Studies have been conducted recently in the Republic on the discovery of local species of *Trichogramma* that parasitize eggs of *Cydia pomonella*, and on technology for the mass-culture and field application of these parasites. In particular, the following local forms of *Trichogramma* have been discovered in the Armenian S.S.R.: *T. euproctidis* (Girault), *T. evanescens* Westwood, and *T. embryophagum* (Hartig). All of the local forms of *Trichogramma* discovered were found in the second half of July. It is interesting to note that *T. euproctidis* and *T. evanescens* were discovered in eggs of *C. pomonella* only in the lower story of the apple tree, whereas *T. embryophagum* was found on eggs in the upper story. It has been established that the latter species is very promising for the control of *C. pomonella* because it has no males on the one hand, and is readily mass-cultured on the other hand.

Pseudococcus comstocki (Kuwana) causes great damage to fruit trees, especially to mulberry, in the Republic. The biological characteristics of the pest, and of beneficial species parasitizing it, have been thoroughly studied. It has been established that under the conditions of the Armenian S.S.R. there is an abundant complex of entomophages of this pest. The following species have been discovered in recent years: Hymenoptera—*Pseudaphycus malinus* Gahan, *Allotropa convexifrons* Muesebeck, *Anagyrus pseudococci* (Girault), *Pachyneuron concolor* (Förster), *Chartocerus subterraneus* [sic][4]; Coleoptera—*Adalia bipunctata* (L.), *Exochomus quadripustulatus* (L.), *Scymnus bipunctatus* Kugelann; Neuroptera—*Chrysopa carnea* Stephens; Diptera—*Leucopis annulipes* Zetterstedt (= *alticeps* Czerny); and Lepidoptera—*Hypsopygia costalis* (Fabricius). It has been established that among the list of entomophages of *Pseudococcus comstocki*, *Pseudaphycus malinus* is a highly effective parasite. This species is currently being applied extensively on farms with a high degree of efficiency.

Numerous other species of scale insects also cause damage to fruit crops in the Armenian S.S.R. The Institute of Plant Protection is developing an integrated method for their control. The major parasitic fauna of these harmful scale insects has been investigated. The useful role of this fauna in the regulation of populations of *Didesmococcus unifasciatus* (Archangelskaia) and *Lepidosaphes malicola* Borchsenius has been studied. Effective insecticides have been selected and dates of their application have been established with consideration of the preservation of the entomophages of these pests in mind.

[4]Editor's Note: = *C. subaeneus* (Förster)?

Development, Use and Management of Insecticide-Resistant Natural Enemies of Orchard Pests in North America[1]

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In deciduous tree fruit orchards of North America, particularly in apple orchards, resistance to organophosphate-based (O-P) insecticides has developed uniquely among certain secondary arthropod pests and natural enemies, but not among the major key insect pests associated with this crop (Croft and Hoyt, 1978; Croft, 1979). These significant developments have improved possibilities for biological control by the manipulation of natural enemies, and have increased the effectiveness and stability of pest control systems for this entire crop-pest complex. Management of apple pests and natural enemies relative to pesticide resistance is becoming a feasible strategy associated with chemical usage (Croft, 1979). In the future, more long-term cycles of pesticide use and chemical conservation may be possible via these types of approaches to integrated pest management. The more specific details of these research developments and implementation applications relative to biological control of orchard pests, particularly in North American orchards, are discussed here.

The Pattern of O-P Resistance in North American Orchards

Insecticide resistance to O-P compounds, and in particular to azinphosmethyl, has not been reported for any major key pest of apple (i.e., codling moth - *Cydia* (= *Laspeyresia*) *pomonella* (L.), plum curculio - *Conotrachelus nenuphar* (Herbst), apple maggot - *Rhagoletis pomonella* (Walsh), redbanded leafroller - *Argyrotaenia velutinana* (Walker)), even though these compounds have been widely used for the past 20 to 30 years in most fruit-growing areas of North America. Plausible explanations for the lack of resistance in these species may be related to their functional biological characteristics, their toxicological response to these agents and to the way O-P treatments have been applied over this time period. More specifically, Croft (1979) cites as reasons for the observed lack of resistance in these species: 1) the highly dispersive nature of these species and their tendency to migrate into orchards from wild, untreated environments; 2) the short residual life of these chemicals; 3) selection pressure is mainly on a single life stage of these species, usually the adults; 4) certain generations of these pests are left untreated; 5) selection pressure has been reduced through time; 6) rotation of different O-Ps with dissimilar modes of action have been used; and 7) azinphosmethyl resistance may be unstable and susceptible to resistance reversion. (See later discussion of these factors.)

Among secondary pests of apple, developed resistance patterns have been very different from those described above. Species such as mites, aphids and leafhoppers, which have rapid rates of reproduction, all life stages exposed to insecticide treatments, low dispersal rates and relatively high host specificity, have developed resistant strains quickly, within the first five to 15 years of O-P use. Fortunately, these species have predators and parasites which provide significant biological control when not affected by chemicals used for key pest control. There was a difficult transition period in the late 1950's and early 1960's with the development of resistant secondary pests and greatly suppressed populations of natural enemies. However, with the continued O-P use (because of the continued effectiveness of these compounds on the key pests), there developed a number of pesticide-resistant natural enemies in the period from the mid-1960's to the present.

The first evidence of widespread resistance beyond the pest trophic level came among predators of plant-feeding mites, including the phytoseiid mites *Typhlodromus occidentalis* Nesbitt

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