*artemisiifolia*. Trudy Khar'kovskogo Sel'skokhoziaistvennogo Instituta ("Urozhai," Kiev) 85(122):100-101.
Rudakov, O. L., 1961. Fungal Parasite of Orobanche, its Culture and application (Grubnoi Parazit Poviliki, ego Vyrashchivanie i Primenenie). Academy of Sciences, Kirghiz S.S.R., Frunze, 65 pp.
Stankevich, G. L., 1971. Concerning a specialized form of *Colletotrichum lagenarium* Halst. et Ell. on *Orobanche aegyptiaca*. Mikologiya i Fitopatologiya 5(2): 208-211.
Timchenko, V. I. and Dovgal', E. S., 1972. Microbiological control of *Orobanche* sp. on vegetable crops. In: Biological Method of Controlling Pests of Vegetables (Biologicheskii Metod Bor'by s Vreditelyami Oboshchnykh). "Kolos", Moscow, pp. 109-111.
Vyalykh, A. K. and Zheryagin, V. G., 1976. *Albugo tragopogonis* Schroet. on *Ambrosia artemisiifolia*. Karantin Rastenii ("Kolos," Moscow) 19: 57-60.
Vyalykh, A. K. and Zheryagin, V. G., 1977. The conditions of infection of *Ambrosia artemisiifolia* with *Albugo tragoponis* Schroet. Mikologiya i Fitopatologiya 11(2): 135-140.

# Advances in and Outlook for Development of Biological Control to Protect Plants Under Glass in the U.S.S.R.

Georg A. Beglyarov

Chief, Laboratory of Biological Control
All-Union Research Institute of Phytopathology
143050 Moscow, U.S.S.R.

Most of the glasshouse acreage in the Soviet Union is used to grow cucumbers, tomatoes and greens (lettuce, celery, etc.), which are damaged by many species of pests, either naturally distributed outdoors in a given locality or imported from some other area. Until recently, only chemical control has been used to protect plants under glass during their vegetation period. The first attempts at biological control application in the glasshouse did not lead to a practical solution of the problem (Zorin, 1932, 1934)[1]. However, an important conclusion was made as a result of those studies; i.e., that ". . . artificial rearing of predatory insects and their release into glasshouses may probably substitute in certain cases for control measures of a chemical nature" (Zorin, 1934). Another attempt was made thirty years later, after introduction of the predator mite *Phytoseiulus persimilis* A.-H. in the U.S.S.R. to control spider mites, the main pests of greenhouse crops (Beglyarov et al., 1964). Solving the problem of biological control of spider mites under glass using *P. persimilis* was a practical success. The technique of mass rearing and application of this predator is detailed in many published papers, so there is no point in discussing it again here. Let me only mention that the procedure of repeated inspections of glasshouses and release of the acariphage on infested plants is used in the U.S.S.R. According to the data of the USSR Ministry of Agriculture for 1978, *P. persimilis* was successfully used on a total area of over 19,000,000 square meters.

During widespread commercial use of *P. persimilis* it was discovered that elimination of repeated chemical treatments against spider mites creates conditions for relatively free multiplication of another group of hazardous pests, aphids. Application of chemicals toxic to aphids, because of their toxicity to *P. persimilis*, provokes certain difficulties in biological control of spider mites. Therefore, in the last decade scientists in our country have given great attention to solution of this contradictory problem. Two main trends have been developed: 1) discovery and use of a *P. persimilis* population resistant to organophosphorous pesticides; and 2) development of biological control of aphids.

A resistant population of *P. persimilis* was found near Antibes, France, introduced into the U.S.S.R., additionally selected with the purpose of increasing the resistance level and is now being widely tested in commercial glasshouses.

A great number of species of predators and parasites has been studied to develop biological control of aphids. Two species of chrysopids, *Chrysopa carnea* Stephens and *C. septempunctata* Wesmael, and the dipterous predator *Aphidoletes aphidimyza* (Rondani) have been studied at greatest length. Various methods for their practical usage have been proposed. Unfortunately, the effectiveness of the chrysopids when applied to aphids on cucumbers is unstable and dependent on many factors (type of sheltered ground, variety and age/size of plants, size of population, light conditions, temperature, and others). It was discovered that chrysopids do not establish and do not multiply independently in the glasshouse. That is why they can be effectively used only as a "live insecticide," i.e., not relying upon independent multiplication of the predators in the glasshouse. Such an application of entomophages proves to be too laborious and must always be economically justified. Judging by the data of N. V. Bondarenko, the use of *A. aphidimyza* looks more promising and has been undergoing extensive commercial trials for several years (on a total area of over 200,000 and 400,000 square meters in 1976 and 1977, respectively).

A possibility of a combined application of those aphidophages is under study now, taking into account that chrysopids show their highest efficiency at a high host population density, whereas *A. aphidimyza* is most efficient at a low host density.

In addition to entomophages, some methods are being developed involving pathogens, entomogenous fungi in particular, to control aphids and certain plant pathogens. However, these methods are still at an experimental stage and cannot yet be recommended for practical use.

Development of biological control of aphids is of special importance for greens, since application of any chemical compound to these crops is not allowed. Our studies show that this problem is successfully solved with *Chrysopa carnea*. Thanks to the fact that the release rates of the predator onto greens are comparatively small, the expenditures for rearing and application of the predator are repaid by an increase in product quality. The biological control of aphids on greens is being successfully put into practice.

The final solution of this problem on cucumbers needs further study including, in the first place, improvement and mechanization of mass-rearing techniques and release of previously screened aphidophages, as well as a search for species able to multiply independently in glasshouses and to control aphids there.

A recent steep increase in the numbers of and damage caused by the greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood), on tomatoes, cucumbers and other crops under glass in some areas of the U.S.S.R. is probably related to intensive development of glasshouse farming and the lengthening of the vegetation period. A well-known parasite, *Encarsia formosa* Gahan, used on a practical basis in a number of countries, and entomogenous fungi of the genus *Aschersonia*, previously introduced to control the related

[1] Editor's Note: No list of references cited was provided by the author.