

Arthropod introductions into British Columbia – the past 50 years

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Introduced arthropods have affected, and continue to affect many different aspects of life in BC. Social concerns arise from public reactions to both epidemics of introduced pests, and to government actions against these pests. Economic losses to both individuals and the provincial economy occur as a result of these introduced species. Finally, ecological impacts of potentially far-reaching nature inevitably occur as a result of these new additions. The extent of the impacts of these introductions spans forestry, agriculture, urban landscapes, and human health, and is too great to allow detailed treatment in these few pages. The effects of introduced species tend to develop over years, if not decades. Some species that were introduced over 100 years ago are still with us. Some of these have undergone important range extensions. Changes in agriculture or forest practices, and shifts in quarantine policies have made these species more or less important. Some species, i.e. natural enemies, have been deliberately introduced for biological control of pests. Changing perceptions of the importance of the impacts of these introduced natural enemies on native plants and arthropod communities has altered the way in which we view and value these introductions.

My objectives in writing this were not to provide an exhaustive account of alien insects in the province. Rather, I hope to touch on some of the significant events surrounding introductions of insects over the past 50 years.

ALIEN SPECIES IN BIODIVERSITY

An important question one might ask is to what extent has the fauna of the province been modified by the presence of introduced species? In their checklist of the Hemiptera of Canada, Maw *et al.* (2000) identify the introduced species of each genus, by province. In the Cicadellidae, 42, or about 9%, of the 485 species present in BC are introduced. The family Miridae has been particularly well studied in BC by Geoff Scudder and colleagues. Among the subfamilies of the Miridae, 2 of 16 Bryocorinae, 0 of 28 Deraacorinae, 10 of 142 Mirinae, 7 of 67 Orthotylinae, and 12 of 79 Phylinae are introduced. Within the Miridae as a whole, 9% are introduced. Among the Aphididae, 19 of 41 *Aphis*, 5 of 8 *Acrythosiphum*, and 8 of 10 *Myzus* are introduced, but only 2 of 31 *Macrosiphum* are of exotic origin. Among the aquatic families, none of the Gerridae, Corixidae, or Notonectidae are introduced.

Scudder and Kevan (1984) provided a checklist of the Orthopteroid insects of British Columbia. Ten of the 130 species listed are identified as alien to the province. These include cockroaches, such as *Blatta orientalis* L. and *Periplaneta* spp., and the praying mantid *Mantis religiosa religiosa* L. Interestingly, all four of the species in Dermaptera are alien, but none of the 74 species in the Order Orthoptera are introduced. To this list can be added the Surinam cockroach, *Pycnocelis surinamensis* L. (Belton *et al.* 1986).

An estimate that from 8 to 10% of the insect species of BC are alien might be relatively accurate. The pest and beneficial species accidentally or deliberately introduced into the province certainly have economic impacts. However, not all alien species are pests. Since these aliens now form a substantial part of the provincial fauna, they are

almost certainly having impacts in a wide variety of habitats in the province. These impacts will have long-term environmental consequences and implications for conservation.

ALIEN SPECIES AS PESTS

In a report on the status of economic entomology in British Columbia, R.C. Treherne (1914), remarked that few of the pests troubling other agricultural areas of North America occurred in British Columbia. He attributed this to the application of quarantine to restrict the importation of these pests. Glendenning (1952), in a review of fifty years of entomology in the Fraser Valley, noted that the pest complex had changed dramatically following Treherne's time, and that British Columbia agriculture was then plagued by many insect pests. Most of these had been introduced into British Columbia since Treherne's (1914) report. The fifty years following Glendenning's remarks have also seen a dramatic change in the insect pest fauna in the province. The pages of the *Journal of the Entomological Society of British Columbia*, and its antecedent, the *Proceedings*, are liberally sprinkled with reports of new pest insects, and with comments on management of recently introduced species. These pests range from species that have had dramatic impacts on the face of agriculture and forestry in the province, to those whose presence is scarcely of significance except to those directly affected. Some of the more noteworthy, interesting, or just plain curious examples are treated in the following paragraphs.

The oriental fruit moth, *Grapholita molesta* (Bsk) (Lepidoptera: Tortricidae) was introduced into the Okanagan valley in 1956. This serious pest of peaches was rapidly quarantined and eradicated within 2 years (Touzeau and Neilson 1957, 1958). The oriental fruit moth continues to be a pest in Washington and Oregon, to the south, but ongoing quarantine measures have apparently prevented its re-invasion. It could be argued that this was the single most significant introduction into the province in the past 50 years, since it demonstrated the opportunities for quarantine and eradication provided by the geographic isolation of the province. Eradication of the grape phylloxera, *Phylloxera vitifoliae* Fitch (Hemiptera: Phylloxeridae), first detected in 1961 in the Okanagan, was attempted then abandoned (Morgan *et al.* 1973). The application of sterile insect release methods against the codling moth, *Cydia pomonella* (L.) and its eradication in the Similkameen Valley (Proverbs and Newton 1975; Proverbs *et al.* 1976) also took advantage of the geographic isolation of the fruit-growing regions of the province. In the current iteration of sterile insect release techniques to control codling moth in the Okanagan Valley, re-introduction from outside of the treated regions, and thus quarantine, remains one of the most serious problems for the program. The apple maggot, *Rhagoletis pomonella* (Walsh) (Diptera: Rhagoletidae), continues to be conspicuous in its absence from the province despite its presence in Washington State. Whether this is because of sound quarantine or good fortune cannot be determined.

The most controversial attempt at control by eradication in this province is certainly that against the gypsy moth, *Lymantria dispar* (L.) (Lepidoptera: Lymatriidae). The first of the recent introductions into the province occurred in 1978, and proposals to eradicate it by widespread application of pesticides to an urban area were met with considerable resistance. Since then, a program of detection of new infestations by pheromone trapping and eradication by application of Btk has been followed. The value of this program is controversial, since some introductions appear to have become extinct without treatment, and the potential for gypsy moth to cause economic impact through defoliation continues to be disputed (Myers *et al.* 1998). A study of the potential range of gypsy moth in the province (Hunter and Lindgren 1995) suggested that this pest would be restricted to the southwest through a combination of climate effects and host availability, and that the garry

oak, *Quercus garryana* Douglas (Fagaceae) zone would be the most affected. The most important impacts of the introductions of gypsy moth into BC have been the generation of a vocal opposition to all eradication attempts, and a general erosion of the public perception of both entomologists and biological control in the province.

The winter moth, *Operophtera brumata* L. was first found in British Columbia in 1977 in Victoria, BC, but had apparently been introduced some years earlier (Gillespie *et al.* 1978). Two exotic parasitoids, *Cyzenis albicans* (Fall.) (Diptera: Tachinidae) and *Agrypon flaveolatum* (Gravely) (Hymenoptera: Ichneumonidae) were introduced (Embree and Otvos 1984). This pest was brought under control by the action of endemic generalist predators, but is regulated under non-outbreak conditions by the exotic parasitoids (Roland 1994; Roland and Embree 1995). The winter moth has since spread to the lower mainland, where it is a pest of highbush blueberry crops (Fitzpatrick *et al.* 1991; Sheppard *et al.* 1990).



Severe defoliation of willows (shown here) and many other wild and domesticated trees and shrubs was caused by winter moth, *Operophtera brumata* in the Victoria, British Columbia area in the 1970s. Invasive pests such as this have long-term economic and environmental consequences.

Photo by N.V. Tonks (deceased)

One of the significant legacies of the introductions of the gypsy moth and winter moth was the creation of the BC Plant Protection Advisory Council (BCPPAC). This inter-agency group, comprising representatives from provincial and federal departments, industry and universities, has facilitated communication and joint action on pests and pest threats, and also provides a forum for review of proposals for introductions of biological controls of weeds.

The European crane fly, *Tipula paludosa* Mg. (Diptera: Tipulidae) was first observed as a serious pest problem in BC in 1964, and was probably introduced some years earlier (Wilkinson and MacCarthy 1967). These authors noted heavy infestations causing extensive damage to pasture and horticulture crops, and consequent extensive use of organo-chlorine insecticides. Although releases of the parasitoid *Siphona geniculata* De Geer (Diptera: Tachinidae) established successfully, there is no evidence that the decline in *T. paludosa* numbers was due to the parasitoid (Wilkinson 1984). In all probability, the

decline was due to the combined action of several diseases (Wilkinson 1984). Recently, a second exotic crane fly species, *T. oleraceae* L. has been found in the Fraser Valley (Costello 1998) which may add to injury to horticultural and pasture crops in the area.

The European pine shoot moth, *Rhyacionia buoliana* (Schiff.) (Lepidoptera: Tortricidae) and the balsam wooly adelgid, *Adelges piceae* (Ratzeburg) (Hemiptera: Adelgidae) were both first reported in the 1960s and were considered serious threats to forestry in the province (Harris and Wood 1967, Wood, 1968). Although *A. piceae* has restricted the replant of *Abies* spp. (McMullen and Skovsgaard 1972; Carrow 1973), no direct losses seem to have occurred. Similarly, *R. buoliana* does not appear to attack *Pinus contorta*, the major economic pine species in the province. The oak-ribbed casebearer, *Buccalatrix ainsliella* Murtf. (Lepidoptera: Lyoneliidae) has established on red oak, *Quercus rubra* L. (Gelok *et al.* 1998) planted as roadside trees in Vancouver. Larvae pupate on almost any surface available, regardless of make or model, causing some consternation in upscale neighborhoods. Although this species does not constitute an economic threat, it and other invasive oak herbivores pose a problem for conservation of garry oak meadows. Of the current threats to BC forests from introduced pests, the importation of wood-boring beetles in dunnage and crating seems to be the most dire (e.g. Humphreys and Allen 1999; Wulf 1999). Based on literature searches, no introductions appear to have established in BC forests.

Other pest introductions of note include the lettuce aphid, *Nasonovia ribisnigri* (Mosley) (Homoptera: Aphididae) (Forbes and MacKenzie 1982), an asparagus aphid *Brachycolus asparagi* Mordivillo (Homoptera: Aphididae) (Forbes 1981), the strawberry tortrix, *Acleris comariana* (Zeller) (Lepidoptera: Tortricidae) (Cram 1973), and the German yellowjacket wasp, *Paravespula germanica* (F.) (Hymenoptera: Vespidae) (Gerber 1990). Recently, the viburnum leaf beetle, *Pyrrhalta viburni* (Paykull) (Coleoptera: Chrysomelidae) and a hemerocallis gall midge, *Contarinia quinquenota* (Diptera: Cecidomyiidae) were reported for the first time in BC (Anon 2001).

Accidental introduction of exotic species is not the only way in which introduced species arrive. Deliberate introductions of biological control agents have also added to the fauna. Biocontrol introductions in Canada, including those made into BC, have been reviewed (Kelleher and Hulme 1984, Mason and Huber, in press). However, these works do not necessarily account for the accidentally introductions and range extensions of putatively beneficial species. *Harmonia axyridis* Pallas and *Coccinella septempunctatum* L. (Coleoptera: Coccinellidae) come to mind as dramatic examples in the latter category, but others have occurred recently, for example aphid parasitoids (Mackauer and Campbell 1972) and a staphylinid beetle (Puthz 1972). Range extensions have also resulted in invasions of new pests, for example the western grape leafhopper, *Erythroneura elegantula* Osborne (Hemiptera: Cicadellidae), (Philip 1998), and a tentiform leafminer, *Phyllonorycter mespilella* (Hübner) (Lepidoptera: Gracillariidae) (Cossentine and Jensen 1992).

The past 50 years of introductions should not be discussed in isolation from the entire complex of alien species in the province. In fact, many of the most serious of our agricultural pests arrived very early in the previous century, and continue as pests to this day. Because of their long residence in the fauna of the province, it might even be argued that these species are now endemic. Redistribution and range extensions of pests such as European wireworms, *Agriotes lineatus* L. and *A. obscurus* L., (Coleoptera: Elateridae) introduced at the turn of the previous century (Wilkinson *et al.* 1976; Vernon and Päts 1997), underscore the long-term costs of management of introduced pests.

Impacts of beneficial species introduced either deliberately or accidentally, on native fauna are becoming a serious issue in pest management and conservation, yet there is no

comprehensive inventory of these species in our province, let alone the resources to consider such important questions as current geographic and host range. With trends to globalization of world trade in the last two decades of the 20th century, I expected to see an explosion of reports of new pest species and exotic introductions in the scientific literature of the past two decades. The reverse seems to be true – there appears to be a noticeable decline in reporting of new pests in scientific journals in the 1990s. Four of the species noted in the past 5 years have been reported in trade magazines and in-house publications, not in mainstream scientific literature. I can imagine many reasons for these trends. Is society becoming so "globalized" that there is no alarm over the appearance of new pests, which are simply viewed in the context of pest management, not from the perspective of potential disruption of native ecosystems? Have resources available to entomologists in this province become so restricted that free publication in trade and in-house magazines is the only option available? Have taxonomic and systematics resources declined to the point that it is impossible for economic entomologists to obtain authoritative consultations and identification on species of concern? Has the size of the entomological community in the province finally declined to a point where we are no longer able to recognize and address new threats to our health and food, fibre and forest production? In view of the continuing loss of entomology professionals in the province, the loss of resources for public-good research, and the emphasis on results-driven research for clients, I fear that all of the above have some vestige of truth. Given the continued threats that further introductions of alien species pose to the economic and social well-being of the province, it is essential that professional and amateur entomologists continue to place these issues in front of the public and argue for the much needed resources.

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