Romanian Journal for Plant Protection, Vol. VII, 2014
ISSN 2248 – 129X; ISSN-L 2248 – 129X

BIOLOGICAL CONTROL RESOURCES FOR A SUSTAINABLE GREEN PEACH APHID CONTROL IN GREENHOUSES – A REVIEW

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Abstract: For a great period of time, in crops where natural enemies for pests were introduced, aphids couldn't be fought against efficiently with the help of selective pesticides that had less harmful effect of useful fauna. With the development of a resistance to such pesticides, new control methods were needed and the use of entomophagous agents and entomopathogenic microorganisms came as an obvious solution. The use of biological control methods needs a deep knowledge of the biology for the species we work with as well as an understanding of the interactions in the agroecosystems created through agricultural practices. The results of using these methods for pest control can be satisfying, but 100% efficiency is rarely obtained. Still, the balance maintained between species, by an efficient manipulation of the environment, is possible and the understanding of this ecosystem can bring us closer to a healthier agriculture and more careful to the impact it has on environment. In this review paper, we will give an overall introduction to biological control resources for dealing with green peach aphids in greenhouses.

Key words: biological control, aphids, Myzus persicae, greenhouses

INTRODUCTION

Research regarding the use of methods for biological control in greenhouses started before the 2nd World War, by using the parasite *Encarsia formosa* Gahan 1924 (Hymenoptera: Aphelinidae) against the white fly *Trialeurodes vaporariorum* Westwood 1856 (Hemiptera: Aleyrodidae) (Speyer, 1927). In 1930, Cheshunt Experimental Research Station from Great Britain, provided more than a million of such wasps for approximately 800 farms in the UK, 18 million being exported in Canada, and later this hymenopter reached also the farmers in Australia and New Zeeland (Hussey and Bravenboer, 1971). After the 2nd World War, this control method faced a downfall due to the DDT (dichlorodiphenyltrichloroethane), a contact pesticide which efficiency was highly superior to the biological control method, especially due to the high spectrum of action. The side effects on human's health and environment lead in the '70s to the ban of DDT in industrialized countries and from 2004, through the „Convention in Stockholm".

The publications of Romanian researchers regarding the knowledge of the purpose of entomophagous species in limiting, naturally, certain pests for agricultural and horticultural plants contributed to knowing the importance of balanced ecosystems. The volumes published by Perju et al. (1988, 1989), Lăcătuşu and Filipescu (1989) and Ciochia (1976, 1986) have a major importance.

In many countries of Europe, companies have been developed for mass rearing insects or manufacturing bio-products. Unfortunately, Romania remained among the last countries in this field. The homologation of biological products is an extremely difficult process and especially expensive. In the useful microorganism collection from RDPP there are in-house strains of which effectiveness in biological control of diseases and pests was tested and confirmed in laboratory and field assess. Years ago, there was a special interest for *Bacillus thuringiensis* strains in RDPP collection. This bacterium was permanently tested and inoculation charges were used in Biosynthesis Factory from Calafat city (Dolj County, South-Western Romania) where mass production of a biopesticide was developed. The first production capacity was Thuringin, a *Bacillus thuringiensis* based biologic insecticide, non-polluting for human and animals. The factory has extended on 11 ha during the communist era, and had used grain corn, sun flower and corn grit as raw materials. After the '90s, the factory was privatised and it was closed a few years later. At this moment, companies like Bayer, Koppert, Biobest, Syngenta Bioline etc have branches and distributors in Romania, therefore biological products are accessible also for Romanian farmers.

Information regarding the biological control of aphids was synthesized by Carver (1989) in the paper "Biological control of aphids". This subject has known an increasing interest since then, and the marketing of natural enemies for biological of aphids is now in full development, being used on a large scale in greenhouses, the more as these insects began to evolve resistance to chemical products. Many studies published all around the world contributed to a better knowledge of the complex aphid-entomophagous-entomopathogens (Byford and Reeve, 1969; Nielsen, 2001; Barta and Cagáň, 2006; Keller, 2007; Roditakis et al, 2008; Hajek et al.2009).

In Romanian scientific literature, important data regarding natural enemies of aphids were presented in the series of *Fauna României* - Braconids (Lăcătuşu and Filipescu, 1989). Peiu and Filipescu (1960) described parasitoids of harmful insects for agriculture. Ciochia and Boieriu published in 1996 a comprehensive synthesis of researches performed on this subject in Romania. A great contribution has been brought by Baicu (1978), Balaj (1960), Bărbulescu (1972, 1973, 1974), Ciochia and Stănescu (1977), Constantinescu (1972, 1976), Hulea (1977), Perju and Ghizdavu (1980), Săvescu (1944-1957; 1960, 1961), Săvescu and Rafailă (1978), Suta et al. (1974) and Mustaţă (2000) with respect to control methods of aphids in agriculture and horticulture crops, including the greenhouse crops.

In this paper we review some of important aspects on aphid biology and natural enemies of green aphid *Myzus persicae*.

General aspects regarding the concept of biological control

"Biological control" was defined by Eilenberg et al. (2001) as being "the use of living organisms to suppress the population density or impact of a specific pest organism, making it less abundant or less damaging than it would otherwise be"

Biological control is made using three methods (Van Driesche and Bellows, 1996): (i) "classical biological control", involving the introducing of natural enemies in geographic areas where they don't exist naturally, for the purpose of limiting species introduced accidentally; (ii) "augmentative biological control", involving the mass increase and releasing of natural enemies already existing in the system, that don't normally occur naturally in sufficient numbers or the right time to control the excessive breeding of targeted pests; and (iii) "conservation biological control", including the consolidation of wild populations of entomophagous agents and entomopathogens naturally occurring in that ecosystem, through an efficient management of habitat or by means of their behaviour manipulation.

Eilenberg et al. (2001) described four strategies of biological control: (i) "classical biological control", (ii) "inoculation biological control", (iii) "inundation biological control" and (iv) "conservation biological control".

The biological control of aphids in greenhouses can be made also using natural extracts, of which the most efficient in greenhouses from The Netherlands proved to be pyrethrin extracted from the *Chrysanthemum cinerariifolium* and *C. coccineum* flowers. (Dinu et al., unpublished data) There are many products based on this substance on market and they are allowed in ecological cultures (e.g.: Spruzit, Biobest manufacturer). Other natural insecticides used against aphids can also be made with garlic, hot pepper or nettle, but their effects aren't that efficient than those based on pyrethrin.

Main aphids of plants cultivated in greenhouses and general information on their biology

Aphids, known as plant lice, form a very large group of insects, respectively the superfamily Aphidoidea (Hemiptera Order, Homoptera sub-order).

The Aphididae family includes a lot a harmful species for cultivated plants and of these the most important aphids **known in greenhouses** are: *Myzus persicae* ssp. *persicae* Sulz. (green peach aphid), *M. persicae* ssp. *nicotianae* Blackman (tobacco aphid), *Aphis gossypii* Glover (melon aphid or cotton aphid), *Macrosiphum euphorbiae* Thomas (potato aphid) and *Aulacorthum solani* Kaltenbach (foxglove aphid) (Malais and Ravensberg, 2003).

The development of aphid colonies depends of several factors, of which the most important are: species and quality of host plant, climate conditions, population density and presence of natural enemies. Under optimum conditions, aphids reach maturity in 6-7 days. They have a high rate of breeding due to their biology: aphids breed mostly parthenogenetically (they breed only like this in greenhouses), are viviparous and a single female gives birth to 40-100 new individuals, with a rate of 3 up to 10 per day, for a few weeks. Aphid generations are what specialists call „telescopic generations", the nymph development inside the insect starting together with its birth. Once it reaches maturity, the aphid can starts the reproduction, because some new young aphids are already under development and ready to give birth in her body. Immediately after birth, the nymph stings the plant and starts to feed on sap of phloem vessels. Until maturity, aphids shed 4 times, the white colour of exuviae helping to early identify their presence in cultures (Figure 1).

Aphids have a complex life cycle, depending on the conditions they develop in, being able to exist in same time with wings (alate) and wingless (apterous). In case of winged forms, the thorax is more developed, due to the fact that it must sustain the two pairs of wings (of which one is bigger than the other) (ANNEX I). The main differences between the two forms are presented in Table 1.

The occurrence of winged forms is directly related to high density of population, degradation degree of the infested plant, abiotic and genetic factors. The colony size, respectively, high density of individuals on a plant, is the main factor determining this metamorphosis. An interesting characteristic of the Aphididae family is that females with wings may lay eggs or give birth to wingless offspring (Moran, 1992). This insures the colonization of the plant chosen by the first offspring of the winged one. Polymorphism allows aphids to adapt to environmental changes and can migrate to other plants where they can initiate a new colony. According to Malais and Ravensberg (2003) the air currents can carry the winged aphids to long distances, up to 1300 km.

Due to the fact that aphid breeding in greenhouses is exclusively asexual, aphid colonies are usually clones of a single individual. Therefore, in the absence of genetic recombination, the resistance of aphids to pesticides remains unaltered.

Aphids can be divided in two categories, depending on the biological cycle: some species change the host plant during winter and some species don't (Figure 2).

Aphids that alternate species of host plant breed asexually during summer time, and in winter they migrate on other herbaceous or wooden plants, where they breed asexually and lay eggs. Aphids that alternate hosts have a holocyclic-dioic life cycle. Aphids in greenhouses develop an incomplete lifecycle (anholocyclic) and their multiplication is exclusively by partenogenesis.

Myzus persicae **(Sulzer, 1776) – description and control methods**

Synonymies: *Rhopalosiphum dianthi* (Henrich, 1896; Borcea 1908, 1909); *Rhopalosiphum persicae* Sulz. (Horváth, 1897); *Rhopalosiphum persicae* Pass (Henrich, 1909); *Siphonophora convolvuli* Kalt. (Borcea 1908, 1909); *Myzodes persicae* Sulz. (Knechtel and Manolache, 1943), (Holman and A. Pintera, 1981).

Wingless form (Figure4)
Colour: *M. persicae* ssp. *persicae* – different shades of green, bright yellow to green or grey to green, pink or red; *M. persicae* ssp. *nicotianae* always pink or red
Length: 1.2 – 2.1 mm
Antennae: approximately equal with the body's length
Curriculum: light green or light brown, 0.6 x the length of the body, slightly swelled from half to the end
Legs: short

Winged forms (Figure 5)
Colour: head and thorax dark brown to black, a spot of dark brown or yellow greenish on the abdomen and with a few transversal black stripes
Length: 1.2 – 2.1 mm
Distribution: in groups, on the entire plant, but mostly on the inferior side of the leaves from the plant's peak (young leaves) and on the flowers.
Other observations: *M. persicae* ssp. *persicae* is the most important vector of plants' viruses, being vector for over 100 viruses. In Holland, it is known the fact that *M. persicae* ssp. *nicotianae* is resistant to pirimicarb (Malais and Ravensberg, 2003).

Attacked plants

M. persicae is a polyphagous aphid, in greenhouses attacking especially the representatives of the Solanaceae family and the Chrysanthemum genus (Asteraceae Family). It is still important to state that the polyphagia of this insect is very extensive, being encountered on many plant species (ANNEX II).

Natural enemies

The biological control of aphids in greenhouses must start before the first infestation signs, because natural enemies need time to „establish" in the culture. Therefore, a series of natural enemies is „delivered" by profile-companies together with aphid infested „banker plants" pertaining to some species that don't attack cultivated plants. Such an example is ERVIBANK (Figure 6), a system marketed by Koppert, where *Sitobion avenae*, an aphid which prefers monocotyledonous plants, is grown on young cereals and used for encouraging the development of *Aphidius ervi*, *Aphelinus abdominalis* or *Episyrphus balteatus* colonies, useful insects also marketed by profile companies.

There are also other entomophagous agents (predators and parasites): *Adalia bipunctata, Chrysoperla carnea, Aphidoletes aphidimyza, Aphelinus abdominalis, Aphidius colemani, A. matricariae* etc (Figure 7*)* as well as entomopathogens: *Beauveria bassiana, Verticillium longisporum (*Figure 8), mass produced by companies and marketed all over the world in order to use themfor biological control of aphids.

A part of the insects used in the biological control of aphids are presented in ANNEX III.

In nature there are many other species that can be considered candidates for the biological control of aphids. Future research can lead these natural enemies in agricultural crops, with the condition to ensure that biological balance of the created agro-ecosystem will not be destroyed by mass introduction of these species. For this purpose, in order to register biological products, a series of tests can be performed, in the laboratory and also in the field. Of all the species we will list only a part, respectively those already marketed, and also a few other „candidates" of which efficiency against aphids was demonstrated through studies and scientific experiments.

Other important aphid parasitoids are *Ephedrus cerasicola*, *E. persicae*, *Praon volucre*, *Trioxys angelicae*, (Düzgüneş et al., 1982); *Aphidius ervi, A. colemani, A. matricariae* (Malais and Ravensberg, 2003).

Also, among the aphidofagous predators are included *Aphidoletes aphidimyza, Harmonia axyridis, Coccinella septepunctata, Adalia bipunctata, A. decempunctata, Scymnus* spp*., Cryptolaemus montrouzieri, Stethorus punctillum, Chrysoperla carnea* syn. *Chrysopa carnea, Hemerobius humulinus, Micromus variegatus, Epysyrphus balteatus, Aphelinus abdominalis* (predator and endoparasite) (Malais and Ravensberg, 2003).

Some entomopathogenic fungi are also known for aphid control: *Erynia neoaphidis*, *Pandora neoaphidis* (Figure 9), *Beauveria bassiana, Verticillium longisporum, Lecanicillium lecanii, Entomophthora aphidis, Entomophthora planchoniana etc* (Barta and Cagáň, 2006).

Fungi species are the most prevalent pathogens of aphids, and consequently fungi have been studied and used for biological control of invasive aphid species (Nielsen and Wraight, 2009). In case that an aphid is infected by a fungus, it doesn't die immediately and characteristic signs occur only a few days later. Even infected, aphids could lay nymphs. (Dinu *et al*., 2013)

The phases of the fungus infection are: adherence of spores on the insect cuticle and germination, penetration of tegument by specialized cells coming from germ tubes, development of fungus in the insect's body, death of insect and initiation of the saprophyte phase of the fungus. Spores produce mucilaginous secretions and enzymes that degrade the cuticle, these exogenous substances helping the entomopathogen to recognise the host and to adhere on the insect cuticle. The spore's incapacity to cling on the insect cuticle is considered a particularity of the non-virulent strains.

After the germinated hyphae, pierced the insect's tegument and entered the insect body, it is multiplied by budding, producing blastospores. The colonization of the insect infected by the fungus is made through incubation of the circulated blastospores through the hemolimph by the continuous increase of the mycelium or by the fragmentation and migration in the blood circulation, leading to a total disintegration of the tissues.

After insect dies, the fungus continues the development saprophyte, forming mycelium masses. Under favourable conditions of humidity and temperature, the conidiophores and sterile hyphae emerge from the cadavers. Under unfavourable conditions, after the insects' death, the fungus may develop resistant structures.

Pathogenicity of hypocrealean entomopathogenic fungi should be assessed at high humidity and temperatures (greenhouse conditions). Results might have been different than in laboratory trials, as suboptimal temperatures and RH are known to delay or inhibit the development of conidia. Large fluctuations of temperature could be a reason for ineffectiveness of treatments with entomopathogenic fungi. On the other hand, entomophthoran fungi require shorter periods of high humidity for transmission and are also more effective at lower temperatures than hypocrealean fungi. (Dinu *et al*., 2014).

Aphids morphology

In Romania, the morphology of aphids, reproductive mode and life cycle were described by Mustaţă (2000). Aphids are small insects, of 0.5 to 8 mm, characterized by a large polymorphism. The body is oval, globular or ellipsoidal. The body colour is variable: green, brown, black or light colours (orange, red) etc. The cuticle is low sclerified, so that usually, the body is soft. The cuticle can has ornaments (hairs, spines, scales) or is covered with a wax secretion. Cerigen glands are grouped and methameric.

The head is well delimited from the thorax in winged forms and more confusedly outlined in wingless forms. They have long antennae with 5-6 articles or less. Antennal articles have organs called sensors, important in taxonomy.

The composed eyes are well developed. The simple eyes (oceli) are found in winged forms and larva, located in a triangle.

The mouth armour is created for stinging and sucking (stylets), homopterous type. The stylets are enclosed in a sheath called “rostrum”, which is formed from modification of mandible and maxilla and have a variable length, depending on the species. Through the saliva channel a toxic secretion can be introduced in plants tissues, provoking the occurrence of tumours or deformation of leafage.

The thorax is united on a large surface with the abdomen. The pro-thorax is well-developed; mezzo-thorax and meta-thorax have each a pair of membrane wings with a simple groove.

The anterior wings have a parallel groove, with the anterior margin resulted from the fusion of sub-costal, radial, median and ulnar. From this stem the grooves detach one by one: ulnar 1, 2 and medium. Up to the peak of the wing can be formed a pterostigma of variable dimensions and an alar more or less pigmented, delimited by sub-costal and radial groove. The second pair of wings is more reduced and has a simplified grooving. The wings are placed as a roof in a pause.

The legs are adapted to walking and usually, homonymous. The posterior tibias have sensitive hairs in sexed females, with the name of pseudo-sensors. It ends with claws and can have different dimensions.

The abdomen is made of 9 segments and usually ends with a digiform, conic or beater extension, forming the tail-like protustion, called a cauda above their rectal apertures. Segment VI presents some organs of variable form and dimensions, called corniculum, important character in taxonomy. Through the corniculum it is eliminated drops of hemolimph, as a defence reaction against natural enemies. This reflex secretion got the name of autohemorage.

In greenhouses, the head shape, respectively frontal tubers (visible at ocular of minimum 50x) (Figure 3) can be used for a preliminary identification of the four species of aphids presented above. This characteristic is not sufficient for a correct taxonomic classification. The accurate species identification is preferably to be made following a complete determination key.

CONCLUSION AND FUTURE DIRECTIONS

The environmental protection and the elimination the causes that led to the disruption of the biocoenosis where humans have intervened, as well as the changes in the biotope and ecosystems, seem to represent the „favourite" topics of our generation. The quick development and evolution of science and technology asked for its price and the results were visible only decades later. The Industrial Revolution represented a big step ahead in the human kind evolution and a big step back in the human-nature relationship. Now we have an "emergency on Planet Earth".

The importance of the entomophagous agents and microorganisms in controlling harmful insects for agriculture as well as for keeping the natural balance of the ecosystems is extending because of great concern over the insects' chemical resistance, environmental and human safety. During last years, the European Union started the development of a process to implement a set of rules that will restrict the use of pesticides (Directive 2009/128/EC).

In greenhouses, the infestation of vegetable crops and flowers by aphids represents an issue of many growers. At this moment there is an increasing interest in regards to the use of natural enemies for controlling these arthropods, and applicative research in this field is a real help especially for the manufacturers of ecological products.

Even though there is an interest in the development of a durable and ecologic agriculture, the public opinion is not very informed regarding the fight against diseases and pests using natural enemies. Essentially, the unbalance that arises from agriculture has one single guilty factor: the human being. The changes in the ratio between the species by exponential breeding of only some are due to the huge preferential vegetal biomass provided in agro-ecosystems. Monocultures on extended surfaces, the use of non-selective pest control products (insecticides, acaricides, fungicides, herbicides etc) and the obsessive consume that increased with the Industrial Revolution is already returning like a boomerang against our species. Even though we don't like to admit it, we are like a virus for Planet Earth, a virus that even though it depends on the health and resources of Earth to breed and prosper, it continues to systematically destroy it. And, at least for now, there is no place for us to move. This is all we have.

Acknowledging the real dangers caused by the human's actions on the surrounding nature must be shortly followed by a change in each individual's behaviour. This can be possible through education and information, through dissemination of knowledge and by applying a system of laws that will socially cement a respectful behaviour towards nature. Any individual action for this purpose is a drop in the ocean. But what is an ocean if not a sum of drops?

It was estimated that throughout the world, there are approximately 67.000 species harmful to crops (including pathogens, invertebrates, weeds and some vertebrates), and the agricultural loss due to them annually exceeded 40% of the entire production (Oerke *et al.,* 1994). Of them, more than 500 species of arthropods have acquired resistance to one or more pesticides (Hajek, 2004). The biological control can be a solution and it must be done with a deep understanding of aphid-natural enemy interactions and ecology.

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All photos used in this review paper are original and are property of Dinu M.M., except: Figure 2 and Figure 3 from Malais & Ravensberg (2003), Knowing and recognizing: the biology of glasshouse pests and their natural enemies, Reed Business Information, Doetinchem, the Netherlands and ANNEX III – all photos marked with **©.**

Table 1. Differences in form of wingless and winged aphids

Characteristics	Winged	Wingless
Wings	Present	Absent
Antennae	Long	Short
Thorax	Big	Normal
Pigmentation	Strong (black)	Weak
Larval period	Long	Short
Reproductive period	Long	Short
Number of brood/nymph	A few	Many
Tolerance to feeding	Strong	Weak
Period of life	Long	Short

Figure 1. Apterous aphid, offspring and cast-off skins(exuviae)

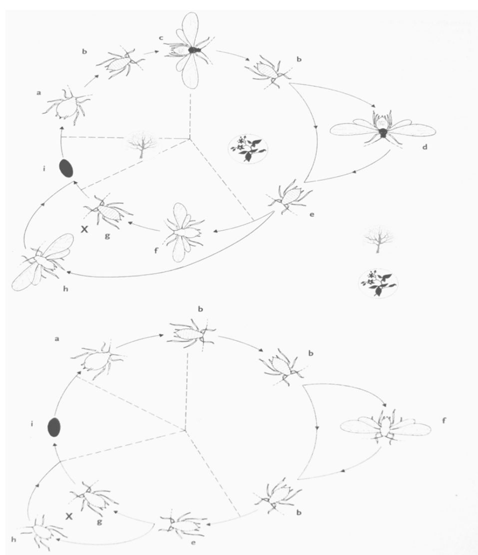


Figure 2. Life cycle of aphids (with and without alternate host plants) (after Jones, 1942)
a) fundatrix or stem mother, b) apterous viviparous female, c) viviparous female – spring migrants, d) viviparous female – summer migrants, e) sexual offspring generation, f) alate viviparous female, g) ovipare, h) male, i) egg, j) mating

ISSN 2248 – 129X; ISSN-L 2248 – 129X

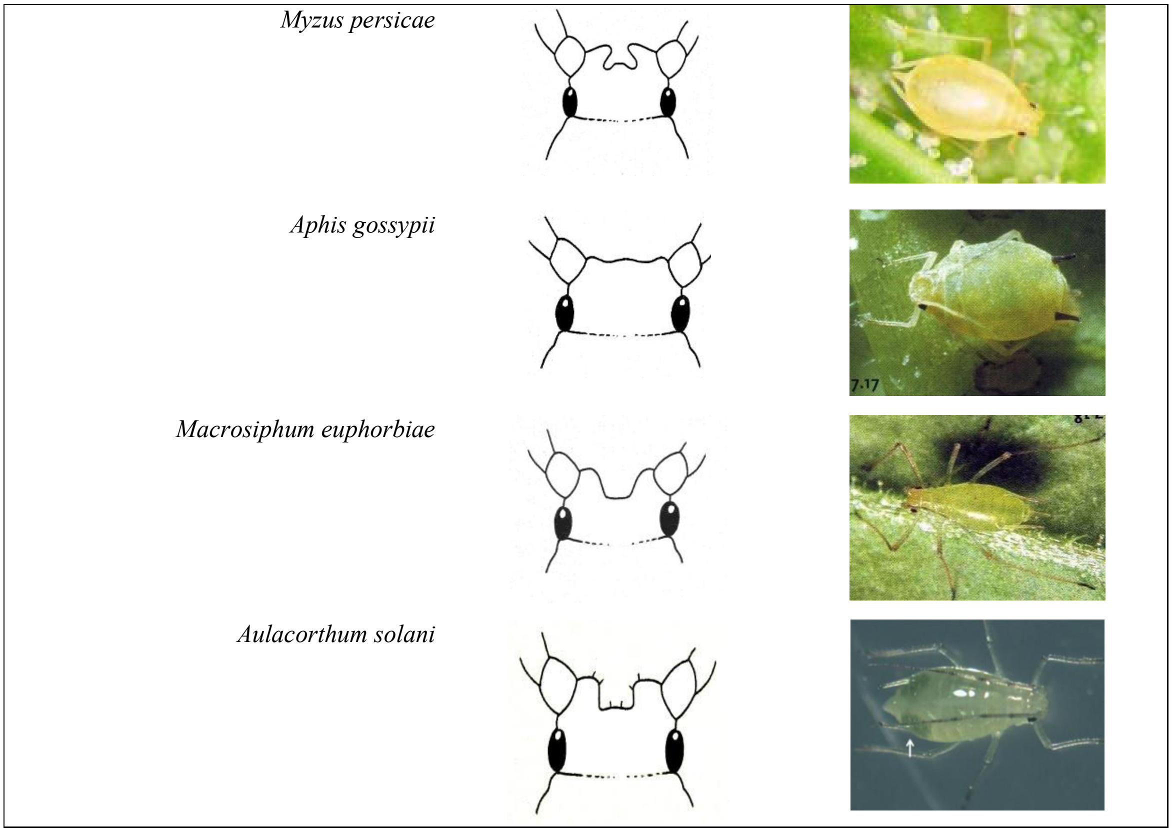


Figure 3 The shape of the head and front tubers of four aphid species most commonly found in greenhouse crops **(**after Malais and Ravensberg, 2003**)**

Figure 4. *Myzus persicae*, wingless form (apterous)

Figure 5. *M. persicae***,** winged form (alate)

Figure 6. ERVIBANK

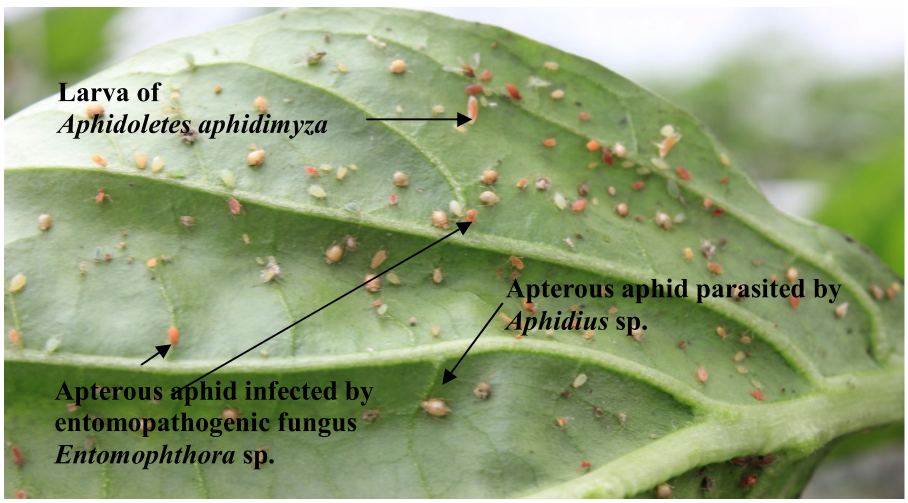


Figure 7 Parasitoids, predators and entomopathogens on apterous aphid

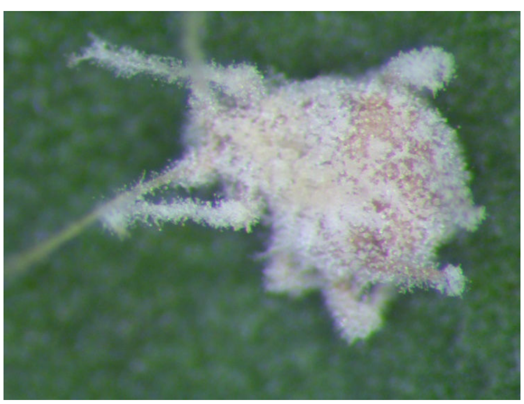
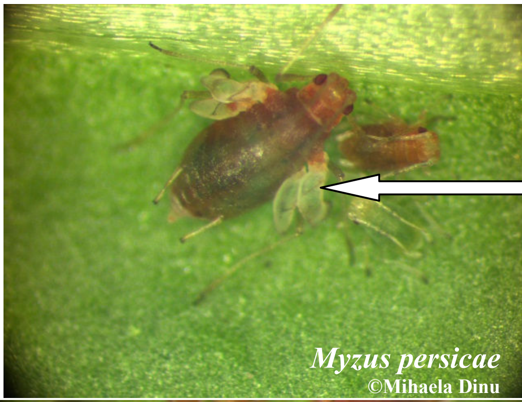


Figure 8. *Verticillium longisporum* sporulated on *Myzus persicae*

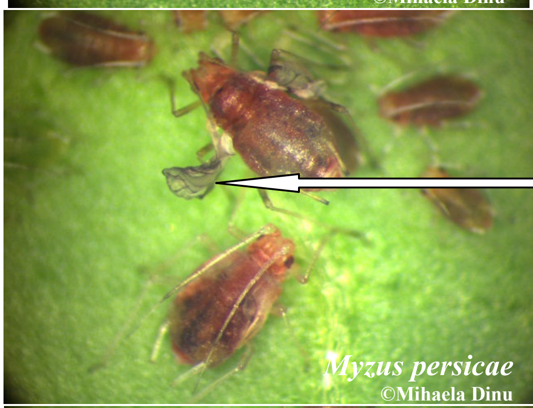
Figure 9. *Myzus persicae* attacked by *Pandora neoaphidis*

Romanian Journal for Plant Protection, Vol. VII, 2014
ISSN 2248 – 129X; ISSN-L 2248 – 129X

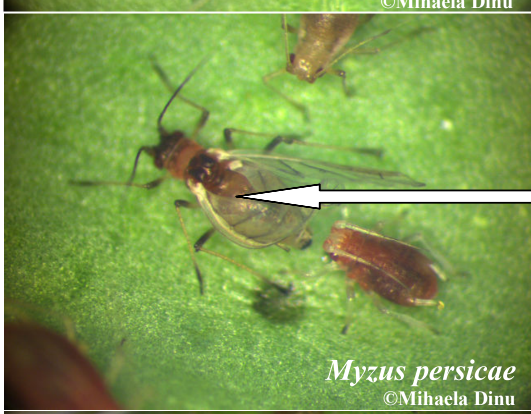
ANNEX I – Wing development in aphids



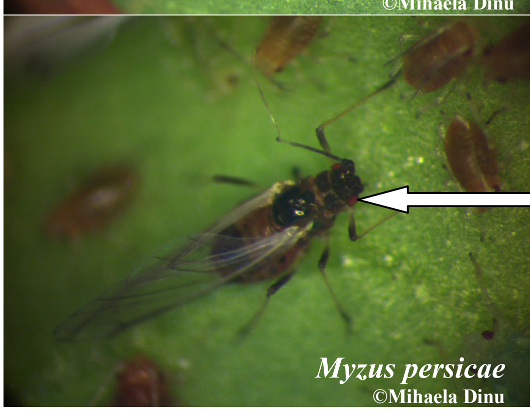
The early stage of wings development – they become visible to the naked eye



The wings are already formed and begins to outline their final form



The morphology of a typical alate aphid become visible; wings finish developing.



Final stage: the wings become fully developed and the head and thorax also become dark brown to black.

ANNEX II – Plant species attacked by *M. persicae*

Abutilon sp., *Aconitum* sp., *Alliaria* sp., *Allium cepa, A. schoenoprasum, Althaea rosea, Alyssum* sp., *Amaranthus* sp., *Ammania* sp., *Amygdalus communis, Anagallis arvensis, Anchusa* sp., *Anthemis arvensis, A. cotula, Antirrhinum* sp., *A. majus, Apium graveolens, Aquilegia* sp., *A. vulgaris, Arabis* sp., *Arctium lappa, Arenaria* sp., *Armeniaca vulgaris, Armoracia rusticana, Artemisia* sp., *A. vulgaris, Asclepias* sp., *A. syriaca, Asparagus officinalis, A. plumosus, A. sprengeri, Aster* sp., *Astragalus* sp., *Atriplex* sp., *A. hortensis, Atropa belladonna, Aubrietia* sp., *Avena barbata, A. fatua, Barbaraea vulgaris, Begonia semperflorens, Behen vulgaris, Bellis perennis, Beta vulgaris, Borago* sp., *Brassica* sp., *B. juncea, B. napus, B. nigra, B. oleracea, Bromus racemosus, B. rigidus, Buddlea* sp., *B. davidii, Calceolaria* sp., *Calendula arvensis, C. officinalis, Calla* sp., *Caltha* sp., *Calystegia* sp., *C. sepium, C. silvatica., Canna* sp., *Capsella bursa-pastoris, Capsicum annuum, Carduus* sp., *Carthamus tinctorius, Celosia* sp., *Centaurea* sp., *Cerastium pumilum, C. semidecandrum, Cerasus avium, C. vulgaris, Cerinthe* sp., *Chaerophyllum* sp., *Cheiranthus* sp., *C. cheiri, Chenopodium* sp., *C. album, C. album* spp. *viride f. suecicum, C. botrys, C. murale, Chondrilla juncea, Chrysanthemum* sp., *C. carinatum, C. indicum, C. roseum, C. segetum, Cichorium* sp., *Cirsium* sp., *Citrullus colocynthis, Citrus* sp., *C. aurantium, Clarkia* sp., *C. elegans, C. pulchella, Cochlearia* sp., *Coleus* sp., *Convallaria* sp., *Convolvulus* sp., *C. arvensis, C. tricolor, Conyza* sp., *Coronilla* sp., *Coronopus didymus, Crambe maritima, Crataegus* sp., *Crocus* sp., *Cucurbita maxima, C. moschata, C. pepo, Cuscuta* sp., *Cyclamen* sp., *Cydonia* sp., *C. japonica, C. oblonga, C. muralis, Cynara scolymus, Cynoglossum officinale, Cytisus* sp., *Dahlia* sp., *Datura* sp., *D. stramonium, Daucus* sp., *D. carota, Dianthus* sp., *D. caryophyllus, D. chinensis, Digitalis grandiflora, D. purpurea, Diplotaxis* sp., *Eqium* sp., *Epilobium* sp., *Erodium cictarium, Eruca sativa, Erysimum* sp., *Erythronium dens-canis, Euphorbia* sp., *E. helioscopia, E. segetalis, Evonymus* sp., *E. japonica, Fagopyrum* sp., *F. multiflorum, Fragaria vesca, Freesia* sp., *Fuchsia* sp., *F. magellanica, Fumaria* sp., *F. parviflora, F. vaillanti, Galium aparine, G. mollugo, Geranium molle, G, robertianum, Gladiolus* sp., *Glycine* sp., *Gossypium* sp., *Hedera helix, Helianthus annuus, Helichrysum bracteatum, Heliotropium peruvianum, Helleborum* sp., *H. purpurascens, Helminthia eqioides, Hemerocallis* sp., *Hibiscus* sp., *Hordeum* sp., *H. vulgare, Hyacinthus orientalis, Hydrangea* sp., *Hyoscyamus* sp., *H. niger, Hypericum* sp., *Impatiens* sp., *I. balsamina, Inula* sp., *Ipomoea* sp., *Iris* sp., *Juncus effusus, Lactuca* sp., *L. sativa, Lamium album, L. maculatum, L. purpureum, Lathyrus* sp., *Lepidium draba, Ligustrum vulgare, Lilium candidum, Linaria* sp., *Lupinus* sp., *Lychnis* sp., *Lycium* sp., *L. halimifolium, Lycopersicum esculentum, Malus* sp., *Malva* sp., *M. neglecta, M. pussila, M. silvestris, Matricaria* sp., *M. inodora, Matthiola* sp., *Melandrium* sp., *Mentha* sp., *Mercurialis* sp., *Mespilus germanica, Mimulus* sp., *Mirabilis* sp., *Myosotis* sp., *M. palustris, Myrtus* sp., *Nasturtium officinale, Nepeta* sp., *Nerium oleander, Nicotiana tabacum, Onopordon acanthium, Origanum vulgare, Orobanche* sp., *Oxalis corniculata, Padus racemosa, Papaver* sp., *P. rhoeas, P. somniferum, Parietaria diffusa, Pastinaca sativa, Pelargonium* sp., *Periploca draeca, Persica vulgaris, Petasites* sp., *Petunia* sp., *P. hybrida, Phalaris purpurea, Phaseolus vulgaris, Phyladelphus coronarius, Phlox* sp., *Physalis* sp., *Pirus sativa, Pisum sativum, Plantago* sp., *Poa* sp., *P. annua, Polianthes* sp., *Polygonum* sp., *P. hydropiper, P. persicaria, Populus alba, Portulata oleracea, Potentilla* sp., *P. anserina, P. recta, Primula acaulis, Prunella vulgaris, Prunus* sp., *P. cerasifera, P. domestica, P.*

spinosa, Pteroselinum sp.*, Culicaria dysenterica, Ranunculus* sp.*, R. bulbosus, Raphanus* sp.*, R. raphanistrum, R. sativus, Rapistrum rugosum, Rheum rhaponticum, Ribes aureum, R. nigrum, Ricinus* sp.*, Robinia* sp.*, Rorippa silvestris, Rosa* sp.*, Rubus idaeus, Rumex* sp.*, Rumex acetosa, R. obtusifolius, Salix babylonica, Salsola* sp.*, S. tragus, Salvia* sp.*, Sambucus nigra, Sanguisorba officinalis, Saxifraga* sp.*, Scandix pecten-veneris, Scopolia* sp.*, Scorzonera* sp.*, Secale cereale, Sedum* sp.*, Senecio* sp.*, S. jacobaea, S. vernalis, S. vulgaris, Setaria viridis, Silene* sp.*, Sinapis* sp.*, S. arvensis, Sisymbrium* sp.*, S. irio, Solanum* sp.*, S. dulcamara, S. melongena, S. nigrum, S. tuberosum, Sonchus* sp.*, S. arvensis, S. oleraceus, Spinacia oleracea, Stellaria aquatica, S. holostea, S. media, Symphitum* sp.*, Syringa vulgaris, Tagetes* sp.*, Taraxacum officinale, Thalictrum minus, Tilaea rubra, Tournefortia sibirica, Tragopogon* sp.*, T. pratensis, Trifolium pratense, T. repens, Triticum* sp.*, T. aestivum, T. durum, Tropaeolum* sp.*, T. majus, Tulipa* sp.*, Typha* sp.*, Urtica dioica, U. pilulifera, U. urens, Valerianella locusta, Verbena* sp.*, V. hybrida, Veronica* sp.*, V. hederifolia, V. persica, Viburnum* sp.*, Vicia* sp.*, V. faba, Vinca* sp.*, V. major, V. minor, Viola* sp.*, V. odorata, V. tricolor, Vitis* sp.*, Zantedeschia* sp.*, Zea mays, Zinnia* sp. (V. Ciochia and H. Boeriu, 1996).

ANNEX III – Insects used for biological control of aphids - predators