Fifty years of entomological research in orchard and vegetable crops in British Columbia

R.S. VERNON

AGRICULTURE AND AGRI-FOOD CANADA,
PACIFIC AGRI-FOOD RESEARCH CENTRE, AGASSIZ, BC, CANADA V0M 1A0

British Columbia has seen tremendous advances and accomplishments in the broad field of entomology over the past fifty years. This is especially true in relation to the orchard and vegetable industries, where entomologists have played essential and often pivotal roles in the production, protection and sustainability of these crops. I have attempted to list as many of the entomologists (and their affiliations) working in orchards and field vegetables as I have been able to retrieve from memory and various archival sources. Unfortunately, to adequately summarize the specific endeavors of the many scientists involved would take more space than allotted for this article. For more in-depth information on the entomologists of BC and their various research specialties, the reader is referred to the joint Entomological Society of BC and Entomological Society of Canada publication 'Entomologists of British Columbia' compiled by P.W. Riegert in 1991. For this paper, I have chosen in part to present a number of the more highly publicized research programs and the entomologists involved that have played pivotal roles in the direction and advancement of entomology in certain orchard or vegetable crops. Since this year marks the 100th anniversary of the Entomological Society of BC, and the 98th Volume of the Journal of the Entomological Society of BC (JESBC), it also seemed appropriate in part to link certain aspects of this article towards key papers published in the Journal since 1951.

General Trends

Reviewing the past fifty issues of the JESBC was a tremendously educational and nostalgic experience, not only from an entomological point of view, but also as a general interest and historical exercise. Who could resist reading, for example, 'An authenticated case of black widow bite', by Carl and Perry in 1959, or so many of the other key articles that in retrospect helped capture our interest and shape our profession in BC. When I had gathered and summarized all of the papers pertaining to entomology in orchards and vegetables since 1951, I was greatly impressed by the diversity and efficacy of our Society's entomologists, both past and present, and by the ebb and flow of various research themes over time.

Volume 47 of the Proceedings of the Entomological Society of British Columbia, issued July 15, 1951, began with an ad by the Nichols Chemical Company congratulating the Entomological Society of British Columbia on its 50th anniversary. I found it interesting to note that there was a total of 8 pages of advertisements by various pesticide companies in that issue, most of which (Monsanto being a notable exception) are no longer in existence. One ad in Volume 49, 1953, had the ominous title 'Improved Controls for Entomologists', and on another page was a photo of two workers (possibly the entomologists referred to in the first ad) wearing no safety equipment, in short-sleeved shirts, applying pesticides in an apple orchard using hand-held sprayers (the chemicals advertized in that ad included DDT, parathion, and lead arsenate). Such photographs of course, are now used to illustrate how 'not' to apply pesticides, and these advertisements went the ultimate way of DDT following the 1954 issue.

The prominence of pesticide advertisements in the JESBC at that time reflected the prominence and influence of the pesticide industry on entomological research. The papers published in the Journal between 1951 and 1960 were heavily biased towards pesticide trials (including studies on efficacy, resistance, phytotoxicity, application technology, etc.), seemingly at the expense of general biological studies (general species descriptions, host range and damage, life history, insect ecology, behavior, etc.) and studies on alternative pest control methods (biological, cultural, natural, physical, mechanical, genetic, semiochemical or SIR) (Fig. 1). It is interesting to note that the number of pesticide-related articles published in the Journal has declined linearly from a high of 25 papers from 1951-60 to a low of 3 papers in the last decade. This probably reflected in part the gradual erosion in the number of existing and pending product registrations, as well as the reviving interest in insect biology and the development of integrated pest management (IPM) theory, tools and strategies (alternative controls, sampling and forecasting, economic thresholds, blended control strategies, etc.). The number of papers in the general biology category overtook pesticide articles in the Journal between 1961-70, and articles depicting IPM and alternative control approaches have also been gradually increasing (Fig. 1).

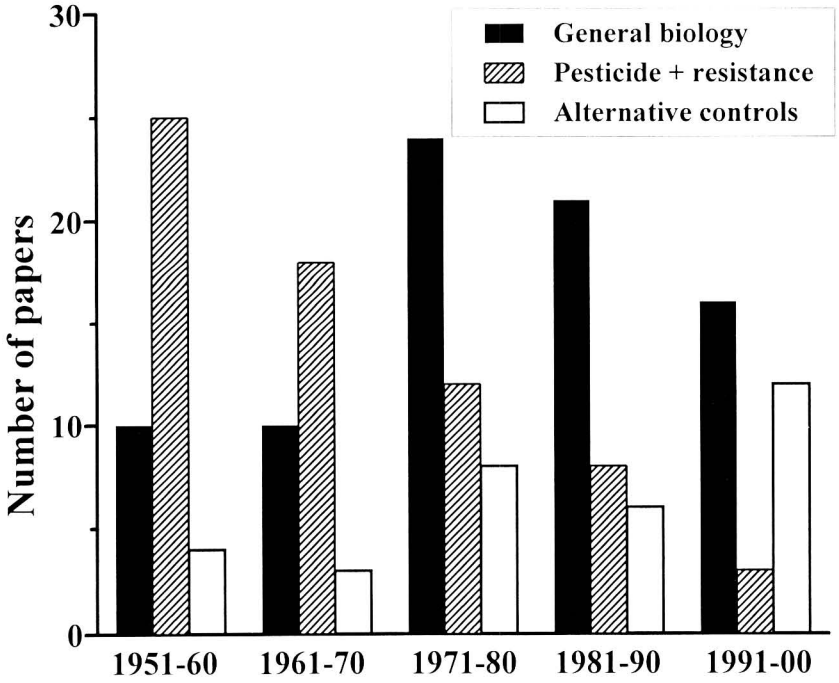

Figure 1. The number of papers published between 1951 and 2000 in Journal of the Entomological Society of BC relating to: general biological studies; pesticide studies; and alternative control methods of insects and mites in orchard and field vegetable crops.

Although the emphasis and general infrastructure of entomological research has changed dramatically in orchard and field vegetable crops over the past fifty years, the insects and mites involved have changed but little. The next sections chronicle the entomologists who have studied insects and mites in orchards and vegetables in BC, and a few examples of key pests

that have demanded a relay team of entomologists and effort spanning the past fifty years are given. Since most entomological research in orchards and vegetables can be classed under biological, chemical or alternative IPM research, these will also serve as broad themes for the discussions to follow.

Entomology in Orchard Crops

The majority of orchard crops in BC, (primarily apple, pear, peach, apricot, plum or prune, and cherry) are grown in the Okanagan and Similkameen Valleys with some production in the Kootenays and more recently in the lower Fraser Valley. Most of the research in orchards over the past fifty years, however, has focused on the Okanagan and Similkameen areas, primarily by Agriculture and Agri-Food Canada scientists at the Pacific Agri-Food Research Centre (PARC) at Summerland (formerly the Summerland Research Station). An interesting and historic paper was published in the JESBC in 1953 entitled "A decade of pest control in BC orchards" by J. Marshall, senior entomologist at the Summerland Research Station. A buildup of federal and provincial staff at Summerland was occurring at that time and Marshall spoke of the facility as having struck a good balance between fundamental long-term biological studies and the chemical investigations that were considered a season-to-season necessity by the industry. In the 1950s, scientists at Summerland included: J. Marshall (specialty: pesticides); D.P. Pielou (specialty: aphids and resistance to insecticides); C.V.G. Morgan (specialty: Eriophyid mites and scale insects); M.D. Proverbs (specialty: codling moth irradiation) and; R.S. Downing (specialty: insecticides and mites). In the 1960s, W.H.A. Wilde transferred to Summerland from the Creston substation in 1961, retired in 1963 and was replaced by R.D. McMullen (their specialty: pear psylla bionomics) who transferred from the Harrow Research Station in Ontario in 1964. H.F. Madsen (specialty: integrated control) joined Summerland in 1964 and replaced Marshall (retired in 1963) as head of entomology. In the 1970s, F.L. Banham, formerly studying vegetable insects began orchard research in 1971 (specialty: stone fruit insects), and following the retirements of Morgan in 1974, Downing in 1979, and Proverbs in 1980, the entomology team at Summerland by 1982 consisted of McMullen, Banham, Madsen and newcomers N. Angerilli (specialty: orchard mite control, San Jose scale) and V.A. Dyck (specialty: management of codling moth). J.E. Cossentine (specialty: biological control) replaced the retired Madsen in 1985, and G.J.R. Judd was appointed in 1989 (specialty: insect chemical ecology and behavior). M. Smirle (specialty: resistance management) joined the station in 1990 and D. Thielmann (specialty: insect baculoviruses) transferred from the Vancouver Research Station upon its closure in 1996. H. Thistlewood transferred to Summerland from the Vineland Ontario Research Station in 1998, was temporarily seconded to the SIR program as general manager between 1998 and 2001 and is now at PARC, Summerland (specialty: insect ecology). Surrounding this core of research scientists have been many technical staff, including, C.J. Campbell, W.W. Davis, M. Gardiner, L.B. Jensen, C. Jong, C. Krupke, D.M. Logan, T.K. Moilliet, J.R. Newton, and J.M. Vakenti (only individuals, whose names have appeared in the literature as author or co-author are listed).

In addition to the federal government researchers mentioned above, significant contributions have also been made by entomologists from the Provincial Government (C.L. Nielson; J.C. Arrand; J. Corner; P.J. Procter; and H. Philip), private consultants (S. Haley; J.M. Vakenti; L. Edwards; F. Peters; D. Thomson) and the Okanagan-Kootenay Sterile Insect Release Program (K.A. Bloem and S. Bloem). Contributions to orchard entomology have also been made by the various BC universities, including UBC (D.A. Chant) and Simon Fraser University (J.H. Borden; B.P. Bierne; B.D. Roitberg; M. Mackauer; G. Gries;) which has had close ties to PARC, Summerland through the Centre for Pest Management (hosting the Master

of Pest Management program (MPM)). The impact of SFU and the Centre for Pest Management on current research personnel at PARC Summerland is evidenced by the fact that three out of five current research scientists (Judd, Smirle and Thistlewood) as well as numerous technical staff (M. Gardiner, M. Claudius and C. Krupke) are former SFU graduate students. Numerous collaborations between SFU and PARC, Summerland scientists involving graduate students have also resulted in significant contributions to orchard pest management, and PARC, Summerland scientists have hosted the orchard pest management summer course in the MPM program since 1973.

General Biology

The list of insect and mite pests as well as the associated suite of beneficial organisms in orchard crops in BC is very long, and has provided entomologists with an abundance of challenging material for study over the years. Downing *et al.* (1956) compiled a list of 63 species of insects and 14 species of mites known to be economically (E) or sporadically (S) injurious to apples (28 E; 22 S); apricot (10 E; 12 S); peach (11 E; 14 S); pear (12 E; 15 S); plum or prune (15 E; 23 S); and cherry (12 E; 26 S). This list has grown since then, and I'm sure the next fifty years will see a number of major new introductions and challenges to the industry, the apple maggot, *Rhagoletis pomonella* (Walsh), for example, being an imminent threat.

Much of the attention of orchard entomologists over the past fifty years has focussed on: scale insects (e.g. San Jose scale, *Quadraspidiotus perniciosus* Comstock), mites, both pest (e.g. the McDaniel mite, *Tetranychus mcdanieli* McGregor, and European red mite, *Panonychus ulmi* (Koch)) and predators (e.g. phytoseiid mites including *Typhlodromus occidentalis* Nesbitt); lepidopterans (e.g. codling moth, *Cydia pomonella* (L.), obliquebanded leafroller, *Choristoneura rosaceana* Harris); pear psylla, *Cacopsylla pyricoli* (Föerster) and the western cherry fruit fly, *Rhagoletis indifferens* Curran. In addition to their popularity as research organisms, some of these species are also the focus of a number of success stories that will be highlighted below.

Insect and Mite Management

The introduction of organochlorine insecticides to the BC orchard industry in the 1940s had an immediate impact on the population dynamics of insect and mite populations, as well as on the job descriptions of many entomologists. The initial efficacy of these new products was so impressive, and the influence of the pesticide companies so great, that much of the research efforts in the 1940s, 50s and 60s were directed at evaluating various products against the key economic orchard pests present at that time. A number of the Summerland scientists mentioned earlier in the 1950s and 60s were very prolific in evaluating insecticides (Marshall, Pielou, Proverbs) and acaracides (Downing, Morgan). It was fortunate for the industry, however, that these entomologists were also aware of the drawbacks to indiscriminate pesticide use, and their concurrent biological and ecological observations and work with less toxic alternatives such as dormant oil sprays (Downing, Madsen) gradually gave rise to more discriminate pesticide use and ultimately to widely adopted IPM programs.

As early as 1953, the need for judicious use of chemicals in orchards in order to preserve beneficial organisms had been recognized by Marshall and others (Marshall 1953). Marshall published another important paper in JESBC a decade later (1963), entitled, "Background for integrated spraying in the orchards of British Columbia", which made reference to the recently published and "woefully biased" 'Silent Spring' by Rachel Carson in 1962 (also reviewed in JESBC by Marshall in 1962), and which essentially described the evolving concept of IPM in Summerland and other fruit growing areas of the world. Among other advances, Summerland

scientists had recently shown that less spraying for insects and mites was possible without crop losses, and the use of more selective pesticides used only when necessary was being advocated for various regions of the Okanagan Valley. In apples, a number of breakthroughs in mite and codling moth control helped shape and direct the course of pest management related research in this major crop.

Much of our understanding of the life histories and distribution of the pest and predatory mites in BC orchards can be attributed to the early efforts of N.H. Anderson (e.g. Anderson *et al.* 1958), Morgan (e.g. Morgan *et al.* 1955), and Downing (e.g. Downing and Moilliet 1971) whose orchard survey and life history work formed the foundation for the integrated mite controls now standard throughout the industry. An important tool in the understanding and management of mites was the mite brushing apparatus, which was adapted by Morgan for use in Okanagan orchards (Morgan *et al.* 1955) and has been in standard use for about 50 years. This apparatus allowed researchers to study both phytophagous and predaceous mites, and with the development of accompanying action thresholds it has become a cornerstone of apple and pear IPM programs delivered by private consultants and packing houses. Along with the findings that dormant oil sprays could control the European red mite (and certain scale insects) without impacting predator mites, and that the predatory mite, *Typhlodromus occidentalis* had developed natural resistance to organophosphates such as azinphos methyl (Guthion), growers have been able to rely heavily on naturally occurring biological control backed up by surveillance-based miticide applications since the early 1970s.

The codling moth, *Cydia pomonella*, is the key insect pest of apples and pears world-wide and much of the general biology of this pest has been determined elsewhere, or pre-dates the current review. However, it is in the development of sophisticated IPM tools and strategies for codling moth management that a number of BC entomologists have distinguished themselves. In the Okanagan and elsewhere, codling moth could only be managed in the 1950s and 60s by repeated use of a variety of insecticides, however three major developments, including: autocidal control; pheromone trapping; and mating disruption, have irrevocably changed this tradition over the past 30 years.

Autocidal control, later to become known as the Sterile Insect Release (SIR) program, was initiated in Summerland in 1956 by M.D. Proverbs with the ultimate aim of eradicating codling moths from geographically isolated areas. Probably the most challenging aspect of this program was the development of an artificial diet and mass rearing facility for codling moth, the efficiency of which was evolved by Proverbs' team to the point that about 17 million sterile moths were eventually being reared and released annually. The rearing facility itself at the Summerland Research Station was an amazing example of what can be accomplished with ingenuity and a shoestring budget, and the larger present day facility near Osoyoos was modeled very closely after the original. The efficacy of SIR was demonstrated in a number of isolated orchards between 1964 and 1976, and from 1976 to 1978 was expanded to include 520 ha of apples and pears in the geographically isolated Similkameen Valley. By the end of the project in 1978, codling moth populations and associated apple damage had been virtually eradicated from the Valley (Proverbs *et al.* 1982), and no additional measures for codling moth control were required in any of the orchards until 1981.

Proverbs' SIR program had gained worldwide attention and recognition by his retirement in 1980, and in 1988 plans for the resurrection and expansion of the SIR program to cover the entire Okanagan and Similkameen valleys were established in a cooperative effort between the Summerland Research Station (V.A. Dyck) and the BC Fruit Growers' Association. In 1990, the Okanagan Similkameen SIR program was formally launched with the goal of eradicating codling moth from key growing regions of the Okanagan and Similkameen Valleys of BC by 1999. The hiring of staff, including K.A. Bloem as program manager (succeeded in 1998 by H.

Thistlewood), began in 1992, and releases of sterile moths began in 1994 in the south Okanagan (Summerland and Naramata south to the U.S. border), Similkameen (Cawston, Keremeos) and Creston regions (known as Zone 1 of the SIR). The program has since expanded to the central (Zone 2) and north (Zone 3) Okanagan regions. After 7 years of moth releases, populations of codling moth had declined dramatically throughout Zone 1, but functional eradication had only been achieved in those regions of the more segregated Similkameen valley where Proverbs did his initial work. Although the goals of the SIR program were shifted from eradication to area-wide suppression in 1999, the autocidal control approach has reduced codling moth populations over large areas to unprecedented low levels.

An interesting paper was published in the JESBC by Madsen and Davis in 1971 which described the use of female-baited traps as indicators of codling moth populations and apple damage. This paper was followed by another JESBC paper by Madsen and Vakenti in 1973, which recorded the initial use of traps baited with synthetic pheromones for codling moth and fruit-tree leafroller, *Archips argyrospilus* (Walker) in orchards in BC. Pheromone traps soon after became a widely used and indispensable tool in orchard IPM in BC, and provided an important cornerstone to the codling moth SIR program still under development at that time as well as in the current SIR program.

Possibly the most exciting development in apple IPM in the past decade has been the development of pheromone-based mating disruption technology for area-wide management of codling moth and other lepidopterous pests of apples and pears (i.e. *Choristoneura rosaceana* and *Pandemis limitata* (Kearfott)). This work, collectively, has been led by G.J.R. Judd at PARC, Summerland in association with industry (Pacific Biocontrol, 3-M Canada, and PheroTech Inc.) and colleagues at SFU, including professors J.H. Borden, B.D. Roitberg, and G. Gries and graduate students M.L. Evenden, N. Delury, H. McBrian and J.P. Deland. In 1992, Isomate-C was registered in Canada by Pacific Biocontrol (Vancouver, WA) as a mating disruption product for codling moth control, and has since been used in Canada and the USA for area-wide management of codling moth (e.g. Judd *et al.* 1996). Mating disruption has become the preferred method for reducing codling moth populations in the clean-up stage of both conventional and organic orchards in Zones 2 and 3 of the Okanagan Similkameen SIR program, and is now being rationally integrated with the sterile moth release program for non-chemical management of codling moth in Zone 1. Mating disruption has also been demonstrated for a number of leafroller pests in BC orchards, and eventual registrations for these additional mating-disruption products will further reduce the reliance of the industry on insecticides.

Entomology in Vegetable Crops

Commercial field vegetable crops are grown in many areas of BC, with the largest concentration of acreage historically being in the lower Fraser Valley and south central interior including the Okanagan Valley, Kamloops and Kootenay areas. As was observed in orchard crops, most of the published entomological research in vegetable crops up until the last decade has involved Agriculture and Agri-Food Canada scientists working out of various research stations or substations in the above regions. In the 1950s, entomological research in vegetables was strong in Kamloops (at that time the Dominion Field Crop Insect Laboratory), Victoria (Saanichton Station), Agassiz (formerly the Agassiz Research Station) and Vancouver (formerly the Dominion Laboratory of Plant Pathology at UBC). In Kamloops in the 1950s, scientists included: R.H. Handford (officer in charge); D.A. Arnott; H.R. MacCarthy; D.G. Finlayson; and F.L. Banham. At Saanichton, scientists in the early 1950s included K.M. King, A.T.S. Wilkinson and A.R. Forbes, however, vegetable research was phased out in the mid-1950s with the retirement of King in 1956, and the transfer of Wilkinson (specialty: soil

insects and biological control of weeds) and Forbes (specialty: aphids and aphid morphology) to Vancouver. At that time, federal entomologists in Vancouver were located on the UBC campus in a building since converted into a cafeteria known as 'the Barn', and also included MacCarthy (specialty: virus vectors) who transferred from Kamloops in 1955. They relocated to the newly built Vancouver Research Station (VRS) at UBC in 1959, and were joined by Finlayson (specialty: root maggots; toxicology) who transferred from Kamloops that year. B.D. Frazer (specialty: aphid ecology) joined the VRS in 1967 and the group remained intact until the retirement of MacCarthy in 1976. In 1981, R.S. Vernon (specialty: vegetable insect IPM) replaced the retired Finlayson (1980), and D.A. Raworth (specialty: biological control) was appointed in 1984. Vegetable research at Agassiz was conducted by R. Glendenning until his retirement in 1953, as well as H.G. Fulton (specialty: vegetable insects), who was stationed at the Entomology Laboratory substation of Agassiz in Chilliwack BC (which later became a VRS substation) until his retirement in 1967. With the closure of the VRS in 1996, Vernon and Raworth (as well as small fruit specialist S. Fitzpatrick, specialty: semiochemicals) were transferred to Agassiz (now the Pacific Agri-Food Research Centre (PARC)) to join D. Gillespie (specialty: greenhouse vegetables), V. Brookes (specialty: minor use registration) and J.T. Kabaluk (specialty: geographic information systems and microbial control). In 1965, Banham transferred from Kamloops to Summerland and was their sole vegetable insect specialist until his specialty was changed to tree fruits in 1971. Excellent technical staff have complimented this core of research scientists, including, C.J. Campbell, C.K. Chan, T. Kabaluk, M. Knott, J.R. Mackenzie, R.R. McGregor and M.D. Noble (again, only individuals, whose names have appeared in the literature as author or co-author are listed).

As was observed above in orchards, additional professionals have contributed in various ways to entomology in field vegetables, including extension officers from the Provincial Government (H. Gerber, H. Philip, B. Costello, J.C. Arrand, T. Kluge, L. Gilkinson) and private consultants (R.S. Vernon, G.J.R. Judd, W.B. Strong, B.D. Henderson, S.Y. Li). Contributions to vegetable entomology have also been made by the various BC universities, including UBC (M.B. Isman) and Simon Fraser University (e.g. J.H. Borden; B.P. Bierne; B.D. Roitberg; M. Mackauer; G. Gries;), the latter again having close ties to the Vancouver and Agassiz Research Stations through the Centre for Pest Management. In fact, the development and implementation of many of the vegetable IPM programs in current use in BC has been through collaborative efforts between the Vancouver and Agassiz Research Stations and SFU staff and graduate students since the mid 1970s.

General Biology

Vegetable crops in BC include a multitude of plant families, species and cultivars, and as such the list of insects associated with these crops is also very long. It is interesting to note that many of the key pests of our more important vegetable crops are not native to Canada, and it is these pests that has demanded much of our attention over the past fifty years. Among the more important introduced pests to BC are: root feeding maggots (e.g. the onion maggot, *Delia antiqua* (Meigen), the cabbage maggot, *Delia radicum* (Bouche) and the carrot rust fly, *Psila rosae* (F.)); wireworms (e.g. the dusky wireworm, *Agriotes obscurus* (L.) and the lined click beetle *A. lineatus* (L.)); lepidopterans (e.g. imported cabbageworm, *Pieris rapae* (L.)); and aphids (e.g. the lettuce aphid, *Nasonovia ribis-nigri* (Mosley)). Other important pests are endemic to the USA and may have entered BC by natural avenues of dispersion or through man's activities (e.g. the tuber flea beetle, *Epitrix tuberis* Gent. and the Colorado potato beetle, *Leptinotarsa decemlineata* (Say)). Much of the research effort in BC vegetables has involved root maggots, tuber flea beetles and various aphids, and brief summaries of the research activities devoted to these pests are given below.

Root maggots. Root maggots are pests of many vegetable crops (i.e. all cruciferous crops, onions and carrots) in BC, and entire fields can be destroyed without adequate protection. Most of what is known about the general biology of root maggots attacking cruciferous crops in BC (particularly *D. radicum*) is through the independent or combined work of Forbes and Finlayson (e.g. Forbes and Finlayson 1957). From the 1950s to the 1980s the majority of research on *D. radicum* as well as on the onion maggot, *D. antiqua*, and carrot rust fly, *P. rosae*, involved the screening of a wide variety of insecticides (Forbes, Fulton, Wilkinson, Finlayson, Mackenzie, Vernon). The amount of spraying for these pests, however, had become excessive, and in the late 1970s to early 1980s a number of monitoring devices and threshold-based IPM programs were developed for onions and carrots through graduate studies at SFU by Vernon and Judd (under the guidance of J.H. Borden). These programs dramatically reduced insecticide use in these crops in the Cloverdale Valley, and formed the basis of BC's first grower-funded private IPM consulting company, Monagro Consultants, in 1979.

Flea beetles. The tuber flea beetle, *E. tuberis*, at one time was one of the most important pests of potatoes in BC, and all published literature on the biology of this insect has been through the efforts of MacCarthy, Banham, Finlayson, Fulton, Vernon and Thomson. As with root maggots, considerable research on this pest since 1950 has been devoted to establishing chemical controls, and growers had become accustomed to spraying their potato fields on a routine basis with broad-spectrum insecticides. This practice also established the need for routine sprays for aphids, largely due to the coincident elimination of aphid parasitoids and predators. In the early 1980s, a monitoring program was established through the efforts of Vernon and SFU graduate students K. Giles and M. Cusson, and this program has been provided to the majority of potato growers in BC since 1980 by private consultants (in particular by Monagro Consultants, and ES Cropconsult Ltd.). Since flea beetles enter potato fields from the field margins, it has been shown that early-season monitoring can detect when and where they first occur, and populations can generally be controlled for the entire season with one (or zero) carefully timed and placed edge spray. By not spraying the entire field on a routine basis, the control of aphid populations through the natural buildup of biological control agents is now common practice.

Aphids. Aphids are found as pests of many vegetable crops, and the efforts of entomologists at the Vancouver Research Station (until its closure in 1996) have been pivotal in determining their biology and control. The early work of H.R. MacCarthy, for example, helped build our understanding of the relationship between aphids and their ability to transmit various virus diseases to potatoes. There is no doubt, however, that the research of A.R. Forbes and his technician C.K. Chan has been most instrumental in building our base of knowledge on the biology and distribution of aphids in BC, many of them pests of vegetable crops. Their work, along with contributions by MacCarthy and Frazer, was published almost annually in a series of 21 papers in the JESBC between 1973 and 1993 (e.g. Forbes and Chan 1991). With the last paper published (Chan and Frazer 1993), this team had described 412 aphid species collected from 1243 different host plants and had identified 2434 aphid-host associations. The collective efforts of these entomologists helped set the stage for the development of management programs for several key aphid species (e.g. lettuce aphid, *N. ribis-nigri* and the European asparagus aphid, *Brachycolus asparagi* Mordvilko).

It is hoped that this paper has adequately portrayed the personalities, scope and at least some of the more public aspects of entomological endeavor in orchards and field vegetable crops in BC. The work of entomologists not profiled in the limited space available is of no less importance, and like a jigsaw puzzle, every piece is required to make the image complete. Assuming some of us will still be around in 2051, it will be interesting to see how much more of the orchard and vegetable entomology puzzle will have been completed when the next fifty years of entomology is reviewed.

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