PROCEEDINGS OF THE ENTOMOLOGICAL SOCIETY OF MANITOBA

VOLUME 18 1962

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Editor-Librarian.

Proceedings of the

ENTOMOLOGICAL SOCIETY OF MANITOBA

Vol. 18 1962

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ALVIN VALENTINE MITCHENER

ALVIN VALENTINE MITCHENER 1888-1962

A. V. Mitchener died suddenly at Ottawa on June 19. Born at Clear Creek, Ont., he attended public school there and high school at Fort Rowan, Ontario. He taught school for two years, obtained a B.A. degree from McMaster University in 1914, and a B.S.A. degree from the Ontario Agricultural College in 1918. He then taught entomology at Manitoba Agricultural College until 1927, when he received an M.Sc. degree from the University of Manitoba. For the rest of his professional career he taught entomology at this institution, being Dean of the Faculty of Agriculture from 1938 to 1946, then chairman of the Department of Entomology until 1954 when he was appointed Professor Emeritus of Entomology.

He is survived by one son, Ralph, a Bureau of Statistics employee at Ottawa. Mrs. Mitchener (nee Myrta Gowdy of Guelph) predeceased him in 1951.

Professor A. V. Mitchener was a stalwart entomologist. He received his own training in our profession under Professor Caesar at O.A.C. and he dedicated the rest of his active life to training his students in the simple but honest habits and virtues that served himself so well.

For nearly two decades he worked alone in the Department of Entomology, to serve the public of Manitoba in the control of noxious insects and improvement of apicultural practice. His administrative abilities were recognized by the University of Manitoba when he was appointed to the Office of Dean of Agriculture in which he served for eight years.

As a teacher, Professor Mitchener was meticulous about formal details, perhaps to a fault, though many of his students both entomology majors and others have testified that his example in stylistic matters proved useful to them in the work-a-day world.

As his undergraduate student assistant, I can recall the latitude he allowed in the first awkward endeavours in research, in sharp contrast with the rigid discipline he imposed on younger students in the classroom. As a researcher, Professor Mitchener exemplified a virtue of cardinal importance - enthusiasm. Though not himself a taxonomist, he nursed the Department's Reference Collection to a stage of permanent usefulness. Though not in any strict academic sense a specialist in any of the fundamental sciences he was not without an appreciation of the relevance of physiology and genetics and other disciplines basic to entomology. As a man, Professor Mitchener was forthright in manner, immaculate in appearance and unbending in integrity - so much so that not everyone could empathize with him on brief acquaintance. Nevertheless, his sterner miens were emphatically not the only aspect of his natural self which was generally cheerful, optimistic and even humorous.

In addition to his professional duties Professor Mitchener played an active role in his community as a member of his church and the school board. He was a keen participant in various forms of extension activity. He invested himself in public service within his capacities and with an evident exuberance in all his activities. His choice of deeds and his manner of doing them implied an amalgam of duty and pleasure.

A. J. Thorsteinson,
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Proceedings of the

ENTOMOLOGICAL SOCIETY OF MANITOBA

Vol. 18 A society to foster the advancement, exchange and dissemination of entomological knowledge 1962

INTRODUCTION

The Annual Meeting of the Society was the oustanding event of the year as we had the honour at that time to be host to the Annual Meeting of the Entomological Society of Canada. This entailed considerable work for the members, particularly the chairmen of the various committees who carried out the major portion of the planning and organization. The success of this meeting demonstrated that the Entomological Society of Manitoba is more than able to maintain the high standard expected at a meeting of the national Society. A summary of the events at this meeting is presented elsewhere in this issue.

The Society was grieved by the loss of our Honorary President, Professor A. V. Mitchener, who passed away on June 19, 1962. He will always be remembered for his part in founding the Entomological Society of Manitoba and assisting unstintingly in its activities during the critical early years. This enthusiastic support Professor Mitchener gave to our Society set an example we would do well to follow in the years ahead. His many other accomplishments have already been dealt with fully elsewhere and need no further elaboration here. A memorial picture of both he and Mr. J. B. Wallis will be hung by the Society in the Department of Entomology at the University of Manitoba, along with that of Mr. Norman Criddle, as a tribute to their permanent contributions to entomology.

Since the stated aims of the Society are to foster the advancement, exchange and dissemination of entomological knowledge, I would urge members to publish information on the insect and mite fauna of Manitoba in the Proceedings of our Society. Any note of interest should be placed on record in the Proceedings because in this way we can make it truly the central publication medium for information on the insect and mite fauna of Manitoba. Articles by both professionals and amateurs will be welcomed.

A project under consideration at the moment in the Society is the sponsorship of an award for an insect collection made by a boy or girl in Manitoba. This would assist in increasing the public's knowledge of insects, a step that seems particularly important today when most insects tend to be classed as pests and, therefore, something to be eradicated. Another outcome of such a project might be the encouragement of more work by amateur entomologists not only in the field of systematics but also in the fields of distribution, migration and life history studies of insects.

At the Banquet following our spring meeting, we were treated to an excellent illustrated talk by Mr. E. F. Bossenmaier of the Game Branch of the Manitoba Department of Mines and Natural Resources. His talk entitled "The Barren Ground Caribou" was highlighted by a film taken by the CBC of ear tagging operations designed to study the migrations of this rapidly diminishing species. As we have come to expect, Mr. Bossenmaier gave a very comprehensive and interesting description of this project.

In closing these introductory remarks, I would like to express my sincere appreciation for the support of the executive in dealing with the problems that faced the Society in the past year, and to all members of the Society who contributed to the success of the meetings.

L. B. Smith,
President.

A REVIEW OF THE HIGHLIGHTS OF THE 12TH ANNUAL MEETING OF THE ENTOMOLOGICAL SOCIETY OF CANADA AND THE 18TH ANNUAL MEETING OF THE ENTOMOLOGICAL SOCIETY OF MANITOBA AT WINNIPEG, OCTOBER 29 - 31, 1962.

L. B. Smith
Canada Agriculture Research Station
Winnipeg, Manitoba

This marked the first occasion the Manitoba Society has had the pleasure of being host for the annual meeting of the national Society since it was officially formed in 1950. The total attendance was 134 which is approximately the same as that of the three previous annual meetings. This number was made up of 80 out-of-town members who represented every province in Canada except Newfoundland, and a few research centres in the United States.

A copy of the complete program is presented in Appendix V to show the order of events. A brief review of the highlights of the meeting is given below.

Invitation Address

An innovation at this meeting was the delivery of the invitation address by Dr. M. O. Beckner of Pomona College, Claremont, California, a philosopher who chose as his subject, "Philosophical Aspects of Biology". In his address, he illustrated the areas in which philosophy and science had common objectives and then proceeded to explore one of these in detail, namely, concept formation. This address had a very favourable reception indicating that entomologists have interests in fields of knowledge outside the sciences.

Symposia

There were two symposia, "Physics in Insect Biology" and "Geographical Aspects of Insect Ecology", both of which were well received. Considerable discussion ensued following the papers, particularly on the topic, "The Role of Sound in Insect Behaviour", indicating a considerable interest in this subject. The first symposium illustrated the elegant results that can be obtained by applying the principles of physics to entomological problems. The second symposium dealt thoroughly with aspects of insect distribution that ranged in character from theoretical to practical, general to specific. Unfortunately it was limited to three participants through the untimely death of Mr. A. R.

Brooks of Saskatoon in August. The chairman, Mr. G. P. Holland, made a few well-chosen remarks at the beginning of the symposium concerning Mr. Brooks, his career and the permanent value of his contribution to science and was joined by the members in a moment's silence in tribute to this outstanding entomologist.

Submitted Papers

Titles of 23 papers were received, of which 22 were presented at the meeting. Abstracts of 20 of these were circulated to the entire membership of the Entomological Society of Canada. There was sufficient diversity in the nature of these papers to divide them into four sections. viz. Insect Control, Insect Behaviour, Bionomics and Taxonomy, and Insect Physiology. The time schedules were very well adhered to by the session chairmen and the objective of allowing the members to attend the maximum number of papers in which they were interested was apparently achieved satisfactorily.

Business Meeting

The business meeting was highlighted by plans for the meeting in Ottawa in 1963 to celebrate the centennial of organized entomology in Canada.

Social Events

The smorgasbord and mixed smoker on the evening of the 29th and the banquet on the evening of the 30th were extremely well attended, 175 being at the former and 202 at the latter. The informality of the smoker was enjoyed by all and was put to good use in meeting friends both old and new. The banquet was distinguished by the presentation of the Society's first gold medal to Dr. R. F. Morris of Fredericton, N. B. for outstanding achievement in the field of entomology. The welcome from the Manitoba Department of Agriculture was eloquently extended by Dr. J. R. Bell, Deputy Minister, who also announced this to be the eve of his retirement. Following the dinner, members were royally entertained by the superb dancing of the Ukranian National Folk Dancers of Winnipeg and a fascinating talk by Dr. Brian Hocking of the University of Alberta on the year he recently spent in Africa. Dr. Hocking illustrated his talk with excellent coloured slides and a very interesting tape recording.

Exhibits

One outstanding feature of the meeting was the display featuring the entomological research being done in Manitoba. This was extremely well done and attracted many visitors.

Publicity

The support of the news media, press, TV and radio, in giving full coverage to the meetings was very gratifying and unexpectedly enthusiastic.

Ladies Program

Three special events were provided for the ladies, in addition to the regular social program: a visit to the Manitoba Rehabilitation Hospital with tea, a luncheon at Kelly House Square and a visit to the Handicraft Guild. The success of these events is attested to by the fact that they enjoyed almost complete participation by the visiting wives and wives of local members.

Bouquets

The success of the meeting was almost entirely due to the wholehearted support of the members of the Manitoba Society, along with assistance from the executive of the National Society. Without these ingredients, the meeting would not have run as smoothly as it did. Local members assisted in a wide variety of ways, such as serving actively on committees, helping out during the pressure of final arrangements or presenting papers in the scientific sessions. The many complimentary remarks made at the meeting were a tribute to the efforts of the members of the Entomological Society of Manitoba.

ENTOMOLOGICAL SOCIETY OF CANADA

PRESIDENTIAL ADDRESS, 1962

A. W. A. Brown
Department of Zoology
University of Western Ontario
London, Ontario

It was thirteen years ago, in this very hotel, that the Entomological Society of Manitoba played host to the Entomological Society of Ontario, and thus acquainted Canadian entomologists with what a truly national meeting could mean. Two years later the Entomological Society of Canada held its first annual meeting, and now today the Manitoba society has welcomed the 12th annual meeting of the national society to the geographical centre of the country. As the current president it falls to my lot to signalize the occasion in an appropriate way by reviewing topics and developments of importance to our national membership.

Perhaps the most important is the forthcoming celebration of the Centennial of Entomology in Canada, a joint meeting of the Entomological Society of Ontario and of Canada which is planned to be held in Ottawa from September 3 to 6. The Centennial Committee, consisting of G. P. Holland, J. G. Rempel and W. E. Heming, has already made great headway in its plans. It is understood that the programme will feature the Canadian contributions to entomology, in terms of blocks of research of lasting or general value.

As we review the Canadian scene in entomology, there are two points which particularly exercise us. The first is the relative balance between the government and the universities. The second is the differential between what interests Canadians and what interests Americans.

With regard to the first point, we scarcely need to state that the Research Branch of the Canada Department of Agriculture, along with the Forest Entomology and Pathology Branch of the Department of Forestry, plays the predominant role in Canadian entomology. Indeed they are almost the exclusive employers of entomologists in Canada. And with their chain of excellent laboratories and institutes across the country they provide unrivalled opportunities for the performance of good research work. Thus there would be a danger that the role of the universities may come to be regarded as solely to produce trained young men for that government organization. This view would be an ironical mockery in times of government austerity. However, it is evident that the university departments are not regarded in this restrictive light. Indeed there are occasions when university staff and public servants meet to consider entomological subject-matter and even formulate action decisions upon it; the Advisory Committee on Entomological Research of the Defence Research Board, which meets here at the end of this week, is a good example. Moreover, the Canada Department of Agriculture has awarded extra-mural research grants to University departments for the expected completion of certain research jobs of use to it and to the country. It is heartening that these university departments are not restricted to Agriculture faculties, where such activities are a fitting as a matter of course, but are found in the Arts faculties of non-provincial universities, even departments of Zoology, Chemistry or Physiology, in which the work is done because the professors are interested and anxious to do it, and the government is happy because it feels that these are the departments competent to do the particular job of research in question.

This has the effect of building entomology in Canada not on the basis of going through motions that are fitting, but on the basis of the subject-matter of research. It is very significant that the number of Ph.D. degrees granted for entomological work in Canadian universities is greatly increasing; even more significant is that many departments now have one or several postdoctoral fellows, from the National Research Council of Canada, the Colombo Plan, the Commonwealth Fund, or other granting agencies. Add to these the groundswell of M.Sc. candidates, and it can be realized that university departments have the makings of effective research groups. We can think of a dozen such groups in Canada, each under its professor-director, to name those of A.S. West, D.M. Davies and A.J. Thorsteinson as 3 examples. Admittedly the personnel in these groups is in a rather rapid state of flux, but there is no better source of energy than young men in pursuit of a degree or a position; admittedly too the facilities are often antiquated and overcrowded, but this is compensated by the independence of enquiry that goes with university life. There is also a broadening international flavour to the graduate student body at present, and we hope that the exigencies of teaching ever more Canadians will not eventually destroy this.

Among the institutes of the Department of Agriculture and the Department of Forestry we find similar research groups based on specific leaders with greater stability and research experience and probably with more uninterrupted devotion of time to the actual work. Indeed also they have had a degree of independence that is almost academic, and their topics of research are definitely basic; one thinks of the groups of W. Chefurka, R. F. Morris, A. D. Pickett, and W. G. Wellington. These are the professionals and the array of their accomplishments and publications is formidable indeed; even if no work was done outside the Research Branch, Canada would produce a sufficient volume and quality of entomological work of which she could be proud. But it would seem that research activities in university departments are also important to provide a balance against one-sidedness in the field. This balance should be epitomized at the annual meetings of our entomological societies, and to some extent it is. But in many respects it is not, because 15-minute papers cannot really convey what a person or group is really doing, and symposia have a habit of diverting a man into a context that is not exactly his own. We know that our colleagues in the University Departments and Entomology Research Institutes are leaders in certain lines of research, but we are continually struck with our ignorance of what they have really done in the field as a whole. It is this ignorance that we know the Centennial Meeting will rectify.

And now for the second point, to contrast the interests of Canadian entomologists with those in the United States. Here we must remember that the population of Canada stands somewhere between that of California and of New York state, and is only one-tenth that of the great American nation. So we need not hang our heads that we seldom constitute the cutting edge of research. A comparison of the pages of the Canadian Entomologist with those of the Annals of the Entomological Society of America or of the Journal of Economic Entomology will reveal that alright. In the recent fields of insect endocrinology, of insect toxicology, and of bacterial insecticides, we do follow in the wake of the American leaders. But we can point out that many of these American leaders came by way of Canada, as for example R. D. O'Brien and A. M. Heimpel in the last two fields mentioned. Moreover the Canadian worker would appear to have the particular ability (or the time) to master a field and review it; one recalls the Annual Review of Entomology for 1960 in which 5 out of the 20 reviews were by Canadians. We are also much more conservative and thus tend to restore the balance between new fields and the older classical fields. Lest we forget that entomology is primarily a science of classification and identification of the overwhelming numbers of insect species, the Supplement Series of the Canadian Entomologist will restore our memory.

It is almost a reflex with us, as Canadians, to wonder what the Americans will be up to next. At the present time, the field which is due to receive special emphasis south of the border is insect genetics. This was kicked off, as it were, by a symposium on insect genetics at the last E.S.A. meeting in Miami, under Section C. But one speaker at that symposium was Professor J. W. Boyes of McGill, and indeed it had been preceded 2 months before by a similar symposium of the E.S.C. at Quebec. There is to be another genetics symposium at the E.S.A. meeting in Phoenix this year, this time in Section D, but again a Canadian will be among the speakers. The genetics of insects, of course, is as important as the genetics of the other half of the animal kingdom, and the irony is that hitherto genetics has been lost to entomology. No credit has redounded to entomology, and no entomological group has resulted, from the work of the Morgan and Bridges school on _Drosophila melanogaster_, nor from that of the Dobzhansky group on the population genetics of D. pseudoobscura and the karyotypes of each Drosophila species, nor from that of the late R. B. Goldschmidt on intersexes in the gypsy moth. What is surely the most interesting field in entomology, that of speciation, has been left to people who count bristles and evaluate colour-patterns of pinned museum specimens. This despite the fact that many of these systematic morphologists, notably W. J. Brown, have urged the dynamic study of speciation for years.

Alas, our insect geneticists are only too few, and those in Canada may be counted on the fingers of one hand. S. G. Smith is of course the doyen of this select few, although on the cytogenetical side rather than that of Mendelian genetics, and to him we owe (for example) much of our knowledge of the Diprionine group of sawflies and of the species of Choristoneura budworms. G. Stehr and I. M. Campbell have carried us further into the genetics of the spruce budworm by hybridizing the western genotype with its 2-year life-cycle with the eastern genotype with its 1-year life-cycle, and by distinguishing two X-chromosome types of contrasting fecundity in this species. A. S. Wilkes is forging ahead into the Mendelian genetics of Lepidoptera, and performs a notable service as editor of the excellent Canadian Journal of Genetics and Cytology. But there is room for much more work in insect genetics, for this is the wave of the future, as the Research Branch and the forest entomologists realize; and it is hoped that when they again are able to recruit normally, they will find their new insect geneticists among the young Ph.D's from Canadian institutions as well as from abroad.

There is so much genetical work here and now simply waiting to be tackled. For example, the September 1954 issue of the journal Mosquito News carried two successive papers, one by B. Hocking entitled "Flight muscle autolysis in Aedes communis", followed by W. E. Beckel on "Lack of autolysis in flight muscles of A. communis". Obviously in these two cases, which were both at Churchill, here was an opportunity of studying allelism in the possible autogeny of this important Canadian pest mosquito, as Hocking himself pointed out 8 years ago. And lest mere entomologists hesitate to undertake such studies, we have had a strong plea from G. B. Craig for more Class A Genetics in entomology, simply the making of hybrid crosses with pure strains and their interpretation by Mendelian principles. There has been much concern with resistance to aldrin, dieldrin and heptachlor by several species of root maggots in Canada. In Kent and Lambton counties of southwestern Ontario the onion maggot Hylemya antiqua is surviving these insecticides and persisting until late in the season. In Norfolk county the root-maggot fauna has been changed since the introduction of these insecticides from one preponderantly the seed-corn maggot H. cilicrura to one almost exclusively the bean-seed maggot H. liturata. Work done on an extra-mural grant given by the Research Branch to the University of Western Ontario has shown that this dieldrin-resistance, as studiable in H. antiqua, is due to allelism in a single-gene, and has indicated that whereas strains of H. liturata with this gene multiply well, strains of H. cilicrura do not, so that in an environment where the soil is treated by these insecticides it is H. liturata that becomes abundant and H. cilicrura a rarity. An analogous situation is the progressive replacement of the northern tomato hornworm Protoparce quinquemaculata by the southern tobacco hornworm P. sexta in the Ontario tobacco fields which receive foliage treatments of DDT; P. sexta having a DDT-resistant genotype, which P. 5-maculata has not, will naturally take over in an environment liberally laced with DDT.

Of course, the field of insecticide-resistance in general is one that can greatly profit from genetical study. In Canada, resistance has now developed in 18 species. Three of these, the housefly, the German cockroach, and the salt-march mosquito Aedes cantator, are insects of public health importance. All the rest are of agricultural importance, consisting of 4 species of foliage mites, the pear psylla, the codling moth and red-banded leafroller, the cabbageworm and cabbage looper, and the dark-sided cutworm, the carrot rust-fly, the spotted root fly, and 4 species of Hylemya root-maggots consisting of the 3 already mentioned plus the cabbage maggot H. brassicae. In our cold climate, it is very difficult to rear agricultural insects in the laboratory in sufficient numbers for good genetical work. But considerable advances can be made with the more laboratory-adaptable species of mosquitoes such as Aedes aegypti and Culex tarsalis, and with them the group at Western has been able to come to grips with the nature, position and action of genes for resistance to DDT, to dieldrin and to malathion.

Genetical studies could provide the answer to the resistance problem if they could discover to what compounds the resistance alleles make the insect more susceptible, and indeed such a negatively-correlated insecticide has been found by Z. Ogita for the resistance gene on chromosome 2 in Drosophila melanogaster; Dr. Ogita will be coming to spend a period in Canada next year. Genetics is even more important in the new type of insect control inaccurately known as the sterile-male technique, for what the Co^{60} radiation really does is to induce dominant lethal alleles in the chromosomes of the irradiated males. Release of large numbers of these males into a field population of modest size progressively reduces the number of viable eggs produced and finally overwhelms it; the classical example is the eradication of the screw-worm fly of cattle from the island of Curacao and later from the peninsula of Florida. This method has been also tried on populations of fruit-flies in certain western Pacific islands (with success) and on mosquitoes in the U.S.A. (without success). The same result is obtained by certain compounds such as aphoxide and apholate which have the property of alkylating the DNA in the chromosomes of the gonadal cells and thus causing dominant lethal alleles; these radiomimetic compounds, inaccurately called chemosterilants, are applied as baits and have achieved successful control of the housefly and several species of fruit flies. Such developments have been hitherto exclusively American, but their promise is so great that they cannot be ignored in Canada, which thus will have a need for entomologists qualified in genetics at the Class A level. Even greater possibilities exist, genetically more complex and much less certain of success, which maybe categorized under the heading of Meiotic Drive. In such instances certain chromosomes are actually favoured against others in the process of gametogenesis in the sex cells, which may result in the preferential production of genotypes that are actually deleterious to the species, or in a preponderance of males or a high proportion of intersexes. These possibilities are being considered at Ottawa consequent on the lucid reviews of J. A. Downes. Such genetical methods of insect control could conceivably be fantastically effective and perhaps totally destroy certain pest populations. What a contrast to the methods of chemical control where it seems we have to keep throwing chemicals at them until they finally become resistant.

But in 1962 we are still in the insecticide age, and chemical control is the principal way in which an economic entomologist can make himself useful to the country and increase its productivity. During the past decade the forest entomologists have been fighting a continuous battle against the spruce budworm in New Brunswick, where by now the total forest area sprayed amounts to 8 million acres; it seems that they have at last got the pest corralled into a million-acre area in the east-central part of the province. Many of the watersheds have been repeatedly sprayed with DDT, and this has resulted in a decimation of the aquatic insect fauna and of young Atlantic salmon in the streams. Although conservationists cannot point to a significant decrease of bird-life in the sprayed area, they can allege that a recently-discovered decrease in reproductive success of woodcock is due to the accumulation of DDT in their natural diet of earthworms. It is fortunate that the New Brunswick operations are annually reviewed by an Interdepartmental Committee on Forest Spraying, which includes the Fisheries and Wildlife as well as the Forestry and Forest Biology organizations of the Canadian government. It is also fortunate that the studies of F.P. Ide show a remarkable resilience in the aquatic insect fauna of all species with the occasional exception of caddis-flies. Indeed it appears that the smaller species of mayflies may even have become DDT-resistant; that the spruce budworm itself has not developed an increased tolerance of DDT over these 10 years is a miracle whose reality has yet to be confirmed by the published results of resistance tests.

Moreover, the province has been favoured with an unusually large spawning-run of salmon from the sea in 1958, so that the fish populations are not as low as they might have been; indeed there is a good possibility that if the budworm can be licked in the next couple of years, the numerous fish-hatcheries now existing could restore the salmon fishery to normalcy. Meanwhile it is perhaps regrettable that the only feasible insecticide was one so persistent and cumulative in soil and run-off water as is DDT. Unfortunately, no other insecticide is so cheap, so easily and safely handled, or so effective. The only one that comes close to DDT in effectiveness is phosphamidon, an organophosphorus insecticide; although it is much more expensive, it is always a matter of congratulation when an effective substitute for DDT can be found without its appalling residual stability. Meanwhile the dosage of DDT in New Brunswick, which was initially set at 1 lb. per acre in 1952 (those of us who were on the Upsalquitch at that time will remember that we wanted to be sure of control) was soon reduced to 0.5 lb. per acre and then in 1960 to 0.25 lb. per acre, occasionally applied twice at a 10-day interval to catch the phenological differential between red spruce and balsam fir. So the forest entomologists have been keeping the accumulation of DDT down to the minimum necessary for budworm control.

Meanwhile the RCAF has been protecting its northern bases against pest mosquitoes and blackflies by airspraying DDT at 0.2 lb. per acre over areas aggregating more than 200 square miles each year. Here again the plans are drawn up by the RCAF in committee not only with the Surgeon-General and the Defence Research Board, but also with the Departments of Agriculture and of Fisheries. This method of control, which was actually developed by entomologists of the universities and of the then Entomology Division for the Defence Research Board and the RCAF, has engendered no detectable deleterious effects on fish at this light dosage.

The third example of really large-scale application of insecticides in Canada is connected with grasshopper control on the prairies. Here aldrin and heptachlor have been used, and these chlorinated hydrocarbons are much more hazardous to wildlife than DDT. The modest dosages employed, namely 2-4 ounces per acre, are insufficient to do much harm; but the residue problem from these persistent compounds is building up, so that substitution of more labile insecticides such as Sevin, malathion and dimethoate is rightly being considered. It was with dieldrin and heptachlor broadcast in granular form on the ground surface at 2 to 3 lb. per acre against the Japanese beetle and the imported fire ant that such astounding mortalities of birds and mammals have been encountered in Illinois and in the southeastern states respectively. Whatever we feel about the truth of Silent Spring, we must admit that the initial conduct of these two programmes with such toxic insecticides at such high dosages was regrettable, even although the latter was set in motion by an act of the U.S. Congress itself. Our American entomological colleagues have rightly responded by searching for insecticides that are effective against the fire ant at much lower dosages in baits, and have come up with Kepone and finally Myrex, in the meantime keeping the programme going with a reduced application of heptachlor at 0.25 lb. per acre applied at the beginning and again at the end of the season.

There is no doubt that the public image of economic entomology has greatly suffered from the fire ant programme. It has also suffered from the use of DDT to control the Dutch elm disease, because it has caused such high mortality among robins and to a lesser degree among other arboreal birds. The mortality was unforeseen because the effect is not direct, but acts through the accumulation of DDT in the soil, then in the earthworms, and then in the robins starved for lack of arthropod food; economic entomologists have not been particularly good at appreciating food-chains. If DDT gives this highly undesirable side-effect, then elm-disease control must be achieved either by sanitation measures to remove infected trees and wood, or by a substitute insecticide. Some municipalities in the United States have taken it upon themselves to substitute methoxychlor, which is scarcely toxic at all to birds and is almost as effective against the elm bark-beetle as DDT itself; it is regrettable that it was not the state government that first directed them to make the substitution.

Whatever we may think of the utter nonsense in allegations that the population of North America is being poisoned by deadly chemicals pushed by an unscrupulous industry and winked at by a duty-delinquent government, we are forced to regret the side-effects of certain insecticides on fish and wildlife. This of course is as much a matter of dosage and mode of application as of choice of insecticide. Dr. Arnason will recall the satisfaction we felt when in 1948 we controlled *Simulium arcticum* along the entire lower stretch of the South Saskatchewan river with a single application without killing any fish whatsoever, but I recall with regret having slaughtered hundreds of fish on the Blue Nile in 1956 in an effort to control *Tanytarsus lewisi*. The Sudanese themselves that lived on the river-banks were delighted, and had wonderful fish-fries which would put a little harmless DDT into their body-fat. But in other countries the public would not have been so kind and would have denied one the opportunity of going back the next year and doing the job without side-effects by using the non-toxic analogue DDD. The North American public *is* critical, and its press encourages it to be so because of its first-class news value. Silent Spring was reviewed in our local paper on the editorial page by the drama critic, who called the book an exposé and said it was being nominated for a Nobel Prize, one presumes in literature. In this business we must remember that we are the "they" whom the general public deeply suspects of a Machiavellian plot to poison them in their ignorance; only thus in fact can antifluoridationism become comprehensible. The entomologist who ignores this fact of human life, whether he is a government servant, teacher or pest-control operator, it would seem does so at his peril. Our answer must be not that it is all nonsense, because some of it isn't, but that we are constantly improving our control programmes to avoid side-effects. For example, dieldrin and heptachlor have been safely used by agriculture for many years by disking these insecticides into the soil; by employment of safe measures the spread of introduced soil insects such as the Japanese beetle, and more recently the European chafer which is now knocking at Canada's door in the Niagara peninsula, may be achieved without public outcry.

The incalculable benefits which have accrued from insecticides to the food-supply and health of man, the colossal amount of research performed on the toxicity to humans and higher animals of hundreds of insecticides, the responsibility and constant vigilance of regulatory entomologists and medical men, all these have been taken for granted and seldom appreciated because they lack the bite of real news. However our incoming president, Dr. C. W. Farstad, and the chairman of the programme committee, Dr. J. G. Rempel, have planned for the Centennial Meeting one symposium on the strategy of insect control, so that we can pass in review the tremendous pros and infrequent (but nonetheless important) cons in this vital and dynamic field. In thus putting this phase of economic entomology up on the blocks for review, I believe Drs. Farstad and Rempel are doing a service to the entire membership of our national society and that of the Entomological Society of Ontario, and of the other provincial societies. I am grateful to the Entomological Society of Manitoba for giving me this opportunity to speak on these matters, for it seems that we entomologists should be concerned not only with the development of our science but also with its position in human affairs. Floreat Entomologia!

EFFECTS OF SOUND ON INSECT BEHAVIOUR[1]

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Insects probably dissipate more energy in the form of sound than do any other group of animals. They have developed an almost infinite number of ways of producing sound and a similar number of sense organs with which to detect it. The number of different uses to which they put sound is likewise enormous.

No apology is made for defining the word 'sound', for we talk and think about sounds in terms of the sensations of our own ears. The simplest valid definition is - sound is any mechanical vibration of the outside medium. By this definition, sound includes vibrations transmitted through liquids and solids as well as through the atmosphere. We are familiar with the use of underwater sounds in the detection of icebergs and submarines, although our own ears are inefficient when submerged. Similarly, we are unable to hear airborne sounds from trains at long distances, although the rails transmit the vibrations efficiently. Even airborne sound waves may be inaudible to us if their frequency is sufficiently high. All airborne vibrations will be referred to as sound waves, although the properties of inaudible vibrations are different from those that we can hear.

Some Physical Aspects of Sound

When sound waves are divergent or reflected, phase differences occur, and when their positive and negative sound pressures coincide the waves are more or less cancelled out. When the wavelength is long the waves travel far before they are cancelled, and it is an everyday experience that low frequency sounds will travel round corners. When the wavelength is short the waves are cancelled in a very small distance and these high frequency waves can be blocked by objects a few wavelengths long. At 100 Kc/s, the wavelength in air is about 3 mm., propagation is virtually rectilinear, and objects less than 1 cm. across can throw distinct 'shadows'. The propagation of such sounds is limited to open areas, and this has prevented their widespread use in pest control (Frings, 1948). Similarly, such airborne sounds could not be received and are unlikely to be produced by animals living in dense under-

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growth or under ground. It is exactly these properties, however, that make high frequency sounds ideally suited for echolocation in open air or underwater. Small objects can be detected and located with accuracy only when the wavelengths are short (Griffin, 1958).

At frequencies above 100 Kc/s the atmosphere is an inefficient transmitting medium and at 200 Kc/s so much energy is used in agitating the air molecules that the sound intensity is approximately halved each time it travels one foot from its origin. Thus, 10 feet away from a source of 200 Kc/s only one thousandth of its original intensity would remain. Sounds of this fequency can however readily be transmitted in less elastic media, such as water and solids, so it is possible that insects could make use of these high frequencies.

To the best of my knowledge no-one has detected, or even looked for, ultrasonic noises associated with aquatic, wood-boring or subterraneous insects, although physically they could occur. From morphological evidence Nachtwey (1961) considered that ants nesting predominantly underground could produce sounds above our range of hearing, but at present there is no behavioural or physiological evidence of this.

The subgenual organs developed in most insects except the Diptera and Coleoptera are extraordinarily sensitive to solid-borne sounds (Autrum, 1943) although their sensitivity to frequencies above 10 Kc/s has not been investigated.

The Use of Sounds by Insects

The airborne sounds produced by insects have been the subject of extensive study and at least 2000 papers had been published about them before 1960 (Frings & Frings, 1960) and it is clear that sound affects the behaviour of a great many insects.

The complex behaviour of insects is often found on analysis to be made up of a series of simple reflexes: for example, male mosquitoes of *Aedes aegypti* can be attracted towards sounds resembling the wing-beat noise of the female. This behaviour, a phonotaxis, can be elicited in a large percentage of caged mosquitoes and is probably a simple reflex. To cite another example, the response of moths to sounds resembling those of bat cries is a rapid change in the direction of their flight. The evasive manoevres, however, appear to be random, a phonokinesis. Under certain conditions both the kinetic and tactic response can be overridden by other types of behaviour. For example, mosquitoes that are not in flight do not respond behaviourally to the female wing-beat noise, and moths that have settled may not respond behaviourally to bat cries although the sense organs are responding to the sound. Little is known about the nervous connections involved, although analyses are being carried out by Professor Roeder at Tufts University on the acoustic nervous system of noctuid moths, and in Belleville we have recorded responses to sound in the ventral nerve cord of male mosquitoes.

Some of Haskell's results (1958), which are of fundamental importance in this type of study, have received very little attention. He found that female grasshoppers, Chorthippus parallelus (Zett.), with both tympanal organs destroyed, made typical stridulation movements in response to the high-intensity play-back of the male's normal song. The sound was apparently received by the abdominal hair sensilla as the response disappeared when these were smeared with vaseline. When the loud-speaker was placed on the same substrate as the insect, however, the response returned and he attributed this to sound reception by the subgenual organs. Excitation in any of these nervous pathways can apparently release identical motor activity in the nerves to the stridulatory apparatus, thus providing a remarkable margin of safety for the insect's response to sound. The structure of these nervous links would repay investigation.

Insects use sound in three main ways: in the exchange of information (communication); in protection; and in detection.

1. In the exchange of information both sound reception and production are involved. Sounds are used: (a) in calling, when they may lead to the aggregation of one or both sexes; (b) in courtship, when they may trigger copulatory behaviour and maintain species isolation; and (c) in alarm and distress, when they may warn others of unfavourable changes in environment.

2. In protection, sound production is involved, often without any associated sound reception. There are two main types: (a) mimicry, e.g. certain Diptera mimic the flight noise of the Hymenoptera that they resemble in appearance (Gaul, 1952); and (b) defensive noises which are produced in many groups and are sounds that have no significance to other members of the same species but that may startle predators, e.g. the use of the stridulatory file of certain lepidopterous pupae (Hinton, 1955).

3. In detection, sound reception is involved, although some of the species can also produce sound. Hearing organs may be used to detect the sound of predators, e.g. most moths can detect bat cries (Roeder and Treat, 1957). They may also be used to detect the sounds of parasites. Green and de Freitas (1955) observed sawfly larvae, Neodiprion sp., crowding together in the presence of a tachinid parasite, Spathimeigenia erecta Ald., and, although the role of vision in this response

does not appear to have been determined, sound receptors may play a part in protection of the sawflies.

Possible Applications of Acoustic Behaviour in Insect Control

Some of the possibilities of applying communicative-type sounds are shown by the following observations.

Busnel et al. (1954) and Haskell (1958) were able to attract both sexes of three species of the acridiid grasshopper, Chorthippus, by using artificial sounds that resembled their calling-song. Artificial sounds also attracted female tettigoniids, Ephippiger spp., (Busnel et al., 1956). These species are, of course, also attracted by their own recorded sound. Busnel showed that if two species are geographically or ecologically separate the sounds of one species may attract the other. If the two species are sympatric, however, sounds may serve to isolate them and prevent hybridisation. Sounds play a similar part in the behaviour of tree-crickets (Walker, 1957) and field-crickets (Alexander, 1957), although in the latter sound may play a part in keeping the males separate from each other in their territories. Thus the play-back of the male calling-song tends to repel other males while attracting females.

Among the Homoptera, cicadas of both sexes can be attracted by recordings of the male song (Alexander & Moore, 1958). There is also evidence that these songs are broadly species specific. The female leaf hopper, Doratura stylata (Boh.), sings in response to the male calling-song and this, in turn, attracts the male (Ossiannilsson, 1949).

Sound is also important in the sexual behaviour of some Heteroptera. Among the water-bugs, the stridulation of male corixids causes the female to swim vigorously, usually in circles, which in turn attracts the mature males (Schaller, 1951). Haskell (1957a) found that stridulatory sounds were important in bringing together the males and females of some geocorisid bugs, including a Kleidocerys sp. (same group as the cotton stainer and chinch bug) and a Piesma sp. that is the vector of the beet-leaf-crinkle virus. In all these Heteroptera, according to Haskell, the onset of stridulatory activity coincides with sexual maturity, as is also the case in the wood-boring beetles and the book-lice whose sounds have been little studied.

Attempts using sound to control mosquitoes in the tropical swamps of Cuba (Kahn et al., 1949) have had some success. Disc-recordings of the female flight sounds of Anopheles albimanus Wied.

were played through a loud-speaker and the attracted males were electrocuted. Wishart and Riordan (1959) showed that the range of intensities attractive to male Aedes aegypti (L.) was limited and that loud sounds actually repelled the mosquitoes. They recommended the use of traps radiating a sequence of sounds with gradually decreasing intensities. This would attract males from greater distances than the uniformly loud sounds used by Kahn. It is clear from Kahn's work that the mosquitoes cannot be attracted when they are at rest, and thus the traps are most effective at dawn and dusk when the mosquitoes are activated by changes in light intensity. Haskell (1961) suggested that sounds inducing flight in resting males could be alternated with attractive sounds. Wishart and Riordan showed that, at any rate in Aedes aegypti, a simple sine wave is just as effective as the complex female wing-beat noise in attracting males. As sine waves similar to those that attract Aedes are also effective in attracting ceratopogonids (Lawson, 1957) and mycetophilids (at Belleville), Kahn's suggestion that the flight sounds of female mosquitoes only attract the males of their own species needs further investigation.

The vibration of the wings against thoracic bristles of male fruit flies, Dacus spp., attracts the females (Myers, 1952). In the two species he examined the attraction was non-specific.

The wing-beat noise of bees has been used to predict swarming. Woods (1959) analysed the sound output of hives throughout the season and found that the construction of queen cells is accompanied by a warbling tone in a particular range of frequencies. He developed an "apidictor" which uses electronic amplification and filtering to detect an incipient swarm several weeks before it occurs.

Haskell (1957b) played recordings of the take-off noise of a swarm of locusts, Schistocerca sp., to disperse settled swarms and found that in about 50 per cent of the trials the swarms were induced to take flight.

In Belleville we have been studying and applying the response of insects to the sounds of their predators. In some preliminary experiments we photographed changes in flight patterns of night-flying moths evoked by sounds resembling the cries of bats. These confirmed Roeder and Treats' (1961) observations that their flight becomes erratic, often causing them to crash to the ground.

We also experimented with a pair of rotating light-traps, one of which was guarded by a loud-speaker radiating pulses of sound at 40 Kc/s, the pulses being repeated about 20 times per sec. (similar to the frequency and rate of pulsing of insectivorous bats). On certain nights the guarded trap did not catch any moths with tympanal organs, although atympanate Lepidoptera were attracted to both traps. The best catches were made on warm humid nights. On wet nights the guarded trap often caught appreciable numbers of tympanate moths; the number of "earless" moths caught also increased. Treat (1962) carried out similar experiments independently with similar results. Tests were conducted to determine whether the apparatus or the propagation of sound was effected by the rain and it was found that any changes in sound pressure that did occur were increases. This may indicate that the moths themselves did not react to sound in rainy weather either because the sensitivity of the tympanal organ was affected or because some other behaviour pattern was elicited by factors associated with the rain. Electrophysiological experiments would provide an answer..

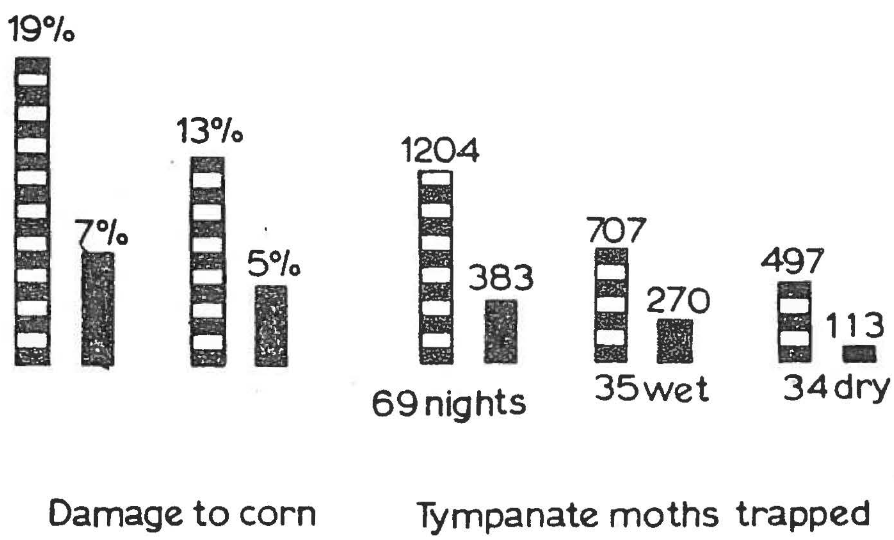

Figure 1. Histogram showing - on the left, percentage of superficial damage in two pairs of corn plots. Solid columns, plots "guarded" by artificial bat noise; striped columns, control plots - on the right, number of tympanate moths caught in light traps. Solid columns, trap "guarded" by artifical bat noise; striped columns, control traps.

Sound affected the behaviour of the European corn borer in Belleville (Belton & Kempster, 1963). High frequency sounds similar to those used in the rotary light trap were broadcast over plots of corn from dusk to dawn each night. During the growing season superficial damage was assessed and, when the corn was harvested, damaged ears and larvae in the stems were counted and compared with numbers in the control plots. The population of corn borers was reduced to about one third of that in the control plots. These results are promising considering that the sound source failed on several nights during the egg-laying season. It is also possible, however, that the rain may affect the reponse of the corn borer to sound as in the light trap experiment. The results of light-trap and corn borer experiments are summarized in the figure.

Sound could probably be used to reduce the population of many other insects. It has two very great advantages over other control methods in that it is highly selective, species-specific in some cases, and it appears to have few, if any, harmful side-effects.

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BEHAVIOUR OF INSECTS IN ELECTROSTATIC FIELDS[1]

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The apparent relationship between insect activity and the weather has been noted both by entomologists and by those whose livelihood depends to a large extent upon natural phenomena. Folklore concerning insects as weather forecasters has grown with man's observations, and in some instances the old beliefs have been substantiated by the scientist. In most studies on weather and insect activity, interest has centered mainly on weather factors, such as temperature, pressure, humidity, and wind. Many now contend that there are other factors in the atmosphere that might influence insect activity. Atmospheric electricity in all its aspects appears to be one such factor.

Whenever atmospheric electricity is considered as affecting biological phenomena, two closely related factors are concerned: potential gradient and air ion density. Potential gradient is an aspect of

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the electrical field about the earth and usually refers to the rate of change of the field intensity with height above the earth's surface. In local situations there may be horizontal components caused by space charges and by gradients that exist around trees and shrubs. Air ions are electrically charged submicroscopic particles of matter. Radioactive substances in the earth's crust and in the atmosphere, cosmic rays and ultraviolet radiation, thunderstorms, and combustion are some of the agents responsible for the production of air ions.

Normally, particles of one polarity are neutralized by particles of opposite polarity. Enormous forces are required to separate large numbers of positive ions from negative ions, or electrons. Nevertheless, atmospheric processes which we observe as weather give rise to such forces and a 360,000 volt potential difference exists between the earth's surface and the ionosphere. Because of this electrical field we walk around even on clear days with our heads in air that is some 200 volts positive with respect to our feet, and during thunderstorms the gradient of the field can build up locally to tens of thousands of volts per meter.

The idea that electrically charged particles might have a biotic effect, especially upon human health and comfort, has been discussed for more than 60 years (Beckett, 1954). Considerable attention was paid to the subject during the late 1920's and early 1930's (Dessauer, 1931; Koller, 1932). With the development of greatly improved ion generators, regulated power supplies, and highly sensitive measuring devices and techniques, interest in this part of the environment has once more been kindled. It would seem from the current literature that in general, as far as man is concerned, air containing an abundance of negatively charged particles produces physical, mental, and emotional uplift whereas positively charged air produces general discomfort, fatigue, headache, nausea, and faintness.

Potential Gradients

It has been proposed that atmospheric electricity influences insect behaviour before and during certain types of weather, particularly thunderstorms (Fabre, 1918; Uvarov, 1931; Wellington, 1957). It is, however, only within the past dozen years that any formal experimental work has been reported.

Schuà (1952) made studies of the effects of atmospheric electricity on insect behaviour. He showed that worker bees increased their number of foraging flights during periods of electrical activity and that guard bees became hostile when electrodes with alternating potentials were placed at either side of the hive entrance.

Flying insects are repulsed when they approach a positively charged screen placed over shrubs and trees and negative electrical fields appear to stimulate moulting of Myzus persicae S. and locomotor activities of Adelges sp. (Hicks, personal communication).

Studies by Levengood and Shinkle (1960) with Drosophila melanogaster Meig. showed that the progeny yields varied directly with fluctuations of atmospheric pressure. When they subjected their cultures to electrical fields, however, the average yield increased 34.4% over the average for the controls and variations in yields attributable to pressures were smoothed out (Levengood and Shinkle, 1961). They believed that because natural ionization levels vary directly with atmospheric pressures the yields of the controls were inhibited in some way, while the experimental cultures were protected from ions by the electrical fields. Work initiated this past summer at Belleville tended to support this theory. The results, however, were not statistically significant in all instances.

The oviposition rate of Scambus buolianae (Htg.), an ichneumonid parasite, can be lowered by a fluctuating electrical field (Maw, 1961) but it is probable that the main cause was merely mechanical. The insects were often seen to become inactive whenever the potential changed. Similar hesitations in activity can be brought about by a change in light intensity, a light breeze, or the insect's awareness of a moving object. Temporary reductions of activity by insects in a fluctuating electrical field have also been shown to occur in Drosophila and the blowfly, Calliphora vicina R. & D. (Edwards, 1960a).

The effects of electrostatic electricity appear in rather unusual ways. Dr. J. A. Juillet, of this Institute, found that one net of a rotary trap (Nicholls, 1960) consistently caught more (sometimes twice the number) hymenopterous parasites than the other. Testing with an electrometer revealed that the smaller captures were in the net that carried a negative charge, creating a potential difference of between two and five volts at 4 inches from the net. Further inspection revealed that this net was slightly higher than the other so that it struck a leaf of a small tree as it revolved. When the leaf was removed the catches in the two nets were more or less equal. By artificially charging one of the nets it was found that the negatively charged net always collected fewer insects than did the electrically neutral one. When the polyethylene collecting bottle was charged as well as the net, the number of insects in the charged bottle represented only 30% of the total insects collected. These observations show that when synthetics are used in insect trap construction care must be taken to insure that electrostatic charges do not interfere with the trap's efficiency. The ease with which the polyethylene bottles become charged is remarkable, and under favourable conditions the charge may persist for more than an hour.

Field observations over the past three years have shown that there is an apparent relationship between the location of male swarms of Aedes trichurus Dyar and the natural electrical gradients that exist around trees and shrubs in a forest glade. Afternoon swarms were noted on several occasions occurring during dull days in May, at times when the potential gradients were exceptionally steep. The configurations of the swarms were altered in 1962 by cutting out certain trees on the periphery of the glade. It was found that the boundaries of the swarms again followed the newly established isopotentials. The normal evening swarms were seen to follow similar patterns but were closer to the trees than the afternoon swarms. This was in keeping with the changed patterns of the isopotentials and with the flatter potential gradients found at these times. On dull days when gradients were small, males could be found throughout the area in limited numbers. The large swarms formed only on days or at times of the day when the gradients were steepest. At these times swarm markers (Downes, 1958) did not seem either to alter the swarms or to initiate them.

In the field there is always the possibility that the swarming mosquitoes were making use of the trees at the edge of the glade as flight guides. Consequently a laboratory study was made with an artificial environment where the trees were represented by 16 pieces of copper screening set in two rows. Connections were such that the 16 screens could be electrically charged in a variety of combinations. Mosquitoes were released in this environment and it was evident that their flight patterns were influenced, at least partly, by the electrical fields rather than by sight alone.

Air Ions

Thus far the discussion has centered around the effect of potential gradients. It is not always easy to decide whether it is potential gradients alone that cause the observable effects or whether air ions are the agents responsible. This difficulty is probably best illustrated by comparing similar end results of work by Edwards (1961), with potential gradients, and by some of my work (unpublished), with ions. Emergence of the phantom hemlock looper (Nepytia phantasmaria Stkr.) was retarded by as much as a day over that of the controls when the pupae were subjected to potential gradients (Edwards, 1961) whereas I found that emergence of Neodiprion lecontei (Fitch) was considerably slowed by negative ionization.

When Calliphora vicina R. & D. adults were subjected to artificially-produced positive air ions there was an increase in flight activity, with the peak occurring approximately three-quarters of an hour after the first exposure to the ions (Edwards, 1960b). Following the peak, the activity returned to the original level while the insects were still exposed to the ions. At Belleville, adult blowflies, Phaenicia serocata Meig., were exposed to air ions of both positive and negative polarities which produced ion currents of about 3.4×10^{-11} amps. Activity was measured as the number of revolutions per minute on a flight mill. In general, exposure to positive ions resulted in greater flight speeds while negative ions resulted in a more moderate flight with fewer bursts of speed and fatigue seemed to be allayed for longer periods. Exposure to ions of alternating polarity after a period of exposure to positive ions produced a definite increase in flight speed, even when fatigue was evident before the changes in polarity.

Discussion

In view of the work just described it would appear that atmospheric electricity can have an effect upon insect activity and behaviour. Though interspecific and intraspecific differences might be encountered it can be assumed, I think, that some degree of response to this factor will be found in all biological activities. This assumption is based on the fact that living matter has developed in ionized air through the long process of evolution and that ions are the basis of the complicated system of negative feed-back controls by which metabolic rates are regulated. Russian experiments with animals, deprived of air ions, indicate a probability that organisms cannot live without them (Hansell, 1961).

It is not known how atmospheric electricity is able to produce the observed effects on insect activity. It may be purely a mechanical stimulation in the case of electrostatic potential gradients. It can be easily demonstrated that a moderately strong electrical field causes wings, plumules of antennae, and other cuticular outgrowths to respond in the same way as the leaves of an electroscope.

When it is suggested that air ions might have a biological effect there is always the question of whether there is a sufficient number of charged particles in nature to produce any effect, no matter how small it might be. There are in one cc. of air about 2.7×10^{20} molecules, and under ordinary circumstances considerably less than 2.7×10^{4} or less than one in every 10,000 million million is in the form of an ion. Nature has, however, the ability to produce relatively enormous results from apparently insignificant beginnings, not only with ions but also with trace elements, vitamins, and bacteria. Take Swann's (1961) example of the bloodhound following a trail. If we are to suppose that it operates through breathing in special molecules originating from the person whose trail he follows, then it operates with a number of molecules, which cannot be considered to be significant when viewed under ordinary conditions.

Hunt and Kimeldorf (1962) have reported evidence for direct stimulation of the mammalian nervous system with ionizing radiation which split many types of molecules into positive and negative charged particles. They state that, aside from photoreceptors, no sensory receptors have been demonstrated to be directly sensitive to radiation stimulation. Direct ganglionic sensitivity to ionizing radiation is also possible. They also suggested that ionizing radiation is a particularly efficient means for stimulating large masses of nervous tissue directly because the energy transfer would occur relatively uniformly with minimum spatial or temporal loss. Perhaps similar situations might exist in insect responses to ionization.

The possible ways in which atmospheric electricity might be used to control insect pests can only remain in the realm of conjecture until more is known of its influence on the insects. It is hoped more interest will be shown in this challenging field, as this factor of the environment might be an important tool in manipulating environments and ultimately insect populations.

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ABSTRACTS OF SOME OF THE SUBMITTED PAPERS PRESENTED TO THE 12TH ANNUAL MEETING OF THE ENTOMOLOGICAL SOCIETY OF CANADA AND THE 18TH ANNUAL MEETING OF THE ENTOMOLOGICAL SOCIETY OF MANITOBA

SESSION I INSECT CONTROL

NOTES ON SILVER TOP OF GRASSES IN THE PEACE RIVER COUNTRY

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In 1960 silver top was found responsible for marked reductions in yield from seed crops of merion blue grass in the Peace River country. Subsequently seed crops of several other grass species were found to be affected. Mite and/or thrips were considered the more probable cause of the damage, mites being most highly suspected. An experiment on control of the damage showed that treatment of the grass with DDT controlled thrips and effectively reduced silver top, indicating thrips the probable causal agent. Treatment of the grass with effective miticides such as Kelthane and Rogor (Dimethoate) gave poor control of silver top and little or no control of mites, indicating mites were probably not involved. In 1961 an eriophyid mite, *Aceria tulipae* Keifer, was found hidden beneath the leaf sheaths of Merion blue grass where feeding on enclosed stems throughout the growing season might cause silver top damage. Further studies in 1962 on the activity and feeding of thrips and the mite on grass stems failed to prove that either organism was the primary cause of silver top. A further experiment on control showed that the miticide Sevin gave poor control of silver top but no control of the mite and Kelthane gave no control of either the mite or silver top. Until it is clearly demonstrated that either thrips or the mite *A. tulipae* definitely causes silver top the problem will remain rather puzzling unless evidence is found for some other causal factor not yet investigated.

DETERMINATION OF INSECTICIDE RESIDUES IN CEREAL AND FORAGE CROPS

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Methods used at the Canada Department of Agriculture Research Station, Winnipeg, to determine terminal residues of dieldrin and toxaphene applied to alfalfa and of dieldrin applied to wheat, oats, barley and flax are described. Instrumental techniques are illustrated and some of the results obtained are presented.

EFFECTIVENESS OF INERT MINERAL DUSTS AGAINST STORED PRODUCT INSECTS

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Experiments with five inert mineral dusts against the rusty grain beetle, *Cryptolestes ferrugineus* (Steph.), showed that effectiveness was directly related to environmental temperature and inversely to relative humidity. Beetles exposed for one minute to a film of a dust insecticide containing silica aerogel impregnated with ammonium fluosilicate lost 40 per cent of their body weight in three hours when kept at 35 per cent R. H. Dust films bound to adhesive surfaces such as masking tape were as effective against beetles as dust films applied to filter paper.

SESSION II INSECT BEHAVIOUR

THE LONGITUDINAL ORIENTATION OF LARVAL HONEY BEES WITHIN CELLS

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Disorientated larvae of the 3 castes of honey bees rarely occur under natural conditions; correct orientation is essential for survival in the worker and drone castes. The distinctive cells of the 3 castes were simulated by gelatin capsules with their end walls modified to give combinations of shape, ventilation, and texture. The effect of cell length and gravity was also tested.

The major factors controlling larval orientation are:

(a) Worker: primarily texture of cell end walls (i.e. basal end smooth, capping end rough) and secondarily shape of cell end walls (i.e. basal end round, capping end flat).

(b) Drone: texture of cell end walls.

(c) Queen: gravity and possibly the rough texture (i.e. the cocoon) of the lower end wall.

BEHAVIOURAL RESPONSES OF THE SMALLER EUROPEAN ELM BARK BEETLE ,(Scolytus multistriatus (Marsh.) (Coleoptera:Scolytidae) TO EXTRACTS OF ELM BARK

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University of Wisconsin
Madison, Wisconsin

The feeding behaviour of Scolytus multistriatus on extracts of elm bark was observed in a "choice" apparatus. Active extracts were designated as arrestants and feeding stimulants. Response increased in the first hour of exposure and then decreased. This behaviour pattern was explained in terms of falling and rising thresholds of response. Leaf extracts were inactive as were those from current growth collected in June. Extracts from bark of second to fourth year growth elicited the greatest response and this activity was correlated with feeding activity in the field. The role of moisture was investigated. Some of the chemical fractions separated from elm bark were highly stimulatory; others were repellent.

FURTHER INVESTIGATIONS INTO THE CHEMICAL BASIS OF INSECT-HOST PLANT RELATIONSHIPS IN AN OLIGOPHAGUS INSECT - Plutella maculipennis (Curt.) (Lepidoptera:Plutellidae)

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Samples of nine crystalline mustard oil glucosides including sinigrin were isolated from plant tissues of species in the families Cruciferae and Tropaeolaceae. The isolations were achieved by the use of column chromatography on cellulose powder, on silicic acid and on activated carbon, and by crystallization from methanol - water mixtures.

Feeding responses of fifth instar larvae of P. maculipennis were tested on agar-cellulose diets containing individual glucosides at various concentrations in the presence or absence of optimal concentrations of glucose. The amount of feeding was measured by counts of frass pellets produced by the larvae during the test period. All the above mentioned glucosides were found to act as specific feeding stimulants for the larvae of P. maculipennis. However, the relative palatability of these glucosides at the same concentration of 50 p.p.m. was found to be in the

following order: progoitrin, > gluconasturtiin, > glucocheirolin, > glucoconringiin, > glucoerucin, > glucotropaeolin, > sinigrin, > sinalbin, and > gluconapin. At higher concentrations some of the glucosides showed a striking inhibitory effect on feeding and two were toxic to the larvae.

INFLUENCE OF SOME PHOSPHOLIPIDS IN PLANTS ON FEEDING ACTIVITY OF GRASSHOPPERS

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Lipids of plant origin have been known to stimulate feeding in *Schistocerca gregaria*. We have confirmed a similar effect in the grasshoppers, *Melanoplus bivittatus* and *Camnula pellucida*. The active substances are phospholipids. However phosphatidyl choline (lecithin), lysolecithin and inositol phosphatide are much more active than phosphatidyl ethanolamine (Cephalin) or phosphatidyl serine. The males in both species are much more responsive than the females although the females eat more wheat leaves per individual than males.

SESSION III BIONOMICS AND TAXONOMY

PRELIMINARY STUDIES OF FLEAS (Siphonaptera) ATTACKING SMALL MAMMALS IN SOUTHEASTERN MANITOBA

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Twenty-five species of mammals were examined for the presence of external parasites, and fleas were collected from twelve of them. Thirteen species of fleas were collected, nine of which were first records for Manitoba as follows: *Corrodopsylla c. curvata*, *Ctenocephalides f. felis*, *Megabothris asio*, *M. quirini*, *Momopsyllus e. eumolpi*, *M. vison*, *M. wagneri systaltus*, *Opisodasys pseudarctomys*, and *Orchopeas c. caedens*. The collections provided the following new host records: *Corrodopsylla curvata* ex *Sorex arcticus*, *Megabothris asio* ex *Clethrionomys gapperi*, *M. quirini* ex *Sorex cinereus* and *Peromyscus maniculatus bairdii*, *Opisocrostis bruneri* ex *Tamiasciurus hudsonicus*, and *Orchopeas caedens* ex *Glaucomys sabrinus*. *Orchopeas leucopus* and *Monopsyllus wagneri* were the most abundant parasites, being found on the most abundant mammal host, *P. maniculatus*. Greatest number of fleas, and the highest percentage of parasitism were found in the year of lowest host populations. Peak

parasite populations occurred in late summer, but a minor spring peak occurred also in O. leucopus. The parasites were more abundant on juvenile than on older hosts, on lactating females than on other adults, and on solitary rather than on gregarious species. Mutual grooming probably accounts for differences in degree of parasitism in various host categories.

SAMPLING PREDATOR POPULATIONS ON APPLE TREES

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Several methods were used to obtain estimates of predator populations on apple trees or units of tree. In field tests in which vacuum samplers were compared with a mechanical shaker sampler the suction device failed to give good estimates but the shaker showed promise. It was first necessary to determine the numbers of revolutions of the latter device to remove all predators from a sample of apple clusters. It was then used to examine the distribution of predators within apple trees and to estimate the predator population per limb in an experimental orchard.

OPTIMAL SOIL UNIT SIZE IN SAMPLING COCOON POPULATIONS OF THE EUROPEAN PINE SAWFLY, *Neodiprion sertifer* (Geoff.)

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One consequence of overdispersion in cocoon populations is that for equivalent precision, samples using the smallest units cover the smallest area of soil surface, although more small units than large ones are required. The time needed to collect and examine soil units increases with unit size, but large units require the least effort per square foot of soil surface. The optimal unit size, i.e., the one for which total sampling time is minimum, varies inversely with both cocoon density and degree of overdispersion. The choice of optimal unit size is most critical at low density.

A SIMPLIFIED TECHNIQUE FOR REARING THE CABBAGE ROOT MAGGOT, *Hylemya brassicae* (Bouché)

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Flies were reared in cylindrical, 30-mesh, plastic screen cages about 8 inches high and 7 inches in diameter, over galvanized iron cylinders filled with sandy loam soil. Their food consisted of slightly moistened pads of whole wheat flour, sucrose, Brewer's yeast, Wesson's salt and granular honey in the rates of 2:1:1:0.5:1, placed on top of the cages. Water was provided by placing dented cotton pads in 3 ounce plastic vials inserted through a hole in the side of the cage. Larvae were reared in Swede turnips (rutabagas) in the soil with a moisture content of 15 per cent and at a fluctuating temperature of from 65° to 70°F. Room temperature varied from 65° to 80°F. Under the above conditions, and starting with 10 females and 10 male flies in one cage, an F_1 generation of 600 to 800 flies was reared in 30 to 40 days. Flies lived for 30 to 70 days and one pad of the food mixture was used repeatedly to rear successive generations of flies for more than six months.

SESSION IV INSECT PHYSIOLOGY

SPECIFICITY OF INSECT DEHYDROGENASES

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The lactic acid and alpha glycerophosphate dehydrogenase systems were examined for species specificity by comparing activity ratios of these enzymes with diphosphopyridine nucleotide (DPN) and several DPN analogs as cofactors. Activity determinations were based on coenzyme absorption spectra.

Results to date indicate an excellent ordinal specificity, as well as a family characterization. Preliminary runs indicate a fair degree of developmental enzymatic changes from juvenile (both nymphs and larvae) to sexually mature forms, confirming findings with vertebrate preparations and blood protein changes in developing insects.

THE EFFECT OF LOW TEMPERATURES ON THE HATCHING AND SURVIVAL OF THE FOREST TENT CATERPILLAR

Malacosoma disstria Hbn.

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The forest tent caterpillar is resistant to 5°F. until about three days prior to commencement of hatching. At this stage 12 days of cold treatment are required to reduce survival to 50 per cent. Newly-hatched larvae are quite susceptible to low temperatures. Survival is greatest at 20° to 25° F. Lower temperatures are lethal probably due to the cold factor and at higher temperatures, mortality may be due to starvation. Hatching occurs when the temperatures rises to 50°F. or higher.

INDIRECT MEASUREMENT OF CONSUMPTION AND UTILIZATION OF FOOD BY THE PALE WESTERN CUTWORM WITH CHROMIC OXIDE

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Dietary comparisons for insects would be more meaningful if consumption and utilization data were available. Percentage utilization has been determined for large animals by adding chromic oxide to the food and determining to what extent the concentration is increased in the feces. Chromic oxide was added to several diets as the indicator in consumption and utilization studies with the pale western cutworm. Results obtained by the chromic oxide method are compared with those of the classical gravimetric method. The general usefulness of this indirect method in studies of insect nutrition is considered.

THE STRUCTURE AND THE MECHANISM OF MOVEMENT OF THE LABRAL BRUSHES OF MOSQUITO LARVAE

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The structure and function of the mouth parts of mosquito larvae were studied. The mechanism of movement of the hairs of the labral brushes was elucidated. Central movement is musculated; lateral return is by elasticity. Various degrees of flexibility of the cuticle of the mouth parts were found by staining with Mallory's triple stain. This variation was confirmed by observing the mouth parts of several species in action. The serrated tips of the labral brush hairs, present in most of the browsing species of Aedes and Culiseta that were studied, are flexible in spite of their function which is raking of food particles from surfaces.

REACTIONS TO INSECT BITES - PROGRESS REPORTS

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Studies on reactions to bites of blood-sucking arthropods, particularly mosquitoes, have been conducted at Queen's University during the past nine years. The present paper reviews progress made and points out existing lacunae in our knowledge. The allergic nature of reactions has been established; the salivary glands have been shown to be the source of allergens; in mosquitoes, at least, multiple secretions are produced by the glands; a recently developed method of collecting mosquito saliva by means of a membrane feeding technique has made possible detailed studies on the active components in the salivary fluid.

VARIETAL RESISTANCE OF PEAS TO PEA APHID BIOTYPES UNDER FIELD AND GREENHOUSE CONDITIONS

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Infestation of thirteen varieties and selections of peas (Pisum sativum L.) by winged migrants of the pea aphid (Acyrthosiphon pisum (Harris) (=Macrosiphum pisi Harris) was carefully measured to detect possible mechanisms of variety preference. At early seedling stage (1 to 6 inches tall) color of the foliage was correlated with the alighting response of winged aphids. Migrants and colonies were in greatest numbers on a variety with yellowish-green foliage, in lesser numbers on varieties with green foliage and least abundant on a variety with deep-green foliage. At early growth stage, increased varietal plant height had a barrier effect that favored a higher initial infestation by migrants. At full growth stage, increased varietal plant height had an exposure effect that reduced ensuing aphid population because of taller stems, longer internodes and lesser dense foliage. Antibiosis did not play a significant role in peas grown in rows but would likely express itself in a solid stand crop as it did under field cage tests. Temperature and aphid biotypes modified the expression of antibiosis and the rating of pea varieties for resistance. The knowledge acquired is applied to understand the nature of antibiosis in peas and to some specific techniques to be used in testing peas for resistance to the pea aphid.

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CONTROL OF ONION MAGGOTS RESISTANT TO CYCLODIENE INSECTICIDES IN MANITOBA[1]

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Introduction

In the East St. Paul district north of Winnipeg a small number of growers specialize in onion set production. This crop is more susceptible to damage by the onion maggot, Hylemya antigua (Meigen), because it is difficult to protect the heavy seedling stands required. When treatment is not complete or adequate, large onion maggot populations are produced which cause extensive damage. In 1960, insect resistance to Heptachlor, successfully used for 5 years, was suspected when spotty damage was observed in fields of sets. The ends of the rows were completely destroyed and patches of heavy damage occurred along the rows. There was also considerable late season damage to crops of sets and table onions. Puparia were sent to the Entomology Laboratory, Chatham, Ontario for tests on the susceptibility of the adults to cyclodiene and organophosphate insecticides. Harris et al (1) reported that these flies were resistant to Heptachlor and Dieldrin, but were readily killed with Diazinon, Ethion and Trithion.

In 1961 most growers did not change to organophosphate insecticides and control failures were common. Areas up to two acres were completely destroyed in fields of sets and poor stands produced oversize sets of poor quality. Damage to fields of table onions was more extensive and in some cases, areas were showing 20 to 30 per cent damage.

Materials and Methods

Field test plots were set up at three locations. Each plot consisted of 240 feet of row, seeded to the variety Ebenezer, at 40 pounds per acre. The treatments were randomized but only one plot was treated with each material. The insecticides tested as granular formulations, were the following: 5% Diazinon (0,0,-diethyl 0-(2 isopropyl-6-methyl-4-pyrimidyl) phosphorothioate), 5% V-C-13 (0-2,4-dichlorophenyl 0,0 diethyl phosphorothioate), 5% Ethion (0,0,0,0,-tetraethyl S,S-methylene bisphosphorodithioate), 10% Tri-

[1]Contribution No. 139, Canada Department of Agriculture Research Station, Winnipeg, Manitoba.

thion (S-(p-chlorophenylthio) methyl 0,0-diethyl phosphorodithioate). 5 and 20% Heptachlor 1, 4, 5, 5, 7, 8, 8-heptachloro-3a, 4, 7, 7a-tetrahydro-4, 7-methanoindene. The insecticide granules were applied directly to the seedfurrow. A Gandy applicator was used at location 3, while a modified fertilizer attachment was used at location 2. The rates of application are shown in Table I. The importance of proper application was demonstrated on location 3. Here the grower applied V-C-13 with the seeds in rows adjacent to the plots that were treated from the surface with a V-belt seeder, at a depth of 3/4 to 1-inch or about 1/2 to 3/4 of an inch above the seed.

To determine the results, four 100-inch rows were staked June 25th and the inches of row damaged were recorded on successive dates (Table I).

Results

Heptachlor did not give adequate control, Table I. Trithion was significantly less effective than Diazinon, V-C-13 or Ethion.

TABLE I

Control Tests on the Onion Maggot in Onion Sets

East St. Paul, Manitoba 1962

Insecticide	Location	Actual insecticide per acre	Percentage seedling loss from 4 (100-inch) rows		
			June 25	June 29	July 11
Diazinon	1	2.7	0.5	0.5	0.7
	2	3.4	5.2	3.2	2.0
V-C-13	1	2.2	2.7	3.2	2.7
	2	2.5	3.0	3.5	2.5
Ethion	1	2.1	1.0	0.8	0.9
	2	3.2	11.5	9.2	8.5
Trithion	1	2.5	5.2	8.7	12.5
	2	2.1	15.2	14.5	12.7
Heptachlor 20%	1	2.6	29.5	65.2	82.0
5%	2	2.2	8.2	20.0	35.5
Untreated	1	-	28.0	64.0	86.2
	2	-	56.0	60.0	79.2

Diazinon and V-C-13 at 2.5 to 3.0 pounds of actual insecticide applied at seeding protected onion sets against the first and second generations of the onion maggot. But the insecticide granules must be applied directly to the furrow with the seed. When V-C-13 was applied in this way damage was 3.8% and when applied above the seed, damage was 52.0% at similar rates of application. For Diazinon, Ethion and Trithion, 17, 64 and 73% damage respectively resulted when the material was placed above the seed at a rate of 3 pounds of insecticide per acre.

In Quebec, Perron and LaFrance (2) found that Diazinon and V-C-13 granules were more effective than Ethion, Trithion or Guthion granules when applied at 1.0 pounds actual per acre to cooking onions grown from seed.

Summary

In the Winnipeg area the onion maggot, H. antigua (Meigen) is resistant to the cyclodiene insecticides Heptachlor and Aldrin used for control during the last 5 or more years. Control failures have now occurred in a 30 mile area surrounding Winnipeg, particularly in a district that has specialized in the production of onion sets from seed. Diazinon and V-C-13 applied to the furrow with the seed, effectively control this resistant strain of onion maggot.

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A NOTE ON Cryptolestes turcicus (Grouvelle) (Coleoptera:Cucujidae) IN A MANITOBA GRAIN ELEVATOR[1]

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The occurrence of *Cryptolestes turcicus* (Grouvelle) in Canada has not been reported previously except in flour mills. In the United States and Europe it has been reported from other sites such as a grain elevator (Bishop, 1959), buffer depots, warehouses, malthouses, mills other than flour mills (Howe and Lefkovitch, 1957), wheat bins and dried fruit (Lefkovitch, 1962). This note is the first known record of *C. turcicus* outside of a flour mill in Canada.

In June, 1961, three live adult specimens of *C. turcicus*, two males and one female, were collected in samples of dust taken from the dust collector bin of a grain elevator at Oak Bank, Manitoba, about 10 miles east of Winnipeg. This dust collector bin was a small annex on the north-west corner of the elevator approximately 20 ft. x 20 ft. x 12 ft. in which dust, aspirated from the grain, has been collected. Previously, the only records of this species occurring in stored grain in Canada were from terminal elevators in Owen Sound and Sarnia, Ontario, where a single dead adult was found in each locality in October, 1956 (Smith, unpublished report).

Since the dust in the collector bin at Oak Bank was removed from grain as it was loaded into the elevator or moved from one bin to another, it is difficult to determine whether the insects were breeding in one of the elevator bins or had been aspirated from grain delivered from a farmer's granary. Grain from a farmer's granary may have become cross-infested either from infested flour on the farm or from a truck that had carried infested flour previously. The adults can fly (Bishop, 1959) as well as crawl, thus, they could reach the grain even though it was not in actual contact with the infested flour. It seems most likely that these insects entered the grain during shipment to the elevator by truck since Liscombe and Watters (1962) found no *C. turcicus* in their survey of 34 empty farm granaries in the Prairie Provinces in 1958.

In association with these *C. turcicus* specimens in the dust were 34 live adults and 76 live larvae of *C. ferrugineus* (Stephens) as well as

[1] Contribution No. 138 from Canada Department of Agriculture Research Station, Winnipeg, Manitoba.

numerous psocids and mites. Larvae of C. turcicus were not found which suggests that there was little or no breeding at the time these adults were collected.

It would be of interest to determine how often C. turcicus does occur in dust collectors of grain elevators and how it gains entrance to this site since it has the potential to become a pest of stored grain although it has not done so as yet.

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A NOTE ON ASSOCIATIONS OF SOME MITES WITH SEED-BORNE FUNGI FROM THE PRAIRIE PROVINCES[1]

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It is generally believed that there is a close association between mites and fungi in deteriorating stored grain and that populations of many species of mites are supported either exclusively or partially by seed-borne fungi. Studies on specific relationships between certain species of mites and fungi in stored grain and grain products are presently being carried out at the Canada Department of Agriculture Research Station, Winnipeg. A note on some of the experimental work conducted on this problem and a few interesting records of stored products mites from the Prairie Provinces are presented below:

Family : Acaridae

Caloglyphus berlesei (Mich.), 1903

This cosmopolitan species has been usually found on extremely moist, moldy wheat, copra, linseed and ground nuts (Hughes, 1961). It has been noted only on damp wheat at Homewood, Manitoba on September 8, 1961, and from Govenlock, Saskatchewan in October, 1943.

An unusual occurrence of C. berlesei was brought to my attention in April, 1961 by Dr. N. E. Stanger, Veterinarian, Department of Animal Science, University of Manitoba, Winnipeg. Large numbers of this mite were removed from the axillary region of a six-week old lamb which had just died. Presumably the lamb had fed on damp grain infested with C. berlesei prior to its death.

In the laboratory, this mite was observed to feed and multiply on Nigrospora sphaerica (Sacc.) Mason at $21 \pm 2^{\circ}$ C., which is a common seed-borne fungus in Manitoba.

Family : Glycyphagidae

Aeroglyphus robustus Banks, 1906

This species was first reported in Canada by Sinha et al (1962). In the laboratory it was reared on various fungi during May, 1961 to

[1] Contribution No. 140 from Canada Dept. of Agriculture Research Station, Winnipeg, Manitoba.

October, 1962, with only limited success. When fed on the seed-borne fungi, Gonatobotrys sp., Aspergillus versicolor (Vuill.) Tiraboschi, and A. fumigatus Fres., it survived for 12 to 14 months but did not reproduce. A few mites laid a small number of eggs and completed their life cycle on Penicillium sp., but the population died out between 11 to 16 months. The mites were reared in groups of ten, in ten replicates, at 21±1° C. in the presence of adequate moisture.

Glycyphagus domesticus (DeGeer), 1778

Smallman (1942) recorded this species from stored grain in Western Canada, but did not indicate the location. G. domesticus was found in association with Cheyletus eruditus (Schr.) on May 1, 1962, on the mycelia of Botrytis cinerea Pers. on rotting onion in Winnipeg, Manitoba.

Family : Nanacaridae

Nanacarus minutus (Oud.), 1902

This rare species was found in a sample of stored wheat in a grain elevator at Indian Head, Saskatchewan on January 21, 1961, associated with Haemolaelaps casalis (Berl.). This is the first record of this species infesting stored grain in Canada.

Family : Tarsonemidae

Tarsonemus simplex Ewing, 1939

The collection of T. simplex from straw in Winnipeg on August 8, 1961 constitutes the first record of this species in Canada. It fed and reproduced on Fusarium solani (Mart.) App. & Wr., emend. S. & H. at 25±3° C., and F. culmorum (W.G.Sm.) Sacc. at 15±1° C.

Tarsonemus waitei Banks, 1904

This mite is being recorded for the first time in Canada. It was collected on February 17, 1962 in Winnipeg, and was observed to feed and reproduce on Fusarium sambucinum Fuckel var. coeruleum Wr. at 18±2° C. in the laboratory.

Family : Tydeidae

Coccotydeus near globifer Thor, 1931

This species was found in Winnipeg on July 5, 1961 and is apparently the first record of the species in Canada. It was observed to feed and reproduce on Absidia orchidis (Vuill.) Hagem and Trichoderma viride Pers. at 24±2° C. in the laboratory.

Lorryia (Lorryia) reticulata (Oud.), 1928

This rare species was sent to me by the late A. R. Brooks from Saskatoon, Saskatchewan on September 20, 1960. It was found in large numbers in stored wheat in association with Haemolaelaps casalis (Berl.), Cheyletus eruditus (Schr.), Glycyphagus destructor (Schr.), Tydeus interruptus Thor, and the lathridid beetle Melanophthalma americana (Man.).

Acknowledgements

I am indebted to Dr. R. E. Beer, University of Kansas, Lawrence, U. S. A. for the identification of Tarsonemus waitei; to Dr. E. E. Lindquist, Entomology Research Institute, Canada Dept. of Agriculture, Ottawa for the identification of Nanacarus minutus (Oud.); to Dr. W. L. Gordon and Mr. H. A. H. Wallace, Plant Pathology Laboratory, Canada Department of Agriculture Research Station, Winnipeg for the identified cultures of fungi used in this study.

References

Hughes, A. M. 1961. The mites of Stored Food. Her Majesty's Stationery Office, London. 287 pp.

Sinha, R. N., E. A. R. Liscombe, and H. A. H. Wallace. 1962. Infestation of mites, insects, and microorganisms in a large wheat bulk after prolonged storage. Can. Entomol. 94: 542-555.

Smallman, B. N. 1942. Entomological investigations. 15th Ann. Rept. (1941), Bd. of Grain Comm., Grain Res. Lab., Winnipeg, Manitoba : 40-43.

APPENDIX I

SPRING MEETING

The spring meeting of the Entomological Society of Manitoba was held April 25, 1962 in the Conference Room of the Canada Department of Agriculture Research Building. President L. Smith was in the chair. The Secretary, H. P. Richardson, read the minutes of the fall meeting held on November 3 and 4, 1961. The Secretary moved that the minutes be adopted as read. Seconded by C. H. Buckner. Carried.

Correspondence: The passing of Mr. J. B. Wallis was reported to the meeting. The Secretary reported that a letter was written to Mrs. J. B. Wallis on behalf of the Entomological Society of Manitoba expressing our sympathy.

Letters were sent to Prof. A. V. Mitchener and the Zoological Society.

Treasurer's Report: W. Romanow stated that an audit was made and reported that one would not be made at the spring meeting. It was pointed out, however, that the audited report should be made at the spring meeting. The fiscal year ends with the calendar year.

Motion: W. R. Allen moved that a final audited report be mailed to each member. Seconded by W. Ives. Carried.

Editor's Report: H. R. Wong reported that the Proceedings was at the printers. He said that the cost would range from $38.00 - $40.00. He reported that requests for copies of the Proceedings has depleted the reserves of certain years. He recommended that an archivist be appointed to take care of the remaining reserve of the Proceedings. H. R. Wong moved the adoption of the report as read. Seconded by W. Turnock. Carried.

Common Names Committee: No report

Regional Director: No report.

Report on Progress of Local Arrangements Committee for the 1962 Meeting of the Entomological Society of Canada: The arrangements have been going steadily forward at an increasing tempo and good progress has been made to date. Since the last report the programs have been drawn up and mailed and arrangements have been made for speakers, social events and finances.

New Business: At an Executive meeting held March 15 it was suggested that a portrait of Mr. J. B. Wallis with an attached plaque giving pertinent information, be placed in the Department of Entomology, University of Manitoba to commemorate his work. President Smith asked a committee of R. D. Bird and A. G. Robinson to investigate the cost of the portrait and plaque and means of defraying this cost.

Motion: W. Turnock moved that the committee be authorized to spend up to $15.00 to frame a picture of Mr. Wallis. Seconded by H. R. Wong. Carried.

Future of the Spring Meeting: Some concern was expressed by President Smith at the poor attendance at the meeting. The suggestion was put forward that unless the meeting served a useful purpose it should be discontinued. After some discussion the consensus of opinion was that the meeting should remain as it is with a considerable degree of flexibility.

Project for Amateur Entomologists: A suggestion was made by President Smith that the Society undertake a project to encourage school students to collect insects. He suggested that the collecting could be divided into three sections:

1. Collections of insects.
2. Collections in ecological areas.
3. Life history collections.

The collections could be shown at the Brandon Fair, science fairs or at other exhibitions. Prizes of books for example could be offered.

In the discussion it was pointed out that the Alberta Society has carried on a similar project and that enquiries should be made of their project before we make any commitment.

President Smith moved that the meeting be adjourned.

APPENDIX II

FALL MEETING

The fall meeting of the Entomological Society of Manitoba was held on Oct. 29, 30 and 31, 1962 at the Fort Garry Hotel, Winnipeg, Manitoba. At this meeting the local society was host to the Entomological Society of Canada. The business meeting opened with President L. Smith in the chair. He asked for a minute silence to honor Mr. J. B. Wallis, Prof. A. V. Mitchener and Mr. A. R. Brooks, members of the society, who had recently passed away.

The minutes of the spring meeting of the Entomological Society of Manitoba were read by the Secretary, H. P. Richardson, who moved their adoption. Seconded by D. Robertson. Carried.

Business Arising from Minutes: W. Turnock resigned as publicity chairman for the joint meeting of the Entomological Societies of Manitoba and Canada and was replaced by S.R. Loschiavo.

Correspondence: A letter received from the Centennial Committee of the Entomological Society of Canada was read. They requested a sum of $150.00 to help defray costs of the meeting.

Motion: F. Webb moved that the Manitoba Entomological Society grant the sum of $150.00 to the Canadian Entomological Society. Seconded by W. G. H. Ives. Carried.

A letter from the Zoological Society of London was received requesting we continue our contribution to the publication of the Zoological Record.

Motion: P. H. Westdal moved that we contribute $10.00 to the Zoological Society of London this year. Seconded by R. J. Heron. Carried.

Treasurer's Report: W. Romanow reported the budget is in the black and that an audited report will be out by November 15. Seconded by F. Watters. Carried.

Editor's Report: H. R. Wong reported that the 1961 Proceedings were sent out to the members. He stated that Kent Oliver is now acting in the capacity of an Archivist. He has stored the back volumes of the Proceedings and the Journals obtained by exchange. The Proceedings cost $40.00 for typing and $5.00 for mailing. Seconded by W. G. H. Ives. Carried.

Common Names Committee: H. R. Wong reported two common names were submitted but these were turned down. The reason being the Family is being revised. Seconded by R. J. Heron. Carried.

Report of the Regional Director: R. J. Heron reported that plans for the Centennial were discussed at the director's meeting and were as reported at the business meeting of the Entomological Society of Canada. He stated that correspondence received by the President prompted considerable discussion concerning the Supplements to the Canadian Entomologist. It was pointed out that the Supplements are not an expense to the society but in fact are a source of revenue. Supplements are distributed to all members some of whom find no use for them. It was suggested that such persons could donate their copies to institutions in the developing nations. Provision is being made by the Agricultural Institute of Canada for the collection and distribution of such material.

R. D. Bird reported for the committee to investigate a frame for the portrait of the late J. B. Wallis. He stated the portrait was in the process of being framed, and that the Department of Entomology of The University of Manitoba was framing a portrait of the late Prof. A. V. Mitchener.

Report on the Joint Meetings of the Entomological Societies of Manitoba and Canada: A. J. Thorsteinson reported that the joint meeting was a success and many favorable comments were received.

Project for Amateur Entomologists: This project is being studied to obtain a workable plan. It was suggested that working through schools would not be as effective as working through some extension program of the Provincial Government. Awards to Amateurs and $50.00 to the top student in Entomology at the University were mentioned as possible prizes. The general feeling of the meeting was that the project should be studied further. The Executive was asked to set up a committee to look into the project.

Nominating Committee: R. D. Bird reported for the Nominating Committee.

Motion: R. D. Bird moved that the Editor, H. R. Wong; Treasurer, W. Romanow; and Secretary, H. P. Richardson retain their posts. He suggested W. G. H. Ives as President and D. R. Robertson as President elect. Seconded by A. J. Thorsteinson. Carried.

President L. Smith thanked the executive and the members of the Society for their assistance during his term of office. He then turned the meeting over to W. G. H. Ives.

President Ives asked for new business, there being none moved the meeting be adjourned.

APPENDIX III

FINANCIAL STATEMENT AS OF APRIL 9, 1963

Receipts

Balance on hand (C/A previous statement Nov 1/61)	$ 37.01
Fees	320.50
Special membership dues	12.07
Refund (re - banquet)	5.00
Donation	1.00
U. S. exchange	.78
	$ 376.36
Savings Account 5917	578.12
Interest on Savings Account	13.21
U. S. exchange	4.19
	$ 971.88

Expenditures

Fees to Ent. Society of Canada	$ 214.00
Banquet (Paddock, Gratuities and Complimentary tickets)	7.00
Banquet (Luigi's, Gratuities and Complimentary tickets)	15.00
Coffee University of Manitoba	7.00
Flowers (Mr. J. B. Wallis)	5.00
Flowers (Prof. A. V. Mitchener)	5.00
Refund on cheque	9.36
Zoological Society of London	10.00
Entomological Society of Canada	150.00
Typing of Proceeding	40.00
	$ 462.36
	$ 509.52

Bank Balance

Savings Account	$ 445.52
Current Account	64.00
	$ 509.52

W. Romanow,
Treasurer.

APPENDIX IV

ADDITIONS TO THE LIBRARY OF THE ENTOMOLOGICAL SOCIETY OF MANITOBA

1. Annuaire de La Faculté d'agriculture et de sylviculture de L'Université de Skopje. Vol. 14, 1960-61.

2. Bollettino dell'Istituto di entomologià della Università degli studi di Bologna. Vol. 24, 1960.

3. Hines, Neal O. Proving ground; an account of the radiobiological studies in the Pacific, 1946-1961. Seattle, Univ. of Washington Press, 1962. 366 p. illus.

4. Institute agronomique de l'Etat. Laboratoire de zoologie générale. Gembloux, Belgium. (Reprints from Jean Leclercq, Charge de Cours a L'Institut agronomique, 1961-62.)

5. Institut royal des aciences naturelles de Belgique. Memoires, fasc. 63, 1962.

6. Journal of the Entomological Society of Queensland. Vol. 1, 1962.

7. Liége, Belgium. Université. Laboratoire de biochimie. (Reprint material with the compliments of Professeur Marcel Florkin.)

8. Nebraska. Agricultural Experiment Station. Quarterly, 1962.

9. Nebraska. Agricultural Experiment Station. Report, 75th, 1962.

10. Nebraska. University. College of Agriculture. Research bulletin, 1962 (selected list).

11. Nebraska. University. College of Agriculture. (Reprint material, 1962.)

12. Pest infestation research. (Great Britain. Dept. of Scientific and Industrial Research) London. 1960.

13. Polska akademia nauk. Instytut zoologiczny. Warsaw, Poland. Annales zoologici, Vol. 19, nos. 11-12, 1961; Vol. 20, nos. 1-8, 10, 13, 15-16, 1961-62.

14. Polska akademia nauk. Instytut zoologiczny. Warsaw, Poland. Fragmenta faunistica, Vol. 8, no. 39, 1961; Vol. 20, nos. 1-25, 1961-62.

15. Polski zwiazek entomologiczny. Warsaw, Poland. Klucze do oznaczania owadow Polski, (Keys to the designation of insects in Poland) Series 33-38, 1961-62.

16. Proceedings of the Entomological Society of British Columbia. Vols. 58-59, 1961-62.

17. McKenney, Margaret. The savory wild mushroom; a Pacific northwest guide. Seattle, Univ. of Washington Press, 1962. 133 p. illus.

18. Redia; giornale di entomologia. (Florence, Italy. Stazione di entomologia agraria) Vol. 46, 1961.

19. Studi sassaresi; Annuli della Facoltà di agraria dell' Università di Sassari. Sezione 3, vol. 9, 1961.

20. Zastita bilja; Plant protection. (Savenzni institut za zastitu bilja. Belgrade, Yugoslavia) Nos. 63-68, 1961-62.

APPENDIX V

PROGRAM OF THE 12TH ANNUAL MEETING OF THE ENTOMOLOGICAL SOCIETY OF CANADA AND 18TH ANNUAL MEETING OF THE ENTOMOLOGICAL SOCIETY OF MANITOBA, OCTOBER 29-31, 1962, FORT GARRY HOTEL, WINNIPEG, MANITOBA

SUNDAY, October 28

2:00 p.m.	Directors Meeting - Salon B, 1st floor, Fort Garry Hotel
1:30 - 4:30 p.m.	Registration - Mezzanine, Fort Garry Hotel
7:00 - 9:30 p.m.	" " " " "

MONDAY, October 29, FORT GARRY HOTEL

9:00 - 9:45 a.m.	Registration - Mezzanine floor
9:45 - 10:00 a.m.	Opening Addresses - Drawing Room - Mezzanine floor Address of Welcome - L. B. Smith, President, Entomological Society of Manitoba.
10:00 - 10:30 a.m.	Presidential Address: A.W.A. Brown, President, Entomological Society of Canada.
10:30 - 10:50 a.m.	Intermission
10:50 - 12:00 noon	Invitational Address: "Philosophical Aspects of Biology" Professor Morton Beckner, Pomona College, Clairmont, California.
12:00 - 1:45 p.m.	Lunch
1:45 - 5:00 p.m.	Symposium: Physics in Insect Biology Chairman - B.N. Smallman, Director of Program, Entomology and Plant Pathology, Research Branch, Canada Dept. of Agriculture.

The Role of Sound in Insect Behaviour - P. Belton, Entomology Research Institute for Biological Control, Belleville, Ontario.

Behaviour of Insects in Electrostatic Fields - M.G.Maw, Entomology Research Institute for Biological Control, Belleville, Ont.

Intermission:

Insect Vision - T. H. Goldsmith, The Biological Laboratories Yale University, New Haven, Conn.

Ionizing Radiation and Insects - W. Baldwin, Atomic Energy of Canada Ltd., Biology and Health Physics Division, Chalk River, Ontario.

7:00 p.m. — Smorgasbord and Mixed Smoker - Banquet Room, PEMBINA HOTEL.

TUESDAY, October 30. UNIVERSITY OF MANITOBA (Transportation arranged)

Chartered bus leaves Fort Garry Hotel for University of Manitoba at 8:30 a. m.

9:00 a.m.-12:30 p.m. — Symposium: Geographical Aspects of Insect Ecology, Agriculture Auditorium, Agriculture Building.

Chairman: G. P. Holland, Entomology Research Institute, Central Experimental Farm, Ottawa.

Perspectives in Insect Geography - E. G. Munroe, Entomology Research Institute, Central Experimental Farm, Ottawa.

Northern Limits of Insect Distribution - J. A. Downes, Entomology Research Institute, Central Experimental Farm, Ottawa.

Intermission - Coffee and Doughnuts

Effect of Land Use on Insect Ecology - R.D.Bird, Canada Agriculture Research Station, Winnipeg.

12:30 - 1:10 p.m. — The Entomology Laboratories of the Canada Departments of Agriculture and Forestry and the University of Manitoba are open to visits by members.

1:15 - 2:15 p.m. — Lunch, University Cafeteria.

2:30 - 3:30 p.m. — Submitted Papers, Sessions I and II.

Chartered bus leaves Agriculture Building for Fort Garry Hotel at 4:00 p.m.

6:30 - 7:00 p.m.	Cocktail Hour - Main Dining Room - Main floor, Fort Garry Hotel.
7:00 p.m.	Banquet - Main Dining Room - Main floor, Fort Garry Hotel. Banquet Speaker, Professor B. Hocking will give an illustrated talk on his recent trip to Africa.

WEDNESDAY, October 31. FORT GARRY HOTEL

9:00 - 11:00 a.m.	Annual Business Meeting, Entomological Society of Canada, Drawing Room - Mezzanine floor, Fort Garry Hotel.
11:00 - 12:00 noon	Annual Meeting, Entomological Society of Manitoba, Salon E - Mezzanine floor, Fort Garry Hotel.
1:30 - 3:15 p.m.	Submitted Papers, Sessions III and IV.
7:00 - p.m.	Insect Physiologists Group Meeting - Salon E - Mezzanine floor, Fort Garry Hotel.
8:00 - p.m.	Board of Directors Meeting - Salon B - 1st floor, Fort Garry Hotel.

Exhibits in connection with some of the work of the Manitoba members will be on display in the Drawing Room of the Fort Garry Hotel on October 29 and 31.

Ladies Program

Ladies are invited to attend the Smorgasbord and mixed smoker on October 29 and the Cocktail Hour and Banquet on October 30. In addition, the following events have been especially arranged for them.

MONDAY, October 29.

2:00 - p.m.	Tea and Tour, Manitoba Rehabilitation Hospital.

TUESDAY, October 30.

1:30 - p.m.	Luncheon, Kelly House Square Tour of the Handicraft Guild (optional)

SESSIONS OF SUBMITTED PAPERS

SESSION I. INSECT CONTROL

Auditorium, Agriculture Building, University of Manitoba

Chairman: L.A.O. Roadhouse, Research Branch, Canada Agriculture, Ottawa, Canada.

TIME	SPEAKER	SUBJECT
p.m.		
2:30-2:45	Arnott, D.A. (Kamloops, B.C.)	Notes on silver top of grasses in the Peace River area.
2:45-3:00	Berck, B., (Winnipeg, Man.)	Determination of insecticide residues in cereal and forage crops.
3:00-3:15	Foott, W.H. (Harrow, Ont.)	A preliminary report on the biology and control of the pepper maggot, Zonosemata electa (Say), in southwestern Ontario.
3:15-3:30	Watters, F.L. (Winnipeg, Man.)	Effectiveness of inert mineral dusts against stored product insects.

SESSION II. INSECT BEHAVIOUR

Room 111, Agriculture Building, University of Manitoba

Chairman: B. Hocking, Department of Entomology, University of Alberta, Edmonton, Alberta.

TIME	SPEAKER	SUBJECT
p.m.		
2:30-2:45	Jay, S.C. (Winnipeg, Man.)	The longitudinal orientation of larval honeybees within cells.
2:45-3:00	Loschiavo, S.R. (Winnipeg, Man.) Beck, S.D. and Norris, D.M. Jr. (Madison, Wisc.)	Behavioural responses of the smaller European elm bark beetle, Scolytus multistriatus (Marsh.) (Coleoptera:Scolytidae), to extracts of elm bark.

TIME	SPEAKER	SUBJECT
p.m.		
3:00-3:15	Nayar, J.K. (Winnipeg, Man.)	Further investigations into the chemical basis of insect-host plant relationships in anioligophagous insect, Plutella maculipennis (Curt.) (Lepidoptera:Plutellidae)
3:15-3:30	Thorsteinson, A.J. and Nayar, J.K. (Winnipeg, Man.)	Influence of some phospholipids in plants on feeding activity of grasshoppers.

SESSION III. BIONOMICS AND TAXONOMY

Salon E - Mezzanine Floor, Fort Garry Hotel

Chairman: A. P. Arnason, Research Branch, Canada Agriculture, Ottawa, Ontario.

Co-Chairman: I.M. Campbell, Canada Dept. of Forestry, Sault Ste. Marie, Ontario.

TIME	SPEAKER	SUBJECT
p.m.		
1:30-1:45	Buckner, C.H. (Winnipeg, Man.)	Preliminary studies of fleas (Siphonaptera) attacking small mammals in southeastern Manitoba.
1:45-2:00	Lord, F.T. (Kentville, N.S.)	Sampling predator populations on apple trees.
2:00-2:15	Lyons, L.A. (Sault Ste. Marie, Ont.)	Optimal soil unit size in sampling cocoon populations of the European pine sawfly, Neodiprion sertifer (Geoff.)
2:15-2:30	McLeod, J.M. (Sillery, P.Q.)	On the habits of a jack pine needleminer, Eucordylea canusella (Free.) with special reference to its association with a fungus, Aureobasidium pullulans (de Bary), Arnaud.

TIME	SPEAKER	SUBJECT
p.m.		
2:30-2:45	Read, D.C. (Charlottetown, P.E.I.)	A simplified technique for rearing the cabbage root maggot, Hylemya brassicae (Bouche).
2:45-3:00	Turnock, W.J. and Melvin, J.C.E. (Winnipeg, Man.)	Distribution and hosts of Bessa harveyi (Tnsd.) (Diptera: Tachinidae)

SESSION IV. INSECT PHYSIOLOGY

Drawing Room - Mezzanine Floor, Fort Garry Hotel

Chairman: A.S. West, Queen's University, Kingston, Ontario.
Co-Chairman: R. Salt, Research Branch, Canada Agriculture Lethbridge, Alberta.

TIME	SPEAKER	SUBJECT
p.m.		
1:30-1:45	Brezner, J. (Syracuse, N.Y.)	Specificity of insect dehydrogenases.
1:45-2:00	Campbell, I.M. (Saulte Ste. Marie, Ont.)	Effect of genetic and temperature interaction on reproductive capacity in Choristoneura.
2:00-2:15	Davis, G.R.F. (Saskatoon, Sask.)	Grasshopper carbohydrases.
2:15-2:30	Hanec, W. (Winnipeg, Man.) and Prentice, R.M. (Ottawa, Ont.)	The effect of low temperatures on the hatching and survival of the forest tent caterpillar, Malacosoma disstria Hbn.
2:30-2:45	McGinnis, A.J. and Kasting, R. (Lethbridge, Alta.)	Indirect measurement of consumption and utilization of food by the pale western cutworm with chromic oxide.
2:45-3:00	Pucat, Amalia (Miss) (Edmonton, Alta.)	The mechanism of movement of labral brush hairs in mosquito larvae.
3:00-3:15	West, A.S. (Kingston, Ont.)	Reactions to insect bites-progress reports.

APPENDIX VI

GUESTS AND MEMBERS REGISTERED FOR THE 12TH ANNUAL MEETING OF THE ENTOMOLOGICAL SOCIETY OF CANADA AND THE 18TH ANNUAL MEETING OF THE ENTOMOLOGICAL SOCIETY OF MANITOBA

Adisoemarto, S.	University of Alberta, Edmonton, Alberta.
Allen, W.R.	Can. Dept. of Agriculture, Winnipeg, Man.
Arnason, A.P.	Can. Dept. of Agriculture, Ottawa, Ontario.
Arnott, D.A.	Can. Dept. of Agriculture, Kamloops, B.C.
Ashraff, A.	Green Cross Products, Winnipeg, Manitoba.
Askew, W.L.	Can. Dept. of Agriculture, Winnipeg, Man.
Baldwin, W.	Atomic Energy of Canada Ltd. Chalk River, Ont.
Ball, G.E.	University of Alberta, Edmonton, Alberta.
Barrett, C.F.	Sask. Dept. of Agriculture, Regina, Sask.
Beaudoin, N.P.	Can. Dept. of Agriculture, Montreal, P.Q.
Becker, E.C.	Can. Dept. of Agriculture, Ottawa, Ontario.
Beckner, M.O.	Pomona College, Clairmont, California.
Belski, P.	Metro Corp. of Greater Winnipeg, Winnipeg, Man.
Belton, P.	Can. Dept. of Agriculture, Belleville, Ont.
Belur, N.V.	University of Alberta, Edmonton, Alberta.
Belyea, R.M.	Can. Dept. of Forestry, Fredericton, N.B.
Berck, B.	Can. Dept. of Agriculture, Winnipeg, Man.
Bird, R.D.	Can. Dept. of Agriculture, Winnipeg, Man.
Brezner, J.	University of Syracuse, Syracuse, N.Y.
Brown, A.W.A.	University of Western Ontario, London, Ont.
Brown, C.E.	Can. Dept. of Forestry, Calgary, Alberta.
Buckner, C.H.	Can. Dept. of Forestry, Winnipeg, Manitoba.
Campbell, I.M.	Can. Dept. of Forestry, Sault Ste. Marie, Ont.
Cartier, J.J.	Can. Dept. of Agriculture, St. Jean, P. Q.
Cole, T.V.	Can. Dept. of Agriculture, Winnipeg, Man.
Corbet, P.S.	Can. Dept. of Agriculture, Ottawa, Ontario.
Cox, G. A.	Can. Dept. of Agriculture, Winnipeg, Man.
Cushan, A.	Interprovincial Co-Ops, Winnipeg, Man.
Daviault, I.S.L.	Can. Dept. of Forestry, Sillery, Quebec.
Davis, G.R.F.	Can. Dept. of Agriculture, Saskatoon, Sask.
Downes, J.A.	Can. Dept. of Agriculture, Ottawa, Ontario.
Drouin, J.A.	Can. Dept. of Forestry, Winnipeg, Manitoba.
Edwards, R.L.	University of Saskatchewan, Saskatoon, Sask.
Elliott, K.R.	Can. Dept. of Forestry, Winnipeg, Manitoba.
Evans, W. G.	University of Alberta, Edmonton, Alberta.
Fast, P.G.	Can. Dept. of Forestry, Sault Ste. Marie, Ont.
Flock, G.R.	Can. Dept. of Agriculture, Winnipeg, Man.
Foott, W.H.	Can. Dept. of Agriculture, Harrow, Ontario.
Ford, P.L.	Can. Dept. of Forestry, Winnipeg, Manitoba.

Forsberg, D.	Velsicol Corp. of Canada, Ltd. Winnipeg, Man.
Fraser, G.R.	Chipman Chemicals Ltd., Winnipeg, Manitoba.
Freitag, R.	University of Alberta, Edmonton, Alberta.
Goldsmith, T.H.	Yale University, New Haven, Connecticut.
Gray, D.E.	Canada Dept. of Forestry, Ottawa, Ontario.
Greaney, F.J.	Line Elevators Service, Winnipeg, Manitoba.
Haffold, D.C.D.	University of Alberta, Edmonton, Alberta.
Hancox, R.W.	Canada Dept. of Forestry, Winnipeg, Manitoba.
Hanec, W.	University of Manitoba, Winnipeg, Manitoba.
Herne, D.H.C.	Can. Dept. of Agriculture, St. Catharines, Ont.
Heron, R.J.	Can. Department of Forestry, Winnipeg, Man.
Hildahl, V.	Can. Department of Forestry, Winnipeg, Man.
Hincks, D.	Can. Department of Forestry, Winnipeg, Man.
Hocking, B.	University of Alberta, Edmonton, Alberta.
Holland, G.P.	Can. Department of Agriculture, Ottawa, Ont.
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