

## **Greenhouse Biological Control Commercial Development in Canada and the Development of Industry Standards**

Greenhouse biological control has a long history in Canada. The whitefly parasite *Encarsia formosa* was first obtained from the Cheshunt Experimental Station in England in 1935 and mass production was started by J.H McLeod at the Dominion Parasite Laboratory in Ontario. McLeod shipped more than 18 million *Encarsia* parasites to Canadian greenhouse growers from 1938-1954. He reported that the parasites had been sent by railway and ship to Newfoundland as well as by rail to all provinces of the Dominion. Unfortunately, with the development of DDT and other new pesticides in the '40s the mass production of the parasites was all but discontinued by 1955.

In the 1970's pesticide resistant spider mite and whitefly appeared and this led to renewed interest in alternative control measures. Researchers in Canada and Europe began work again on parasite and predator mass rearing and a commercial greenhouse biological control industry began to develop. At first this consisted of only a few small companies and these worked closely with local government research facilities and agricultural advisory services. Important research on mass production was conducted by N.E.A. Scopes in 1969 at the Glasshouse Crops Research Institute in England. Scopes developed and published improved methods of mass rearing the whitefly parasite *E. formosa* and the spider mite predator, *P. persimilis*.

In Canada, *Encarsia* mass production was started up again in Ontario in 1970-1972 at the Agriculture Canada Harrow Research Station and a publication "Integrated Control of the Greenhouse Whitefly" by R.J McClanahan was produced as a biological control guidebook for tomato and cucumber growers. In 1973, whitefly parasite production costs were supported by the Ontario Greenhouse Vegetable Producers Marketing Board and 4 million parasites were supplied to local growers. In 1974 in Ontario, Pat Reeves formed Better Yield Insects Co., and started small scale commercial production of *Encarsia* and *Persimilis*. In Western Canada, Norm Tonks began rearing *Encarsia* and *Persimilis* at Agriculture Canada Saanichton Research Station in Sidney, British Columbia in 1973. This enabled a pilot program of biological control for whitefly and spider mite to start in British Columbia vegetable greenhouses in 1978 and in 1980 led to commercialization and the formation of Applied Bio-Nomics Ltd. In British Columbia, rapid research, development and commercialization was facilitated by the active cooperation of individuals from the greenhouse industry, research and extension entomologists and federal and provincial funding agencies. Critical to this process were the growers who took part in the biological control programs and the British Columbia Greenhouse Growers Research Council which provided funding and practical direction for the research. Linda Gilkeson working at Applied Bio-Nomics in 1986, developed rearing, release methods and non-diapausing lines of the predatory aphid midge, *Aphidoletes aphidimyza*. In 1981, Bob Costello, of the B.C. Ministry of Agriculture published a British Columbia growers' handbook on Integrated Control of Mites and Whiteflies in Greenhouses. In 1982, George Purich and Norm Tonks published a method of integrating the use of insecticidal soap with *Encarsia* for greenhouse whitefly control.

In 1983 Marilyn Steiner working at the Alberta Environment Centre and Muttart Conservatory in Edmonton and Don Elliott working at the Crystal Gardens in Victoria,

developed and published a handbook on biological pest management techniques for use in interior plantscapes. In 1986, Dave Gillespie and Don Quiring working at Agriculture Canada in British Columbia developed and published the use of sticky yellow traps as an early detection and monitoring tool for greenhouse whitefly and thrips. In 1993 in Ontario, a pyrethroid resistant strain of *Amblyseius fallacis*, was developed by Howard Thistlewood at Vineland Research Station. At Agriculture Canada London Research Station, Jay Whistlecraft developed mass rearing systems for *A. fallacis* (1993) and the spider mite predatory beetle, *Stethorus punctillum* (1996). The use of *A. fallacis* and *S. punctillum* was licensed to Applied Bio-Nomics Ltd. by Agriculture Canada for biological control applications on green house and field berry crops. Dave Gillespie also developed a number of new biological control agents: the thrips and fungus gnat predatory mite, *Hypoaspis aculeifer* (1990); the spider mite predatory midge, *Felteilla acarisuga* (1994), the looper parasite, *Cotesia marginiventris* (1997) and the predatory whitefly Mirid bug, *Dicypus hesperus* (1999).

Large volumes of live biological control agents are now being shipped around the world by a large number of commercial producers. This has attracted the interest of regulatory agencies and created some restrictions on importation and use. In 1991 a workshop was held in the Netherlands under the International Association of Biological Control (IOBC) to work towards self regulation and developing quality control standards for mass reared arthropods. This was primarily a European initiative although some members from Canada and other countries attended these sessions. Initially, the commercial producers resisted working together on this initiative but after considerable discussion from government and university scientists, a common ground was reached. J.C. van Lenteren from Wageningen University in the Netherlands, played a large part in assisting with this process, bringing researchers and commercial producers together and helping to obtain funding from the European Union and the IOBC for a series of quality control workshops. It was decided at these workshops that the main focus would be on quality control characteristics which were relatively easy to determine in a laboratory (e.g. numbers, emergence, sex ratio, lifespan, fecundity, adult size, predation and parasitization rate). The guidelines referred to product control procedures, not internal production or process controls which were considered trade secrets. Guidelines were designed to be as uniform as possible so they could be used as a standard by many producers and were designed to be carried out by the producer after all handling procedures just before shipment. It was suggested that the grower only perform the basic quality check test of emergence or number of live adults. The guidelines were usually written by 2 or more producers with the assistance of government and university scientists and the results were re-evaluated and modified as necessary at following workshops. As a result of this work after 8 years, there are IOBC quality control guidelines for more than 20 biological control agents. This and earlier work on biological control selection and mass rearing is an example of excellent cooperation between commercial producers and scientists.

In Canada biological control agents fall under the Pest Control Products Act which currently regulates pesticides. An attempt was made to register commercial biological control agents in Canada in 1993 but this was abandoned in favor of harmonization with USA regulations. The USA Agriculture Department attempted to regulate biological control agents in 1995 but unfortunately classified them as plant pests. This move was strongly opposed by the both the scientific community and the biocontrol industry and the proposed regulations were eventually withdrawn. In some countries (France, Japan) there are now regulations and registration requirements that restrict the use of biological control agents. To prevent over-regulation and develop workable standards to deal with

issues such as quality control, registration, legislation and ethics, the biological control industry is continuing toward improved standards and self regulation. In North America, in 1990, the Association of Natural Bio-control Producers (ANBP) began developing product profiles and industry standards for biological control products and in 1998 began working with the American Society for Testing and Materials (ASTM) to formalize these standards. In Europe an International Biocontrol Manufactures' Association (IBMA) has been formed to also deal with these issues.

**TABLE 120.1**
**A History of Canadian Greenhouse Biological Control Showing Contributions to Research and Development for Commercial Applications**

YEAR	NAME AND ASSOCIATION	BIOLOGICAL CONTROL AGENT OR RELATED IPM CONTRIBUTION
1935	J.H McLeod, Dominion Parasite Lab, Ont.	Encarsia mass rearing for whitefly control
1970	R.J. McClanahan, Ag. Canada Harrow, Ont.	Encarsia mass rearing, growers IPM Guide
1974	P. Reeves, Better Yield Insects, Ont.	Encarsia commercial production and sales
1975	N. Tonks, Ag. Canada Saanichton, B.C.	Encarsia and Persimilis mass production
1978	R. Costello, D. Elliott, B.C. Min. of Agriculture	Encarsia, Persimilis, Vegetable Growers IPM Guide
1980	D. Elliott, Applied Bio-Nomics Ltd.	Encarsia, Persimilis commercial production and sales
1982	G. Purich, N. Tonks, Ag. Canada, B.C.	Insecticidal Soap, IPM, whitefly, Encarsia
1983	M. Steiner, D. Elliott, Alta. Environment	Biological Pest Management for Interior Landscapes
1984	R. Costello, D. Elliott, D. Gillespie	Verticillium lecanii testing on whitefly, aphids, thrips
1986	D. Elliott, D. Gillespie, Applied BioNomics	A. cucumeris, commercial production and sales
	L. Gilkeson, S. Hill, Macdonald College.	Aphidoletes diapause prevention using low intensity light
1987	D. Gillespie, D. Quiring, Ag. Canada, B.C.	Yellow Sticky Traps, Monitoring, IPM
	D. Gillespie, D. Quiring, Ag. Canada, B.C.	Hypoaspis mass rearing, IPM
1989	L. Gilkeson, D., Elliott, Applied BioNomics	Hypoaspis IPM R&D, commercial production
	W. Bond, D. Elliott, Applied BioNomics	Aphidius matricariae commercial production
	A. Hale, Natures Alternative Insectary	Cryptolaemus commercial production
1990	L. Gilkeson, Applied BioNomics Ltd.	Aphidoletes, Aphidius, IPM, peppers, tomatoes
	L. Gilkeson, Applied Bio-Nomics Ltd.	Orius tristicolor, R&D, commercial production
1991	L. Gilkeson, D. Morewood, D. Elliott, App. Bio.	A. cucumeris diapause, Orius tristicolor for thrips control
1992	R. Costello, D. Elliott, L. Gilkeson, D. Gillespie,	B.C. Min. of Agriculture, Vegetable Growers IPM Guide
1993	J. Matteoni, Applied Bio., Westgo, Plant Prod.,	Biological Control Manual, IPM, greenhouse crops
	L. Gilkeson, W. Bond, Applied Bio-Nomics.	Deraeocoris R&D, commercial mass production
	H. Thistlewood, Ag. Canada, Ag. Can. Vineland	Pesticide Resistant Predatory Mite, A. fallacis
1994	H. Thistlewood, J. Whistlecraft, Ag. Can., London	A. fallacis pesticide selection and mass rearing
	D. Gillespie, Ag. Canada, B.C.	Feltiella selection, mass rearing, IPM
	D. Elliott, Applied Bio., B.C. Growers Res. Council	Delphastis, Degenerans mass rearing, IPM
1995	J. Whistlecraft, Ag. Canada, Vineland	Stethorus pilot mass rearing R&D
	D. Elliott, Applied BioNomics	Stethorus commercial production and sales
	A. Hale, Natures Alternative Insectary	Feltiella commercial production and sales
1998	A. Hale, Natures Alternative Insectary	Podisus commercial production and sales
1999	D. Gillespie, R. McGregor, G. Opit, Ag. Can. B.C.	Cotesia selection, mass rearing, IPM
	McGregor, Gillespie, Quiring, Ag. Can. B.C.	Dicyphus selection, mass rearing, IPM
1997	S. Bjornson, M. Steiner	Persimilis quality control
2000	R. Rea, Applied Bio-Nomics Ltd.	Cotesia, Dicyphus commercial production and sales
	S. Bjornson, D. Raworth, Ag. Can. B.C.	Persimilis, Evaluation & Quality Improvement