991-92 Projected
Endowment Fund	$27,006.48	$30,000.00	$35,000.00[5]
REVENUE			
Membership Dues	1,609.41	1,450.00	1,450.00
Proceedings	514.01	950.00[3]	500.00
Social Committee	225.00	200.00	200.00
Youth/Education Committee	3.00	0.00	200.00
Fund Raising Committee	260.00	600.00	600.00
Student Awards and Scholarship	100.00	100.00	100.00
Meetings	1,513.00	1,500.00	1,500.00
Investment Income	2,975.69	3,050.00	3,350.00
Other Committees: Heritage	300.00	0.00	0.00
TOTALS	$7,500.11	$7,850.00	$7,900.00
EXPENSES			
General Society Expenses	$ 768.93	$ 825.00	$ 900.00
Proceedings	860.31	1,200.00[3]	600.00
Newsletter	111.55	985.00[4]	600.00
Social Committee	432.98	600.00	600.00
Youth/Education Committee	0.00	400.00	400.00
Fund Raising Committee	0.00	300.00	300.00
Student Awards and Scholarship	1,208.35	1,300.00	1,300.00
Meetings	3,195.00[2]	2,000.00	2,800.00
Other Committees: Heritage	2,991.66	0.00	0.00
TOTALS	$ 9,568.78	$ 7,610.00	$ 7,500.00
Net Gain (Loss) for Year Ending August 31st	($2,068.67)	$ 240.00	$ 400.00

[1]Fiscal Year ends August 31.
[2]Includes a $500.00 deposit toward 46th AGM (1990) hotel banquet facilities.
[3]Includes revenue and expenses for printing 2 Proceedings: Vols. 45 (1989) and 46 (1990).
[4]Includes payment for 1989-90 Newsletters.
[5]Subject to approval of membership.

APPENDIX H

ANNUAL REPORT OF THE NEWSLETTER AND PUBLICITY COMMITTEE - 1990

The Newsletter was once again published quarterly as has been done in the preceding years. Volume 17, Numbers 1-4 were dispatched in January, April, August, and October.

Inclusion of the 1989 Proceedings, enclosures concerning the 1990 E.S.M. Annual Meeting, and enclosures from the Social Committee, which were mailed out with issues of the Newsletter, resulted in overall reduced postage costs to the Society.

My thanks to Gene Fortney for his help in gathering information and packaging of the Newsletter. Thank-you also to those who contributed to the Newsletter in terms of content and/or production.

B. Galka, Chairperson
Newsletter and Publicity Committee
29 October, 1990

APPENDIX I

YOUTH ENCOURAGEMENT AND PUBLIC EDUCATION COMMITTEE ANNUAL REPORT

Visits to schools (2) and special interest groups (8) constituted the focus for 1990. As well, the Committee's display collection was lent for education purposes 4 times. Thanks to all those who assisted with giving presentations to budding scientists.

Barbara Deneka, Chairperson

APPENDIX J

REPORT OF THE COMMON NAMES COMMITTEE

There have been no applications from E.S.M. members during the past year for new common names, or changes in old common names, and there are therefore no local activities to report.

One request for a new common name, sunflower midge for *Contarinia schulzi* Gagné, was sent by Dr. G.K. Bracken directly to the Chairman of the E.S.C. Committee on Common Names of Insects, Dr. E.M. Belton.

The Entomological Society of America have published a list of Approved Common Names, but I have not heard when the official list of the E.S.C. will be available.

A.G. Robinson, Chairperson

APPENDIX K

REPORT OF THE ARCHIVIST

The Archives materials of the Entomological Society of Manitoba are held in Room 213B of the Department of Entomology, University of Manitoba. Two copies of the E.S.M. Newsletter are received at each publication, and donations of any old records are welcome.

A.G. Robinson, Chairperson

APPENDIX L

REPRESENTATIVE TO THE MANITOBA ENVIRONMENTAL COUNCIL ANNUAL REPORT 1990 FISCAL YEAR

The past year was marked by relative stability at the Manitoba Environmental Council. The provincial election did not change personnel at the Minister of Environment or Deputy Minister level. Unfortunately, there also was no change in the provincial funding of the Council, which continues to restrict its effectiveness and capabilities. At present, the Council is examining possible changes in priorities and the re-ordering of membership distribution to include more rural representation. The Minister has also expressed a desire to have a smaller council, to be attained by not renewing memberships due to expire.

Correspondence with the Minister by the Council that received the most attention included ongoing discussions of the Environmental Licensing of Phase I Mill Conversion by Repap Manitoba Inc. at The Pas, water management concerns caused by the Rafferty-Alameda project in Saskatchewan and the diversion of the Pembina River into Pelican Lake, the request for full hearings and an Environmental Impact Assessment of the development proposal by Ducks Unlimited Canada for construction of an office building at Oak Hammock Marsh, and consultations on the regulations in the new Ozone Depleting Substances Act. The Council also continued its pursuance of a sustainable forestry strategy and participation in the Public Utilities Board review of Manitoba Hydro's 20 year development plan.

Issues dealt with by the Environmental Chemicals Committee chaired by Bill Turnock included the drafting and presentation to the Federal Pesticides Review Committee of recommended changes to the proposal for a Revised Federal Pest Management Regulatory System, consultation with the Association on a Clean Rural Environment (ACRE) involving pesticide container recycling, and correspondence with the Minister regarding herbicide spraying by government departments and Crown Corporations of road allowances and rights-of-way. I would be pleased to respond to any questions concerning these activities, and to submit environmental concerns of E.S.M. members to the Council.

Ian L. Wise
Agriculture Canada
195 Dafoe Road
Winnipeg, Manitoba
Phone: 269-2100

APPENDIX M

REPORT OF THE E.S.M. STUDENT AWARD COMMITTEE

The Committee reviewed the nominations received for the Student Achievement Award and the SWAT Student Award. Mr. Randall Brant was selected to be the recipient of the Student Achievement Award. Mr. Rhéal Lafrenière has been selected to receive the SWAT Student Award.

W.J. Gallaway (Chairperson)
J. Conroy, B. Fingler, W. Preston

APPENDIX N

ENTOMOLOGICAL SOCIETY OF MANITOBA SCHOLARSHIP COMMITTEE

The Entomological Society of Manitoba Scholarship Committee has considered the applicants for the E.S.M. Scholarship. Two applicants were considered. The Committee has recommended that the Entomological Society of Manitoba Postgraduate Award be made to Mr. Stephen Pernal.

John C. Conroy, Chairman,
E.S.M. Scholarship Committee

APPENDIX O

E.S.C. POSTGRADUATE SCHOLARSHIPS

The Entomological Society of Canada Scholarship Committee considered the applicants for the E.S.C. Postgraduate Scholarships. There were 10 applicants and all candidates were of an extremely high calibre. The Committee has recommended that the Postgraduate Awards be made to Marie-Chantal Bertrand (Laval) and Colleen Teerling (Simon Fraser).

John C. Conroy, E.S.M. Representative,
E.S.M. Scholarship Committee

APPENDIX P

SCIENTIFIC PROGRAM COMMITTEE

The 46th Annual Meeting of the Entomological Society of Manitoba was held at the Freshwater Institute, 501 University Crescent, Winnipeg on 1-2 November 1990. The keynote speaker was Prof. Florence V. Dunkel, Head, Entomology Research Laboratory, Montana State University, Bozeman, Montana, U.S.A., who presented a well-illustrated paper entitled "The stored-grain ecosystem - a global overview". A symposium moderated by Dr. S.R. Loschiavo with a general theme, "Management of postharvest ecosystems: current and future trends" was held with four invited speakers: Prof. J. Arnason, the University of Ottawa, Ontario; Drs. P. Fields, H. Kawamoto, and N.D.G. White of the Agriculture Canada Research Station, Winnipeg.

In the submitted paper session, chaired by Dr. R.E. Roughley, nine papers were presented of which three were given by graduate students who participated in the Student Paper Competition. The $100 prize was won by Andrew Fox, a student of Prof. R. Brust of the University of Manitoba.

Displays were set up at the meeting by Carl Weiss microscopes and the Insect Control Branch, City of Winnipeg. Fifty-five individuals were registered for the Annual Meeting, of whom 12 were students.

An "Evening Mixer" was held at the home of Drs. Pat MacKay and Bob Lamb on 1 November, and on 2 November a formal dinner-banquet was held at the Radisson Suite Hotel, Winnipeg Airport, 1790 Wellington Ave, Winnipeg. After dinner guest speakers were D. Giberson and P. Crawford who presented an illustrated talk on "Maritime Manitoba".

The Scientific Program Committee sincerely thanks various members who helped in organizing this meeting, especially Colin Demianyk.

R.N. Sinha, Chairperson

APPENDIX Q

MEMBERSHIP COMMITTEE

The Entomological Society of Manitoba showed modest growth this year. Currently, there are 135 members in the Entomological Society of Manitoba. Of these, 7 members joined in 1990. Prospective members, especially those from the agricultural business sector, were encouraged to join our organization.

R.A. Ellis
Chairman

ABSTRACTS OF PAPERS PRESENTED TO THE ANNUAL MEETING, 1990

GUEST SPEAKER

THE GRAIN-STORAGE ECOSYSTEM: A GLOBAL PERSPECTIVE. F.V.Dunkel, Entomology Research Laboratory, Montana State University, Bozeman, Montana, USA 59717.

Ecosystem principals such as limits to growth, biological succession, and food webs apply to grain-storage systems as well as to forests, lakes and prairies. Odum (1989) classifies the food-storage system as a human subsidized, solar-powered ecosystem, one of the four main ecosystems of the world. A grain-storage ecosystem is a complex system that can be described at several levels. One may consider the storage structure itself an entire system. One may add transportation and describe the system as an archipelago of islands linked by transportation and commerce. Government policies , end-user demands, and the economic environment are part of the system that must be considered in sound management. Understanding sampling techniques, the interrelationship of biological and physical factors, and genetic drift in the system are also essential to making sound decisions about the long term direction of postharvest research. This understanding is also essential to the making of sound decisions in the daily management of stored grain and other food commodities. Proper management of this system is crucial to human survival. This presentation will use ecosystem principals to draw together progress which has been made in understanding the physical elements, defined in part by the structure, the biological elements, including human society, and their interrelationships in storage systems throughout the world. Suggestions for future directions in the ecosystem based research on the postharvest system will be presented.

SYMPOSIUM

Management of postharvest ecosystems: current and future trends

A MULTIDISCIPLINARY APPROACH TO STORED-GRAIN RESEARCH. N.D.G. White, Agriculture Canada Research Station, 195 Dafoe Road, Winnipeg, Manitoba, Canada R3T 2M9.

The management of stored grains and oilseeds is a complex process. Grain bulks form distinct ecosystems with dormant seed as producers and communities of insects, mites, microflora and occasionally rodents or birds interacting in a unique environment. An effective interaction among many scientific disciplines is needed for effective grain management. Biologists, such as entomologists, acarologists, mycologists, biochemists, toxicologists, geneticists, ecologists,

and mycotoxicologists, interact with physical scientists such as agricultural engineers, computer modellers, and food scientists, as well as economists and statisticians. A critical factor that encourages multidisciplinary research is the potential manipulation of the storage environment to control or prevent pest outbreaks, a method that cannot be used on growing crops. Some examples of practical studies to solve storage problem with expertise from many different perspectives are discussed. The development of computer "expert systems" to integrate biological and physical models and direct areas of research will stimulate further multidisciplinary research. Although the grain-storage specialist will have limited knowledge of the relevant disciplines outside his or her own, it is important to have a good grasp of the whole system and to plan and execute research as a team effort.

RESISTANCE IN CEREALS TO STORED-PRODUCTS INSECTS. J.T. Arnason, Ottawa Carleton Institute of Biology, University of Ottawa, Ottawa, Canada K1N 6N5.

We have been examining mechanisms of resistance in cereals, including maize and wheat to stored-product insects such as the maize and granary weevil, Sitophilus spp., and the larger grain borer, Prostephanus truncatus. Performance parameters of weevils (number of eggs layed, number of progeny, Dobie index and grain consumption) were negatively and significantly correlated ($r=-0.8$, $P = 0.05$) to the E ferulic acid content of grain varieties. With Prostephanus truncatus, the performance parameters showed the highest correlations with another phenolic acid, p-coumaric acid. These phenolic acids were found in highest concentration in the pericarp and cell walls of the endosperm by fluoresence microscopy. Phenolic acid content was also found to correlate strongly with hardness of the grain. In the subaleurone layer we have detected phenolic aminos that have toxic effects and may damage the cells of gut wall of the insect.

MECHANISMS THAT ENABLE STORED-PRODUCT INSECTS TO DEAL WITH ENVIRONMENTAL EXTREMES. P. Fields, Agriculture Canada Research Station, 195 Dafoe Road, Winnipeg, Manitoba, Canada R3T 2M9.

Canada has zero tolerance for live grain-feeding insects in export wheat, yet there is a growing demand for foods free from pesticide residues. One solution is to manipulate the stored-grain insects' environment to reduce population growth or even eliminate populations. In temperate regions this has meant cooling grain through ambient air ventilation. In Australia, considerable work has been done on heating the grain to temperatures hot enough to kill insects in a few minutes. The modes of action of environmental extremes on stored-product insects will be discussed as well as areas of future research.

COMPUTER SIMULATION MODELLING FOR STORED-GRAIN PEST MANAGEMENT.
H. Kawamoto, Agriculture Canada Research Station, 195 Dafoe Road, Winnipeg, Manitoba, Canada R3T 2M9.

Simulation models are used to solve various problems in stored-grain management. Changes in temperature and moisture content of stored grain are simulated to evaluate the efficacy of ambient air ventilation and to estimate the maximum safe storage period of grain. Population dynamics of stored-grain insects are simulated to estimate the risk of pest outbreaks. Degradation of pesticide is simulated to evaluate the efficacy of the application. These individual simulation models will be organized into a granary-ecosystem model to simulate the dynamics of the ecosystem. The simulation models can be used as part of an expert system to optimize granary management.

Several simulation models have been developed at CSIRO of Australia, USDA Agriculture Research Service, ADAS of UK, and our multidisciplinary research group in Winnipeg. We have developed the physical model, population and bioenergetic models for the rusty grain beetle, *Cryptolestes ferrugineus*, and a simple model of fungal deterioration. A population model for the grain mite, *Acarus siro*, is being developed. These models will be the submodels of a granary-ecosystem model.

A regional model is being developed to predict the pest infestation in farm granaries on the Canadian prairies to help local extension personnel warn farmers of potential infestations, and recommend intensive monitoring of their grain and proper management actions. The regional model would use the granary-ecosystem model with regional estimations of initial storage conditions using meteorological and other databases. A method for the regional model to estimate the temperature and moisture content of freshly harvested grain from a meteorological database is being developed.

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SUBMITTED PAPERS

THE ASSESSMENT OF GONOTROPHIC AGE IN CULISETA INORNATA WILLISTON.
A. Fox and R.A. Brust, Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2.

Criteria for determining the gonotrophic age of Culiseta inornata were established from the analysis of ovarioles of females of known oviposition history. It is assumed that wild mosquitoes are primarily anautogenous and seek a blood meal within a few days of emergence and oviposition. Ovarioles were considered nulliparous if the pedicel had at least 6 cells and no dilatation; otherwise, the number of dilatations was considered synonymous with the degree of parity. Mosquitoes were reared at 21 ± 1°C with a 16-h photophase. The ovaries of live females

were teased apart in physiological saline and assessed using phase contrast microscopy. All the nulliparous females had an average of 87.9 nulliparous ovarioles, and 50% had an average of 2.6 uniparous ovarioles. All the uniparous females had an average of 72.1 uniparous ovarioles, and 47% had an average 2.0 biparous ovarioles. Ninety-four percent of biparous females had an average of 12.1 biparous ovarioles, and 28% had an average of 1.4 triparous ovarioles. The following criteria were established for assessing the gonotrophic age of Culiseta inornata. A nulliparous female has at least 25 nulliparous ovarioles, and a uniparous or multiparous female has at least 15 uniparous ovarioles. A biparous female has at least 5 biparous ovarioles, and between 1-4 biparous ovarioles if there is a triparous ovariole.

THE EFFECT OF THE REMOVAL OF ELMS WITH DUTCH ELM DISEASE ON THE RIVER BOTTOM FOREST COMPOSITION IN MANITOBA. C. Essenburg, Department of Botany, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2.

In river bottom forests, elms with Dutch elm disease are either removed or left as standing dead trees. This creates canopy gaps. Twenty-four removal gaps and twenty-one dead standing tree gaps along the Red River, between Winnipeg and St. Adophe and one large clearing in the Selkirk area were sampled. The plant communities in gaps areas were compared with each other and with those in the surrounding forest. Preliminary analyses indicate that there are few differences between the community composition in removal gaps, dead standing tree gaps and the surrounding forest, but there is a marked difference between the large clearing and the other sites. Seedlings and saplings of several tree species were recorded in the gaps, but very few in the clearing.

HORN FLY RESISTANCE TO PYRETHROIDS IN MANITOBA: IS IT OF LOCAL OR EXTERNAL ORIGIN? F.S. Mwangala, Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2.

Horn fly (Haematobia irritans (L.)) resistance to fenvalerate and permethrin was evaluated in Manitoba from 1987 to 1989. The number of resistant populations and intensity of resistance increased during the period. In 1987, 18 herds were sampled from the eastern, central and interlake regions. Tolerant flies were observed on 3 herds and resistance factors were less than 6-fold for fenvalerate and 3-fold for permethrin compared to the susceptible strain except for flies from a herd near Carman that were 14-fold resistant to permethrin. In 1988, 26 herds were sampled from the above regions and southwest region. Seven resistant populations were found and resistance factors ranged from 0.03- to 38-fold for fenvalerate and 0.1- to over 100-fold for permethrin. In 1989, 23 herds were sampled from the eastern, central and interlake regions. Resistant flies were found on 11 herds and resistance factors ranged from 1.0- to 62-fold for fenvalerate and 0.8- to over 100-fold for permethrin. In 1988, only one resistant population was

found near the border with the U.S. but in 1989 two other highly resistant populations were found in the southern eastern region, one of which had no flies in 1988. It is hypothesized that these flies might have dispersed from the U.S. into Manitoba.

THE POTENTIAL OF NEEM FOR FLEA BEETLE CONTROL IN CANOLA.

P. Pachagounder and I. Wise, Agriculture Canada Research Station, 195 Dafoe Road, Winnipeg, Manitoba, Canada R3T 2M9.

Three neem formulations, SNI, Margosan and RD-9 Repelin, all based on products from the neem tree, Azadirachta indica A. Juss (Family: Meliaceae), were tested for their antifeedant and repellent properties against the crucifer flea beetle, Phyllotreta cruciferae (Goeze) on canola seedlings. All formulations were applied as a spray, seed treatment, or as a drench to germinating seeds. The plants grown in greenhouse were exposed to flea beetles in laboratory bioassay arenas. In both choice and no-choice tests, the damage to cotyledons was minimal in SNI treatments than in controls. SNI also showed excellent repellent properties, in that the number of beetles found on plants treated with SNI was significantly lower than the controls. Highest dose of RD-9 also reduced flea beetle damage to cotyledons, but Margosan was not effective at any of the concentrations tested. High concentrations of SNI and medium to high concentrations of RD-9 Repelin and Margosan were phytotoxic to plants. As a seed treatment, only SNI was effective in reducing flea beetle damage. Margosan, but not other formulations, inhibited germination. As a drench application to germinating seeds, excellent systemic activity against flea beetles was noticed with SNI and to some extent with RD-9. Margosan, in addition to being ineffective in reducing damage to cotyledons, produced severe phytotoxic effects.

NEMATODES FOR BIOLOGICAL CONTROL OF PHYTOPHAGOUS INSECT LARVAE.

V.N. Converse and O.N. Morris, Agriculture Canada Research Station, 195 Dafoe Road, Winnipeg, Manitoba, Canada R3T 2M9.

Entomophagous nematodes of the Families Steinernematidae and Heterorhabditidae were bioassayed in the soil agianst the following species of plant pest larvae: Mamestra configurata, Agrotis ipsilon, Pseudaletia unipuncta, Peridroma saucia, Euxoa ochrogaster, Paleacrita vernata, and Galleria mellonella for comparison. All tests were carried out on sixth-instar larvae. The efficacy varied between insect species as well as between nematode species or strains. Limited tests in the greenhouse and in mini-plots at Morden with the most promising nematodes gave encouraging results.

THE HISTORY OF SPRUCE BUDWORM MANAGEMENT WITH BACILLUS THURINGIENSIS IN MANITOBA. A.R. Westwood, Forestry Branch, Manitoba Department of Natural Resources, 300 - 530 Kenaston Blvd., Winnipeg, Manitoba, Canada R3N 1Z4.

Since forest pest surveys began in Manitoba in the late 1920's there have been two large scale outbreaks in spruce budworm. The most recent outbreak (1979 to the present) has covered much of eastern Manitoba. In response, Manitoba Natural Resources has implemented suppression programs to protect recreational and commercial forests. The dynamics of spruce budworm epidemics in Manitoba, in conjunction with the effectiveness of various Bacillus thuringiensis products are discussed. The future of spruce budworm management in the province is addressed.

THE ACCUMULATION AND DEPLETION OF TOTAL LIPIDS IN CULEX TARSALIS (COQUILLETT) IN RELATION TO OVERWINTERING. L. Manaigre and R.A. Brust, Dept. of Entomology, Winnipeg, Manitoba, Canada R3T 2N2.

To determine the quantity of lipid that is accumulated in adult females of Culex tarsalis (Coquillett), a modified calorimetric assay from Van Handel (1985) is used. Results illustrate the variation in total lipid content during 1986 and 1987, the relationship between temperature and lipid content, and the depletion of lipids during overwintering.

HOST DISCRIMINATION BY TWO FLEA BEETLES, PHYLLOTRETA SPP., THAT ATTACK OILSEED RAPE. R.J. Lamb and P. Pachagounder, Agriculture Canada Research Station, 195 Dafoe Road, Winnipeg, Manitoba, Canada R3T 2M9.

The flea beetle, Phyllotreta cruciferae (F.), was attracted to the cruciferous plants Brassica oleracea L. and Raphanus sativus L., but not to B. campestris L. and B. napus L. which are important natural host plants, nor to Pisum sativum L., a legume. The presence or absence of attraction was demonstrated by exposing small groups of caged plants to natural populations and trapping beetles near the plants. In choice and no-choice laboratory feeding experiments, P. striolata fed on eight Cruciferae in the genera Brassica, Raphanus, and Sinapis, but not on P. sativum. Phyllotreta striolata fed less on the two Sinapis species than on plants in the other genera. Within the genus Brassica, some species were preferred to others. Discrimination at the attraction phase of host selection did not account for discrimination shown in laboratory feeding experiments nor in the natural attack of flea beetles on cruciferous crops.

The flea beetle, P. cruciferae (Goeze) also fed only on the cruciferous plants, but showed a lower level of discrimination than P. striolata. Cotyledons of the two species of Sinapis were less preferred than those of the other crucifers, but the beetles showed no preferences among the other species. Differences were evident between the feeding behaviors of the two flea beetles with P. cruciferae spending less time on the seedlings, but consuming more foliage than P. striolata.

SYSTEMATICS OF DYTISCUS L. (COLEOPTERA: DYTISCIDAE) OR ARE SPECIES REAL? R.E. Roughley, Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2.

Two species-groups of Dytiscus Linnaeus are examined from a systematic viewpoint. Chosen for detailed analysis are numbers of two species-groups: D. verticalis-group and D. hybridus-group. These species are arranged phylogenetically as D. verticalis Say + [D. harrisii Kirby + (D. habilis Say + (D. marginicollis LeConte + D. hybridus Aubé))]. Systematics is viewed as a synthesis of classical taxonomy of species coupled with information about natural history, chorology, and phylogeny. Most practical concepts of species are based on structural features only. As such these species represent hypotheses which can be tested by means of the additional kinds of data listed above. The major test of structural species is to overlay various kinds of information onto the phylogeny of these species and to examine this information for degree of congruence. A low level of congruence suggests that structural species are real. High degrees of congruence would suggest that structural species are not real or that the isolating mechanisms have not been discovered. It is argued that systematic research in its broadest sense has internally consistent mechanisms by which to test species status.

STORED PRODUCTS ENTOMOLOGY IN CANADA

S.R. Loschiavo, Retired
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Winnipeg, Manitoba R3T 2M9

HISTORY

Insects that infest stored grain and cereal products have posed problems in Canada since at least the 1850s. Probably the first record of a stored product insect in Canada was by Dupont on the granary weevil Calandra granaria (= Sitophilus granarius) (Linnaeus) from Cote de Beaupré, Quebec in 1857 (1). In 1884, James Fletcher found the pea weevil, Bruchus pisorum (Linnaeus) in Canadian seed collections, and by 1902, this species was estimated to cause losses of more than one million dollars annually (2). The consequence was a significant reduction of pea acreage in Canada. In 1889, Fletcher's discovery of the Mediterranean flour moth, Ephestia (= Anagasta) kuehniella Zeller was a first record of this species for North America. In 1916, Arthur Gibson noted it to be the most important pest during a national survey of flour mill insects. In 1898, the bean weevil, Acanthoscelides obtectus (Say) was recorded for the first time as a pest of stored beans in Canada (2).

In 1913, W.A. Ross used high temperature in a flour mill in Dundas, Ontario to control the Mediterranean flour moth. This was the first time that heat was used to control a stored product insect in Canada. In 1916, C.G. Hewitt served with C.J.S. Bethune, Ontario Agricultural College and E.M. Walker, University of Toronto on a committee appointed by the Royal Society of Canada to investigate the economic importance and control of insects infesting stored grain (3).

In 1919, E.H. Strickland, then employed by the Canadian government, studied the economic species of mites in grain stored in eastern terminal elevators and insect pests in flour mills and dried fruits. Gibson studied life histories and habits of several stored product pests. From 1924 to 1928, C.H. Curran assisted him and published a list of common stored pest species and a paper on the identification of adult months of stored products. In 1929, Gibson and C.R. Twinn published an illustrated bulletin entitled "Household Insects and Their Control", with revised editions appearing in 1931 and 1939 (4).

In 1931, grain was examined for insects in Canadian grain elevators. In 1932, Twinn found mites in terminal elevators at the lakehead cities of Fort William and Port Arthur, Ontario.

As the above reports indicate, there was no systematic or cohesive approach to stored product entomology in earlier years, and problems in this discipline were handled on an ad hoc basis by federal entomologists in field and orchard crops.

However, serious infestations of the hairy spider beetle, Ptinus villiger (Reitter) in western Canada led to the appointment of H.E. Gray in 1932 to investigate stored products insect problems on a continuing basis (2). A temporary laboratory was set up in Winnipeg to study the spider beetle problem and devise control measures. After two years, Gray was transferred to Ottawa.

In 1934, he surveyed flour mills in eastern Canada to examine flour shipments to Norway and the ships carrying the flour. The ships were not infested but most of the mills were. Cooperation between Canadian and Norwegian authorities and meetings on sanitation resulted in better conditions in Canadian mills. This policy and practice continued through the second world war. Also in 1934, Gray developed a standard inspection technique for grain-carrying ships (2). The technique was used in a program to inspect lakers and ocean-going grain vessels beginning with the outbreak of the war in 1939. To achieve this aim, inspectors of the Plant Protection Division of the Federal Department of Agriculture were trained in ship inspection. The program was so successful that it has continued and become standard practice at the Canadian lake and ocean ports for grain-carrying ships.

The necessity for long-term grain storage during the war years led to an increase in insect problems. In 1940, the Indian meal moth reached outbreak proportions in terminal elevators at several Georgian Bay ports. Grain was being stored in annexes and other temporary storage structures, some of them unsuitable for this purpose. Consequently, problems arose with the grain mite, Acarus siro Linnaeus and the rusty grain beetle, Cryptolestes ferrugineus (Stephens). B.N. Smallman, a grain inspector with the Board of Grain Commissioners, Winnipeg, in 1941 was seconded to the Entomology Division to investigate grain insect problems in the war-time storages under the Board's jurisdiction. The efforts of the stored product entomologists during the war contributed in large measure to the maintenance of sanitary grain storage facilities, thus ensuring supplies of insect-free, wholesome food for overseas shipment.

H.H.J. Nesbitt was with Gray from 1936 to 1948 (2). In 1947, J.W. Arnold joined the Ottawa staff of the Stored Product Insect Unit (5). He, Nesbitt and Gray as head were the agricultural scientists. In addition, there were three technical support people and a stenographer. The laboratory was located in the basement of a downtown Ottawa building until 1948 when it was moved to the Science Service Building, Central Experimental Farm, which is now the old wing of the K.W. Neatby building. During 1948, Nesbitt collected mites in Nova Scotia, and Arnold inspected grain elevators and flour mills in the Vancouver area. Nesbitt resigned in the fall of 1948 to go into university teaching. J.H. Follwell joined the Ottawa staff in 1949, principally as an extension entomologist and then proceeded to Vancouver to establish a

laboratory there. He returned to Ottawa in 1952 and was succeeded in Vancouver by P. Zuk, formerly with the Plant Protection Division. About 1957, he reported through the Entomology Section of the Research Station in Vancouver but continued his work on stored products insects in terminal elevators in the Vancouver area.

After the war, Smallman and B. Berck, a chemist with the Grain Research Laboratory in Winnipeg, were transferred to the Entomology Division. The Winnipeg laboratory was re-established in 1946 with Smallman in charge. In the same year, F.L. Watters joined the staff as a senior agricultural assistant. In 1951, Smallman was transferred to the Entomology Research Institute in London, Ontario, and Watters became officer-in-charge of the Winnipeg laboratory. Support staff consisted of two technicians, G.A. Cox and R.A. Sellen, and a stenographer. The laboratory was located in the Dominion Public Building on south Main Street.

The most rapid expansion in stored product entomology occurred in the 1950s (see Appendix). S.R. Loschiavo joined the Ottawa laboratory in 1950 after spending seven months at the Winnipeg laboratory. In 1956, he was transferred to Winnipeg when it was decided that research in stored product entomology should be consolidated there. E.F. Cashman joined the Ottawa staff in 1951 but resigned in 1953 to study medicine. Follwell returned to Ottawa from Vancouver in 1952 and resigned a year later to enter private industry. D.B. Waddell who had come from the Science Service Laboratory in Summerland, B.C. went to Ottawa in 1953 after spending a few months at the Winnipeg laboratory. He spent two years with the stored product unit and then transferred to the Administration Unit. L.B. Smith joined the Ottawa group in 1955. After graduate studies in England from 1957 to 1960 he returned to his position which had been transferred to Winnipeg. When the stored product entomology program was moved to Winnipeg in 1956, Gray transferred to the Board of Grain Commissioners and became its first entomologist, but he remained in Ottawa.

During the years between 1948 and 1956, Gray's extensive travels on behalf of the Stored Products Insects Unit and FAO kept him away from Ottawa most of the time thus depriving the staff of firm continuous leadership and direction and a climate in which research could flourish. Despite this drawback, some excellent fundamental and applied work was conducted and published.

In 1957, the Winnipeg laboratory was moved to the newly established Research Station on the campus of the University of Manitoba. At the same time, the Field Crops Laboratory at Brandon moved to the same building where all federal entomological research in Manitoba was consolidated. R.D. Bird, who had been officer-in-charge at Brandon, was appointed head of the entomology section, including stored product entomology (6). The entomologists and cereal breeders, rust pathologists and quality control scientists who formerly had been part of the Dominion Rust Laboratory, together with support and administrative personnel, formed the staff of the Research Station under its first director, T. Johnson. At this time, the stored products

staff of professionals consisted of F.L. Watters, B. Berck, S.R. Loschiavo, and E.A.R. Liscombe who had joined the staff in 1956. The following year, R.N. Sinha was added to the professional staff. As mentioned earlier, Smith went to Winnipeg in 1960 to resume the position which had been transferred from Ottawa in 1956.

Liscombe resigned in 1965 to become the entomologist for the Board of Grain Commissioners in Winnipeg and was succeeded by P.S. Barker. The late H.A.H. Wallace, who had started with the Cereal Diseases Section at Winnipeg in 1938, was formally transferred to the crop protection group in 1964 when he continued collaborative work with Sinha and Mills until he retired in 1972. He continued working on fungi associated with stored grain for 10 years after his retirement.

In 1966, Bird retired and A.J. McGinnis, who was transferred from the Lethbridge Research Station, became head of the crop protection section which included the entomologists from the field crop laboratory at Brandon and the stored products entomologists from the amalgamated Ottawa and Winnipeg laboratories. J.T. Mills came in 1967 from Trinidad as a mycologist to succeed J.E. Machacek and became associated with the stored products entomologists. Mills began working full-time on storage mycology in 1974 and became officially a member of the stored products group in 1981. McGinnis left in 1972 to assume the directorship of the Vineland station. By this time, Watters had returned from a two-year tour of duty as a grain storage specialist with the Food and Agriculture Organization of the United Nations, and was appointed as head of the section. He held this position until his retirement at the end of 1981, at which time Loschiavo was appointed as section head.

In 1978, D. Abramson joined the stored products group as a mycotoxicologist. In 1981, N.D.G. White assumed the duties and responsibilities of Watter's position. A computer modeller, H. Kawamoto was hired to a two-year term position from 1989-1991, and P.G. Fields joined the stored-products group in 1988 to study the behavior and physiology of stored product insects, following the retirement of S.R. Loschiavo.

By 1983, each of the scientists in the crop protection section was working on one or more discipline areas of research dealing with stored cereals and oilseeds. In 1983, the name was changed to the Stored Products Section to more precisely reflect its mandate. In 1983, the professional staff consisted of Drs. Abramson, Barker, Loschiavo, Mills, Sinha, Smith and White (see Appendix). The technical staff was made up of J.M. Barron, R.J. Bell, C.J. Demianyk, G.H. Hamilton, R.W. Jenkins and T. Thorsteinson. L.B. Smith retired in 1986 and S.R. Loschiavo retired in 1987.

In 1989 the stored products group and integrated pest management entomologists at the Winnipeg Research Station were amalgamated into the Crop and Stored Products Section with the Crop Storage Project consisting of Drs. N.D.G. White (Project Leader), D. Abramson, P.S.

Barker, P.G. Fields, H. Kawamoto, J.T. Mills, and R.N. Sinha. Technical staff were J.M. Barron, R.J. Bell, C.J. Demianyk, R.W. Jenkins and D. Smith.

PAST AND CURRENT RESEARCH

The long distance separating the Ottawa Headquarters stored product laboratory from the major grain-growing regions of Canada influenced the type and direction of research that could be conducted. At Ottawa, most of the work was done in the laboratory although practical or mission-oriented research was included (5). Gray devoted himself almost entirely to extension work, visiting and inspecting many of the terminal elevators at both coasts, the Lakehead, the Georgian Bay ports, and the terminal elevators along the St. Lawrence seaway. He was instrumental in establishing inspection methods for flour mills and grain elevators and conducting, with the aid of his research staff, short refresher courses for inspectors in regulatory agencies of government. His familiarity with senior management in terminal elevators and mills helped to generate in the industry an appreciation of the importance of insect pests. In addition to doing extension work and attending to his administrative duties as head, Gray also undertook short-term field tests of fumigant effectiveness in areas of western Canada where outbreaks of the rusty grain beetle had occurred. Sometimes other research officers had to temporarily abandon their long-term laboratory projects to help in short-term control projects in the field. In fact, from 1947 to 1949, research officers could not devote their attention to long-term programs and had to limit their research to short-term projects such as effectiveness of inert dusts as grain protectants, toxic effects of various fumigants, and movements of flour beetles in flour, and granary weevils in wheat (5). The results appeared in laboratory reports and in-house reports of the Entomology Division.

Initially in 1947, Arnold compared the effectiveness of inert dusts as grain protectants, compared fumigant toxicity, and started a laboratory study of the movements of flour beetles in flour, and granary weevils in grain. He became interested in locating the site of action of fumigants in insects by histological methods. From 1949 to 1952, this project developed into a study of blood cell classification in the Mediterranean flour moth and the effect of fumigants on the different kinds of blood cells. Additionally, Arnold investigated the effectiveness of paradichlorobenzene and other insecticides (5). Nesbitt, one of the earliest members of the Ottawa laboratory, studied the biology and taxonomy of mites until his resignation in 1948 to teach at Carleton University. Follwell's primary work was to analyze conditions in Ontario mills and prescribe good housekeeping to help prevent or minimize insect infestations. He began a study of the biology of Laemophloeus (now Cryptolestes) in 1952 but this project was discontinued after his resignation.

Waddell's few months in Winnipeg in 1953 were spent primarily on surveys of insects in farm-stored grain during which he collected insects which he took to Ottawa in 1953 to organize and identify. He was unable to complete this work before he transferred to administration. He participated in some preliminary work on insect control in terminal elevators. During his two

years with the Ottawa laboratory between 1951 and 1953, Cashman found out that parental feeding had no effect on the rate of development of progeny of the confused flour beetle. He also helped evaluate insect-proof packaging for prepared food mixes and became involved in a study on the effect of the mechanical action of milling machinery on the development and reproduction of mill insects (5).

From 1950 to 1956 in Ottawa, Loschiavo investigated the effectiveness of DDT to control flour mill insects, effects of sub-lethal exposures of flour beetles to fumigants, and insect food preferences in specially designed equipment. After transferring to Winnipeg he continued food preference studies, completed a life history - behavior study of a dermestid, Trogoderma parabile Beal (now T. variabile) and found a previously unknown coccidian pathogen of this species. After a year at the University of Wisconsin in 1961 he returned to Winnipeg where he developed a photometric method to study the chemosensory behavior of flour beetles. Individually or collaboratively he has investigated locomotory, feeding and reproductive behavior of rusty grain beetles on wheat and storage fungi, measured effects of disturbance on survival and reproduction, developed an escape-proof detection device for insects in grain and evaluated it in laboratory and field tests, developed a flour beetle assay to assess the nutritive value of cereals as feeds, measured growth effects of vitamins and fungi in insect diets, determined the distribution and economic importance of the merchant grain beetle, Oryzaephilus mercator Fauvel in Canada, conducted a survey of stored products insects in Hawaii, and helped to characterize triglycerides in wheat germ and the fungus Nigrospora sphaerica that elicit aggregation in flour beetles. He has evaluated antifeeding compounds, insect growth regulators, pheromones, and new insecticides potentially useful against stored products insects. He has been involved in a study of the effects on growth, development and reproduction of several species of stored grain insects reared on early and recent cultivars of canola seed. He has compiled and edited a departmental brochure on insects, molds and mites in farm-stored grain in western Canada. The stored product group contributed to the revised, updated version which remained current from 1983-1990 and was updated in 1990 with J. Mills acting as editor. Loschiavo was Section Head of the Stored Products Section from 1982 - 1984.

Watters' primary interest was in the physical and chemical control of stored products insects and biology. His research on physical control was concentrated on control of insects by high frequency electric fields and gamma radiation for the control of stored products insects, protection of packaged foods with silica gel, and the value of cotton and jute flour bags in reducing infestations by the hairy spider beetle. In his chemical control work, he evaluated synergistic mixtures of pyrethrins and piperonyl butoxide against flour mill insects, effectiveness of spot fumigants in flour mill equipment, effects of moisture content on residual toxicity and repellency of malathion, effectiveness of chlorinated hydrocarbon and organophosphorus insecticides against the hairy spider beetle, persistence and uptake of malathion and bromophos, toxicity and persistence of insecticides on building surfaces such as concrete, wood and metal, uptake of bromophos by stored rapeseed, and the use of organophosphorus insecticides for

controlling susceptible and malathion-resistant strains of the red flour beetle. In biology, Watters studied the effects of temperature on insecticidal toxicity, the locomotor activity of some species of stored products insects, and environmental factors influencing the development and rate o increase of the larger grain borer, Prostephanus truncatus (Horn) on stored maize.

In the early 1950s, Smallman, Watters and Berck were mainly concerned with the evaluation of new contact insecticides and fumigants for the control of insects in stored grain and flour mills, radio frequency sterilization, and the susceptibility of mill stocks to insect infestations. As officer-in-charge, Smallman created an atmosphere in which research could flourish. He not only stimulated and encourage his staff but also set example by his personal output of high quality research.

Berck as a chemist initially worked on developing methods to measure DDT and then measured losses in boxcars carrying flour as well as absorption and efflorescence of DDT deposited on wood. Later, he studied the factors that included fumigation, fumigant retention on treated shelled walnuts, and developed analytical methods to determine fumigants in air. He demonstrated that wheat acts as a chromatographic column toward several fumigants in the vapor phase and that carbon tetrachloride, when present in admixture, acts as an eluting agent. He measured the distribution and persistence of methyl bromide, ethylene dibromide, and carbon tetrachloride applied in grain fumigant mixtures and their sorption by cereal products. Berck retired in 1977.

Upon his arrival in Ottawa, Smith carried out several short-term projects including evaluation of pyrenone sprays to protect stored grain from the Indian meal moth, factors affecting population increase, and a description of a white-eyed strain of this species. After arriving in Winnipeg in 1960, Smith embarked on long-term research on the biology and population dynamics of stored products insects. His study of the intrinsic rate of increase of the rusty grain beetle has added to our knowledge of the biology of this serious pest of grain in western Canada. One of Smith's objectives was to determine cold tolerance levels for the ten most important species of stored grain insects. This study has enabled recommendations of temperatures and exposure times that will kill rusty grain beetles in stored grain. His finding that the flour beetle Tribolium madens, a new pest in Canada, can survive at -5°C for four weeks indicates that this insect can successfully overwinter in some parts of Canada. In a collaborative study of a history of infestation in a terminal elevator, it was shown that turning grain in winter controlled infestations of this species. Smith's mandate included a distribution study of insects in farm granaries in western Canada. His survey of boxcars loaded with grain in western Canada showed that almost half of them were infested with insects. His other research activities included the taxonomy of various species of insects associated with stored products.

Liscombe's work during his relatively short period in stored products entomology was on surveys and insect control in flour mills and warehouses. His survey of empty granaries

provided useful information on the kinds of mites and insects found in grain residues on the floor, cracks and crevices on floors and walls, and grain spillages. He also calculated milling losses due to infestation of wheat used for flour production. Liscombe resigned in 1965.

Barker, who succeeded Liscombe, assumed responsibility for research on the control of mites and beetles associated with stored products. As a prerequisite to the chemical control of mites, he conducted an extensive series of studies on the biology and life history of several species of mites. He then initiated research to develop economical and effective methods of fumigation against stored products insects. An important finding was that the fumigant phosphine generated from hydrogen phosphide gave poor control of mite eggs and hypopi as well as poor control of insect eggs. Barker's other main objectives were to determine the efficacy of fumigants and atmospheric gases such as carbon dioxide against adults and eggs of stored products insects, to establish rates of application of fumigants, and to evaluate synergists for use with insecticides.

Sinha's initial research was on the role of insects, mites and fungi in the heating of stored grain. Early in his career he devoted considerable time to studies of granary ecology of mites associated with stored grain. Later, in collaboration with associates, he elucidated the factors that contribute to the heating of grain in storage. He and his colleagues, including Prof. W.E. Muir, Department of Agricultural Engineering, University of Manitoba, have developed an ecosystem approach to the protection of cereals and oilseeds from post-harvest losses due to insects, mites and microflora. This approach is based on the premise that stored grain is a man-made ecological system in which deterioration of grain results from interactions among physical, chemical and biological variables. The storage ecology program includes studies on the inter-relationships of insects, mites and fungi in the aging and deterioration of stored cereal grains and oilseed, the measurement of abiotic and biotic variables in stored grain ecosystems, grain aeration, energy budgets for major stored grain insects and determination of moisture-temperature equilibrium curves and post-harvest pest infestation potential for cereal and oilseed cultivars.

Wallace collaborated with Sinha for several years elucidating the role of insects, mites and fungi in the heating of stored grain and the interrelationships of mites, insects, and fungi in the aging and deterioration of stored grain. In 1983, Sinha and F.L. Watters completed a monograph on insect pests of stored wheat and other cereals and their products in terminal elevators, flour mills and feed mills. The monograph is designed for use by the grain industry, regulatory agencies, researchers and students.

During his term as section head, McGinnis maintained an active interest in research. Because of his background in insect nutrition, he became interested in studies on the chemosensory behavior of stored products insects and collaborated with Loschiavo in this area. He and others found that triglycerides in wheat germ elevated aggregation responses in flour beetles. McGinnis also participated in the development of an insect bioassay to evaluate cereal grains as feeds.

Mills' work on fungi associated with stored grain led to a collaboration with Sinha in storage ecology. He initiated a project on the development, prediction and prevention of molds associated with loss of quality in stored cereals, oilseeds and their products. He has established the invasion route of storage fungi into mature canola seeds and has shown that specific fungal enzymes are involved. He has developed a fluorescence method for determining fungal growth within seed coat tissue. His recent and current research activities include studies of microflora in damp seed in swath and in storage, identification of mycotoxin-producing molds, establishment of safe storage limits for cereals and oilseeds, storability of frost-damaged canola seeds, evaluation of susceptibility of new cereal and oilseed cultivars to invasion by storage molds, and identification of molds in stored wheat treated with malathion. In 1989, he published a comprehensive manual on "Spoilage and Heating of Stored Agricultural Products". He served as Section Head of the Stored Products Section from 1984-1990.

Abramson, as a mycotoxicologist, has focused on mycotoxin-producing fungi and mycotoxins in cereal grains, oilseeds and feeds. He has collaborated with Mills and Sinha to determine ecological causes of mycotoxin production in moist cereals and to develop analytical methods for early detection of grain deterioration. Abramson and Mills have investigated conditions affecting toxin production using cultures of toxigenic fungal strains obtained from samples of cereals and oilseeds in western Canada. In collaboration with veterinarians and provincial governments in western Canada, Abramson documents suspected mycotoxicoses in western Canada and assays feeds for mycotoxins. He also checks the incidence of mycotoxins in tough and straight-grade export grain, in collaboration with the Canadian Grain Commission.

White is interested in the control of stored products insects with contact insecticides and protectants as well as physical controls and insecticide resistance. His program includes evaluating the effectiveness of chemicals in stored grain and storage structures. His primary areas of interest are: the degradation of contact insecticides in cereals and oilseeds, uptake of insecticides into cereals from different surfaces, monitoring of resistance in insects and the effects of resistance on biology. He is measuring the impact of various insecticides on stored-grain ecosystems, degradation rates of new insecticides, for example, pirimiphos-methyl, chlorpyrifos-methyl, and synthetic pyrethroids on cereals and residual activity of insecticides. In collaboration with Prof. D.S. Jayas, Dept. of Agricultural Engineering, University of Manitoba, he is studying controlled atmosphere storage of grain and suitable storage conditions to avoid pest infestations.

Kawamoto joined the stored products group as a post-doctoral fellow studying the application of computer models to predict processes in stored grain ecosystems and to effectively manage stored grain. In 1989 he was hired by the government of Canada on a term contract and produced models of population dynamics of the rusty grain beetle; common mite species; and the integration of these models into an ecosystem model to predict pest infestations. He has also developed a model to predict grain moisture content and temperature at harvest across the Canadian prairies for any particular year, based on temperature and precipitation.

Fields joined the stored products group as an eco-physiologist. His main interests include the cold-hardiness of stored-product insects and improved methods to use low temperature to control pests; insect trapping behavior; and pheromone studies. In 1990, using pheromone-baited flight traps, he was the first person to detect large numbers of the lesser grain borer, Rhyzopertha dominica (F.) in western Canada.

This historical account of stored product entomology in Canada would not be complete without reference to the related work at London, Ontario and Winnipeg. The late H.A.U. Monro at London, worked on standard and atmospheric fumigation of stored commodities in the early 1940s and later on the prevention and control of insect pests in cargo ships. His research included studies on selection of methyl bromide-resistant granary weevils, low temperature fumigation, and insect respiration at reduced pressures. Probably, his most significant contribution from a practical standpoint was the FAO sponsored publication entitled "Manual of Fumigation for Insect Control" dealing with several aspects of fumigation to preserve food. It is a useful guide to those engaged in fumigant application.

E.J. Bond worked closely with Monro during the late 1950s and early 1960s on the toxicity of fumigants to the cadelle, Tenebroides mauritanicus (Linnaeus). Bond became involved in basic studies on the effect of some fumigants on the activity and respiration of certain insects with fumigants at low temperatures or in atmospheres of carbon dioxide, and toxicity of mixtures of fumigants. Since 1980, he has been investigating the sorption of fumigants by various stages of the red flour beetle, and the effects of mixtures of phosphine and carbon dioxide. He completely revised Monro's manual on fumigation in 1984 and it is currently the main reference book on fumigation world-wide. Following Bond's retirement, stored products research was terminated in London by 1990.

The other Canadian entomologists concerned with stored products insects are those under the jurisdiction of the Canadian Grain Commission. The position was created in 1956 and the first appointee was H.E. Gray who held the position until 1965. E.A.R. Liscombe, who had been with the Winnipeg stored product insect group until that time, succeeded Gray and held the position until 1969. He was succeeded by A.G. Rudd from 1969 to 1974. J. van Loon was appointed in 1974 and still holds this position (1990). The Commission entomologist's mandate is to minimize infestations in Canadian grain intended for export. His responsibility to minimize insect infestations begins at the primary elevator and continues during transit to and storage at the terminal elevators until the grain is loaded onto ships. The entomologist tries to influence good maintenance of grain on farms by establishing a harmonious working relationship with the grain companies. The commission's entomologist works in close cooperation with the stored products entomologists in the Research Branch.

In 1985, Y. Bousquet at the Biosystematics Research Centre of Agriculture Canada in Ottawa began a taxonomic manual including distribution and known biology of stored products beetles

in Canada. In 1990 the manual "Beetles associated with stored products in Canada: An identification guide" was published.

OBJECTIVE AND RESEARCH RESPONSIBILITY IN THE 1990s

Presently, the broad objective of the stored products group is to do research in grain storage ecology, stored product entomology and mycology and mycotoxicology as a basis for developing effective control recommendations for reducing losses from insect and mite infestations, and storage fungi in cereal grains, oilseeds and their products during post harvest storage, transportation and processing.

Areas of research responsibility includes farm granaries, primary elevators, rail cars, terminal elevators, ships, feed mills, processing plants including flour mills, warehouses, retail stores, and homes in all parts of Canada. Although the Winnipeg-based group technically has a national responsibility, resource limitations preclude regular programs in all geographical areas of Canada. It has concentrated instead on solving immediate problems of local or regional importance, for example, with the brown house moth and white-shouldered house moth in west coast terminals, or outbreaks of the rusty grain beetle in farm granaries in the prairie provinces. Occasionally, one or more members of the group works collaboratively with Inspectors from the Plant Products Division or Canadian Grain Commission, Agriculture Canada to solve insect problems in terminal elevators or grain vessels in ports on the Great Lakes, St. Lawrence Seaway, and the Maritimes. The seven scientists in the group collaborate with each other in solving grain storage problems, and with other station or University colleagues in different disciplines, for example, cereal breeding, plant pathology, botany, pesticide residue analysis, agricultural engineering, and veterinary medicine. Some of the group are adjunct or honorary professors at the University of Manitoba. Some train graduate students or give lectures in various university departments.

IMPACT OF RESEARCH

The early work in stored product entomology developed with the need for insect control. This pragmatic approach provided information that was immediately usable. Also, it contributed to a knowledge of the types of problems likely to be encountered in the field and how to solve them. In Gray's time, stored product entomology provided a useful service to the grain industry and to regulatory agencies of government concerned with the quality of our export cereals and cereal products. The accumulated information enabled the group to make recommendations on stored product insect prevention and control in flour mills and elevators. The training courses provided by the stored products research entomologists in the early 1950s were significant contributions to better recognition of pest species and a more uniform method of inspection by regulatory inspectors concerned with grain quality. Similar courses were provided for inspection personnel concerned with insect contamination of food from a human health standpoint. In the

years since the 1950s, there has been considerable expansion in research on stored products insects. The added components of microflora and mycotoxins have allowed greater diversity in the research program as has extensive collaboration with agricultural engineers. In recent years, scientists in the group have had considerable impact in the agricultural industry, for example:

- Knowledge of the specific role of insects, mites and microflora and their interrelations is contributing to protection and improved quality of stored grain and oilseeds. These data are used by the grain industry to improve keeping quality during storage, and by the Canadian Wheat Board (our grain marketing agency in Canada) to increase export sales.

- Economical aeration units which can lower moisture content of rapeseed by 2% and temperature by 15 to 20°C are being increasingly used by grain producers in western Canada.

- The ecosystem and energy budget concepts have enabled the agricultural industry to assess qualitative and quantitative losses of food energy in stored grains and oilseeds.

- The canola, canola meal, and wheat charts for predicting storability of canola, canola meal, and wheat at different temperatures and moisture contents will enable producers and processors to plan sales at the time of optimal prices within the storability period.

- Analytical methods for determining the presence and quantity of mycotoxins in grain will provide a means of early detection in grain to be sold domestically or for export. They have been used to confirm cases of suspected mycotoxicoses in poultry, swine, and cattle. This information has aided provincial veterinarians.

- A one-year project to trace the history of an infestation in a terminal elevator bin has led to recommendations by the Canadian Grain Commission that turning grain in winter is the most effective means of controlling insects.

- The flour beetle assay used to evaluate cereal lines for feed quality is being used by some barley breeders for screening lines. The assay showed a correlation between larval development and lysine content in barley lines. It may be useful to animal scientists. It is an economical, quick method to compliment traditional feeding trials.

- Recommendations on the safe and effective use of insecticides and modified atmospheres in farm granaries, primary and terminal elevators, boxcars, warehouses, and ships has provided the grain industry and regulatory agencies with guidelines for the prevention and control of infestations.

FUTURE RESEARCH

Most of the past work in stored product entomology arose from a recognized need to control insects that infest food and fiber. It was of a practical problem-solving nature. As a result, much information was gathered that was put to immediate use. But more knowledge is necessary to provide a basis for more effective long-term control. Practical knowledge is needed to solve the on-site problems of grain producers and those involved with the processing of stored grains and their products. Fundamental research is needed to improve our basic knowledge of insect biology, ecology and behavior within the framework of the Canadian environment, to enable us to make recommendations for the prevention and control of insect infestations on a long-term basis.

Surveys of granaries, primary elevators, and food-processing establishments should be conducted regularly to provide more precise information on the kind, incidence, distribution and habits in situ of stored products insects. The use of monitoring devices and sampling techniques will enable us to evaluate the potential economic importance of domestic pests and those of recent introduction which may become established in Canada as the result of changing storage practices. Species such as the rice weevil, Sitophilus oryzae (Linnaeus), the American black flour beetle, Tribolium audax Halstead, and a similar European species, Tribolium madens (Charpentier) have been found in Canada in recent years. The highly destructive lesser grain borer, Rhyzopertha dominica has spread in the U.S.A. to infest grain in the most northern counties in the states along the Canadian border (7) and has been found in pheromone-baited flight traps across the Canadian prairies in 1990. These reports should concern us and should stimulate support for research on species hitherto considered exotic.

Ecology and control studies must be conducted on a long-term basis in grain elevators and flour mills. To do this, we must be prepared to compensate producers and industry people who allow the use of their premises and facilities for any losses sustained during the experiments. Otherwise, we are obliged to do trial and error field research which produces only fragmented information. The long-term use of such premises will allow us to do adequately designed experiments on chemical control in different seasons to determine optimal concentrations and methods of application and effects on different stages of insects, effects of combinations of insecticides in different formulations and longevity of residues.

More biological studies are necessary not only to determine optimal conditions for development but from an ecological standpoint, to determine cause of population growth and development, intra- and inter-specific relationships, distribution, and behavior. Although we have considerable knowledge of the ecology of major pests like the rusty grain beetle, flour beetle, and some other grain beetles, we are ignorant of many other species, particularly those of recent introduction.

Fundamental research that has little obvious or immediate practical application should not be ignored in stored product entomology even though under present budgetary constraints it does not enjoy a high priority. Stored products insects are ideal for such studies because they can be reared economically in large numbers on a year-round basis. They are suited to studies in toxicology and the physiology of nutrition, respiration, reproduction, behavior and diapause.

With a more thorough and systematic knowledge of biology, storage ecology, population dynamics, behavior, and control, we should be able to more effectively manage our post-harvest production and minimize losses due to insects, mites and microflora in the future. The importance of a discipline concerned with the preservation of food and its quality should not be minimized. We cannot afford to take our daily bread for granted.

ACKNOWLEDGEMENTS

The author thanks Drs. D. Abramson, P.S. Barker, J.T. Mills, R.N. Sinha, L.B. Smith, and N.D.G. White for their useful suggestions.

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APPENDIX

PROFESSIONAL STORED-PRODUCT WORKERS IN CANADA

Name	Year started in Stored Products	Location
Abramson, David	1978	Winnipeg
Arnold, J.W.[1]	1947	Ottawa
Barker, Philip S.	1965	Winnipeg
Berck, Ben	1946	Winnipeg
Bond, Ed. J.[1]	1950s	London
Bousquet, Y.	1980s	Ottawa
Cashman, E.F.[2]	1951	Ottawa
Fields, Paul G.	1988	Winnipeg
Follwell, J.W.[3]	1949 1950 1952	Ottawa Vancouver Ottawa
Gray, H.E.[3]	1932	Ottawa
Kawamoto, Hitoshi	1989	Winnipeg
Liscombe, E.A.R. (Ray)[2]	1956	Winnipeg
Loschiavo, Sam R.	1949 1950 1956	Winnipeg Ottawa Winnipeg
McGillis, A.J. (Bud)[1]	1966	Winnipeg
Mills, John T.	1967	Winnipeg
Monro, H.A.U.[3]	1940s	London
Nesbitt, H.H.J.[2]	1936	Ottawa
Rudd, A.G.	1957	Winnipeg
Sinha, Ron N.	1957	Winnipeg
Smallman, Beverly N.[1]	1941	Winnipeg

Smith, Lawrie B.[3]	1955	Ottawa
	1960	Winnipeg
Van Loon, John	1974	Winnipeg
Waddell, D.B.[2]	1953	Winnipeg
	1953	Ottawa
Wallace, H.A.H.[3]	1964	Winnipeg
Watters, Fred L.[1]	1946	Winnipeg
White, Noel D.G.	1981	Winnipeg
Zuk, P.[1]	1952	Vancouver

[1]Retired
[2]Resigned
[3]Deceased