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CHRYSOMPHALUS AONIDUM (LINNAEUS, 1758), A NEW ALIEN PEST OF ORNAMENTAL PLANTS IN THE CZECH REPUBLIC (HEMIPTERA: COCCOIDEA: DIASPIDIDAE)

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Abstract

HLAVJENKOVÁ I., ŠEFROVÁ H.: *Chrysomphalus aonidum (Linnaeus, 1758), a new alien pest of ornamental plants in the Czech Republic (Hemiptera: Coccoidea: Diaspididae)*. Acta univ. agric. et silvic. Mendel. Brun., 2012, LX, No. 5, pp. 69–78

First records of the alien species *Chrysomphalus aonidum* (Linnaeus, 1758) (Diaspididae) on ornamental plants in the Czech Republic are described. The species was registered in 2008–2010, on plants of *Dracaena reflexa* var. *angustifolia* (sold under the names of *Dracaena marginata* "Bicolor" and *D. marginata* "Tricolor") in garden centres of northern and southern Moravia (Opava, Ostrava, Brno). It was also found on two specimens of the same plant in households (Brno, Ostrava). *Chrysomphalus aonidum* had been occasionally introduced into the Czech Republic with citrus fruits formerly, but it had not been found on cultivated plants. Basic information on the morphology, diagnostic characters, biology, ecological requirements, host plants, geographical origin and distribution of this species is summarized, based on a review of relevant publications. Diagnostic characters are also figured. Economic importance and possibilities for control of this new pest are discussed.

alien species, Sternorrhyncha, armoured scale insects, houseplants, plant protection

The scale insect family Diaspididae (Hemiptera: Sternorrhyncha: Coccoidea), also known as armoured scale insects, includes a number of important pests of wild and greenhouse plants (Lindinger, 1912; Miller, 1956; Alford, 2002, 2007). The Diaspididae fauna of the Czech Republic was treated in several papers by Zahradník (1959, 1968, 1977, 1990). There are 56 species known from the country (Zahradník, 1977, 1990; Březíková 2005), of which 26 species were introduced from warmer regions of the world and their occurrence is restricted here mainly or exclusively to tempered spaces (Šefrová & Laštůvka, 2005). This number does not include species occasionally introduced with southern fruits and not reproducing in the Czech Republic (six species; Zahradník, 1959). Increasing transport of various materials and live plants carries the risk of introduction of other exotic species of this family which may then become major pests of greenhouse and house plants.

The genus *Chrysomphalus* Ashmead, 1880 includes 17 species worldwide, five of which were found in Europe: *Ch. pinnulifer* (Maskel, 1891), *Ch. diversicolor* (Green, 1923), *Ch. dictyospermi* (Morgan, 1889), *Ch. bifasciculatus* Ferris, 1938 and *Ch. aonidum* (Linnaeus, 1758) (Ben-Dov, 2012). Zahradník (1968, 1977, 1990) mentions only one species, *Chrysomphalus dictyospermi* from central European greenhouses. Specimens of *Chrysomphalus aonidum* (cited as *Chrysomphalus ficus* Ashmead, 1880) were previously occasionally imported into central Europe on citrus fruits, but the species had not been detected in greenhouses (Zahradník, 1959).

This paper reports on first findings of reproducing populations of *Chrysomphalus aonidum* in the Czech Republic. Relevant publications dealing with this species are reviewed and general information on its reproduction, development, host plants, geographical distribution, and possibilities for control is provided.

MATERIALS AND METHODS

Specimens of *Chrysomphalus aonidum* were collected from plants of *Dracaena reflexa* var. *angustifolia* (commonly available in the Czech Republic under the names of *Dracaena marginata* 'Bicolor' and *D. marginata* 'Tricolor') in garden centres and households in northern and southern Moravia (Opava, Ostrava, Brno) in 2008–2010. The samples were stored in 70% ethanol; some plants were taken into laboratory to observe the development of *Ch. aonidum*. The species was determined based on microscopic slides of adult females, prepared using a modified procedure by Martin (1987). The determination of adults was performed under microscopic magnification 10×10 or 10×20. The method involves a thermal maceration, removal of wax and dyeing with acid fuchsine. Coloured female bodies were then mounted in a synthetic resin (Solacryl). Photographs were prepared using a digital camera mounted on a stereomicroscope. Diagnostic characters were selected based on Miller & Davidson (2005). The identification was kindly confirmed by Dr. Gillian Watson, specialist in the family Diaspididae (Plant Pest Diagnostics Branch, California Department of Food & Agriculture, Sacramento, USA).

RESULTS AND DISCUSSION

1. *Chrysomphalus aonidum* (Linnaeus, 1758) – material examined and finding circumstances

Material examined: Czech Republic, Moravia bor., Opava, Globus Supermarket (field code number in the grid for mapping central European flora and fauna, e.g. Pruner & Míka, 1996: 6073), 31.vii.2009; OBI Garden centre (6073), 4.viii.2009, 19.vii.2010; Ostrava, OBI Garden centre (6175), 10.vi.2010; Moravia mer., Brno, Globus Supermarket (6765), 30.xi.2008, 21.i.2010, 13.v.2010; Brno, household (6765), 19.xi.2008; Brno, Komárov, Baumax Garden centre (6865), 15.v.2010. All records comprising a few larvae and females on *Dracaena reflexa* var. *angustifolia* (=*Dracaena marginata* "Bicolor" and *D. marginata* "Tricolor"), I. Hlavjenková lgt. et det. Ten slide preparations of females are deposited in the collection of the Department of Crop Science, Breeding and Plant Medicine, Mendel University in Brno.

The first infested plant was brought from a household in Brno on 19.xi.2008. It was covered with honeydew and wax fiber clumps of *Pseudococcus longispinus* (Targioni & Tozzetti, 1867) (Hemiptera: Coccoidea: Pseudococcidae). Larvae and females of *Ch. aonidum* occurred between the wax fibers. Larvae and females of *Ch. aonidum* were later found in garden centres of several cities, always on *Dracaena reflexa* var. *angustifolia*, as stated in the material examined section. The specimens were not immediately apparent and easily escaped attention. No distinct damage was observed on plants.

2. Morphology and diagnostic characters

The morphology of *Ch. aonidum* was described in detail by Schmutterer (1959), MacFarlane (1999), Miller & Davidson (2005), Stahas & Kozar (2005), and Watson (2005). Adult female cover is 1.5–2.5 mm wide, slightly convex, circular, dark brown, black or reddish brown. Shed skins are central, lighter than scale produced by adult, reddish yellow (Fig. 1). The adult female cover size depends on the host plant (2–2.5 mm on leaves of citrus, 2.0–2.2 mm on *Ficus benjamina*, and 1.3–1.7 mm on *Ligustrum japonicum*) (Stahas & Kozar, 2005).

Female body is first pale yellow, later darker, with a light pygidium, pear-shaped, rounded anteriorly, elongate posterior to mesothorax, with a prominent thoracic tubercle (Fig. 2). Adult female body size is 1.1–1.7 mm. Before oviposition, the body is slightly elongated along its axis. During oviposition, it is becoming more rounded and the pygidium appears closer to the rest of the body. After removing the cover, the ventral part of the female body remains in contact with the host plant epidermis.

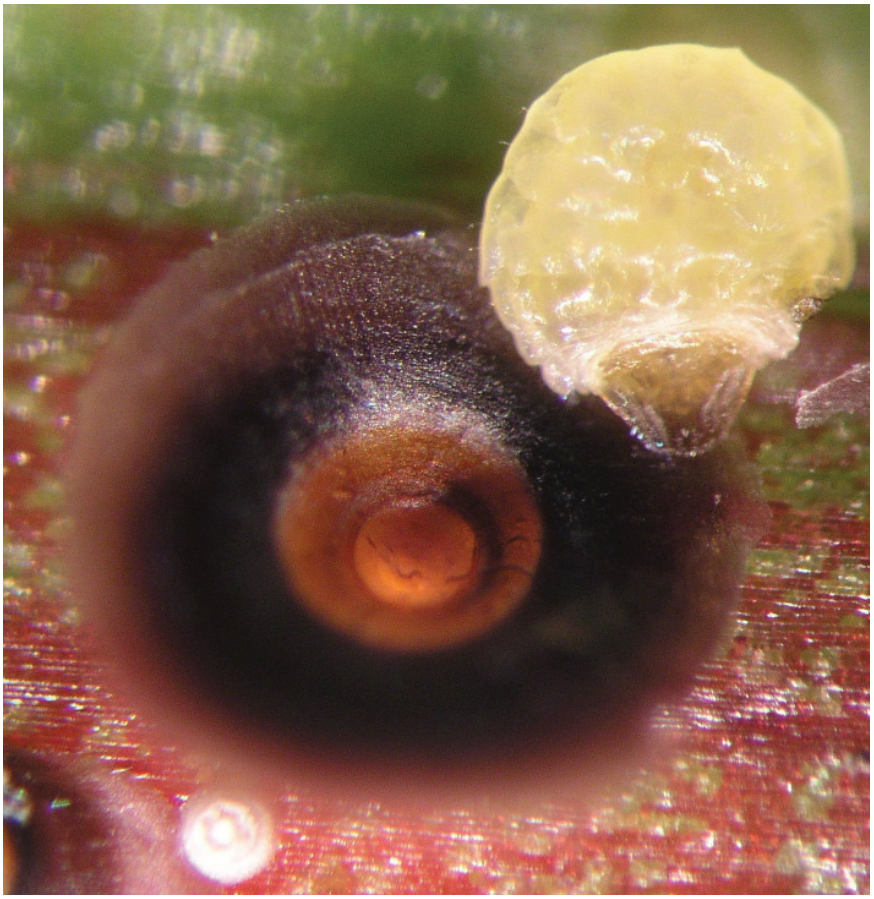
Male cover is slightly elongate, about 0.6–1.0 mm long, dark chestnut-coloured, with apex located excentrically. Exuviae are light brown, located submarginally, closer to one edge, about in the middle of the front plate. Adult males are about 0.8 mm long, orange-yellow, winged, and short-lived.

Miller & Davidson (2005) and Watson (2005) give diagnostic characters for similar species, *Chrysomphalus bifasciculatus* and *Ch. dictyospermi*, which can be safely distinguished from *Ch. aonidum* by morphological characters on the adult female body. The main diagnostic character is the number of marginal clusters of the prepygidial macroducts (Fig. 3, 4). *Chrysomphalus aonidum* has one marginal cluster on each side of the pygidial segment 2 while *Ch. bifasciculatus* has two groups on each side of the pygidial segment 2 and 3. Marginal clusters are completely missing in *Chrysomphalus dictyospermi*.

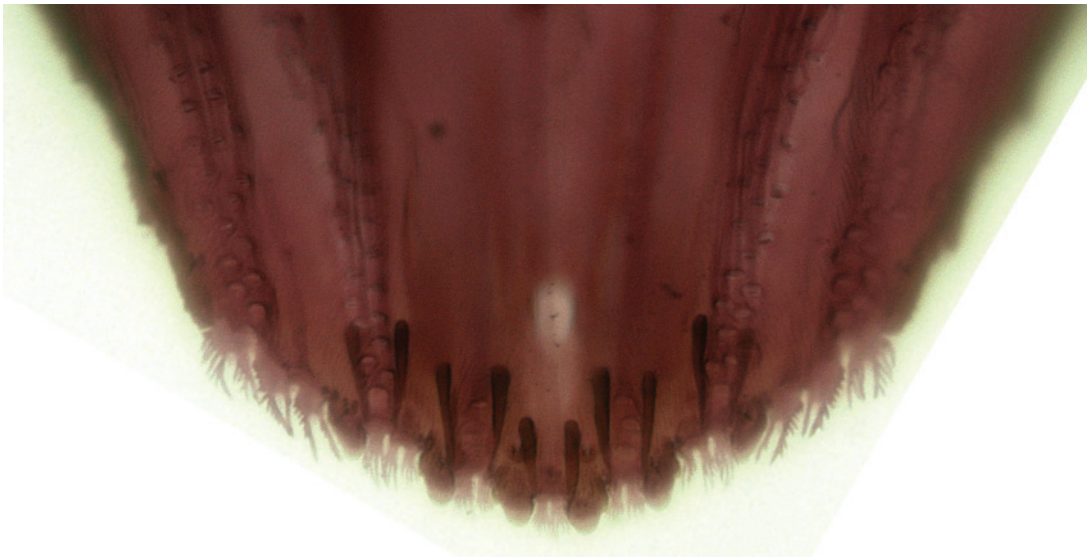
3. Biology

Schweig & Grunberg (1936), Fasulo & Brooks (1993), Koteja (1990), MacFarlane (1999), Waterhouse & Sands (2001), Miller & Davidson (2005), Watson (2005) and Ben-Dov (2012) provide details on the biology of *Chrysomphalus aonidum*. It is oviparous, bisexual, occasionally parthenogenetic. Its development depends on temperature, lasting 40–55 days in summer and about 170 days in winter, and sex (40–180 days in females, 26–160 days in males). Sex-ratio is 0.82:1 males:females (Nur, 1990; Santos & Gravena, 2005). Eggs are pale yellow, oval, laid in groups of approximately ten eggs under the scale cover. The number of eggs laid by a single female depends on the host plant (Rosen & DeBach, 1978), ranging between 19–300, with 145 eggs in average. On citrus, a significantly higher fertility was observed on fruits than on leaves. Hatching occurs a few hours up to ten days after the oviposition,

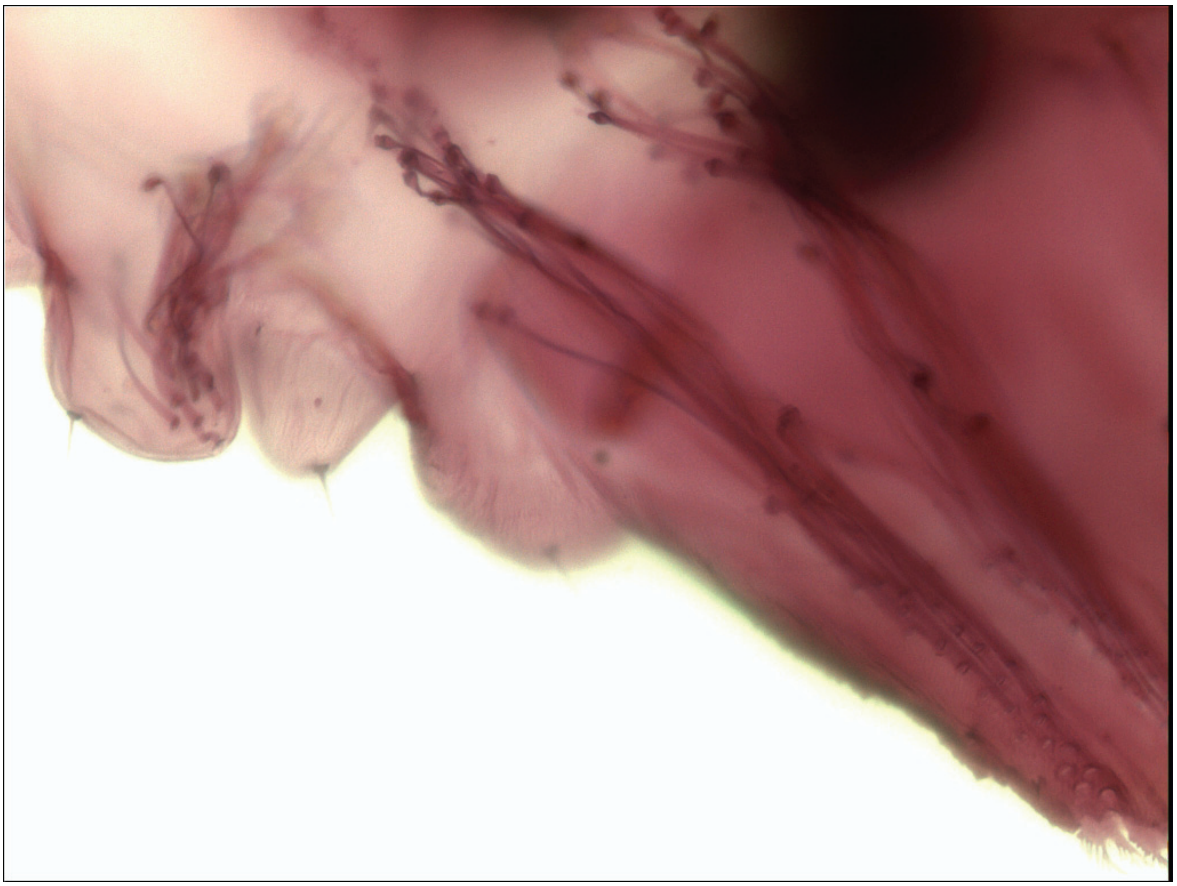
1: *Chrysomphalus aonidum – female scales*



2: *Chrysomphalus aonidum – exposed adult female and its scale*



3: *Chrysomphalus aonidum – detail of the female pygidial margin*



4: *Chrysomphalus aonidum – a marginal cluster of female prepygidial macroducts; all photographs by I. Hlavjenková*

depending on the abiotic environmental factors. Santos & Gravena (2005) reported an average duration of the egg stage as 8.1 days under 25 °C, 70% humidity and 12-hours light period. According to some other authors, the larvae hatch 24–48 hours after the oviposition. Fertility and female life expectancy are also affected by relative humidity and temperature. Optimum conditions are 70% humidity and average daily temperature in the range of 23–27 °C when the survival rate from egg to maturity is 62.7% and the adult life expectancy is 62 days (Santos & Gravena, 2005).

Females are paurometabolous, males parametabolous. The larval development includes two instars

in females and four instars (the last two resting) in males. Only the first larval instar (crawler) is vagile in both sexes, with the ability to spread and find a host plant. The larvae are easily dispersed by wind, other insects and human activities. Young larvae can be found along the central rib and veins on leaves or in fruit depressions. After having found a suitable place for feeding, crawlers start secreting a characteristic waxy coating. The second female instar has reduced legs. The females mature by neoteny and start oviposition about 43 days after the settlement of crawlers.

The number of generations depends on the host plant species, the location of the plant and environmental conditions. Miller & Davidson (2005) reported 3–6 generations annually outdoors under subtropical climate. In China and Palestine 3–4 generations per year were observed, in Australia 2–6 (Waterhouse & Sands, 2001; Miller & Davidson, 2005; Schweig & Grunberg, 1936), in Florida and California 6 (Fasulo & Brooks, 1993; Watson, 2005), and in Spain 3–4 (Soto *et al.*, 2008). In heated greenhouses and tropical areas, the development is continuous throughout the year and generations overlap.

4. Ecological requirements and host plants

Chrysomphalus aonidum prefers relatively humid conditions, it does not tolerate frost; its abundance is reduced by heavy rain and increases during dry weather (Schweig & Grunberg, 1936; Watson, 2005). Plants can be infested in their vegetative growth, flowering, fruit production, as well as post-harvest stages (Watson, 2005). *Ch. aonidum* prefers fruits and leaves but it occasionally develops also on green shoots (Schweig & Grunberg, 1936; Hill, 1983; Fasulo & Brooks, 1993; Miller & Davidson, 2005; Watson, 2005; Hill, 2008; Ben-Dov, 2012). It sucks out the content of parenchyma cells (Watson, 2005). Male larvae are more tolerant to lower humidity. They can be found on the upper side of leaves (Hill 1983; Miller & Davidson, 2005; Borrás *et al.*, 2006; Hill, 2008; Soto *et al.*, 2008). During the months with the highest sums of temperatures, there are three times more individuals on fruits than on leaves (Miller & Davidson, 2005). Leaves near the heavily infested fruits may be relatively free of infestation (Fasulo & Brooks, 1993).

Chrysomphalus aonidum is a widely polyphagous species that attacks both cultivated and naturally growing monocotyledonous and dicotyledonous plants. The species has been detected on 192 genera of 77 unrelated families, including crops, ornamental plants and forest trees (Borchsenius, 1966; Claps & Teran, 2001; Albuquerque *et al.*, 2002; Miller & Davidson, 2005; Watson, 2005; French, 2006). The real host range is probably even wider. In the laboratory *Ch. aonidum* can be kept on *Citrulus* spp., *Solanum tuberosum*, *Cucurbita pepo*, *C. maxima*, or *C. moschata* (Bedford, 1989; Stahas & Kozar, 2005; Andrade *et al.*, 2008).

5. Origin and distribution

Chrysomphalus aonidum probably originates in tropical south-eastern Asia (Gill, 1997; Miller & Davidson, 2005). It has been introduced into most tropical and subtropical areas of the world including North and South America, tropical Africa, Australia, Pacific Islands, the Mediterranean, and the Far East (Miller & Davidson, 2005; Stahas & Kozar, 2005, Culik *et al.*, 2008, Ben-Dov, 2012). It has become stabilized outdoor in southern Europe (Pellizzari & Germain, 2010). In northern regions and central Europe, however, it has been recorded only in greenhouses (Kosztarab & Kozar, 1988; Watson, 2005; Miller & Davidson, 2005; Pellizzari & Germain, 2010). Its worldwide distribution is also shown in maps by CABI (1988) and Miller & Davidson (2005).

In Europe, *Ch. aonidum* has been found in Croatia, Cyprus, Greece, Malta, Romania, Serbia, Spain (CABI, 1988), Belgium, Bulgaria, Denmark, France, Germany, Great Britain, Hungary, Italy, Madeira, Morocco, Netherlands and Poland (Ben-Dov, 2012; Burckhardt, 2011; Watson, 2005), and, since 2008, also in Slovenia (Beloglavec *et al.*, 2009). In Portugal, according to Pellizzari & Germain (2010) this species was eradicated.

6. Economic importance and host plant protection possibilities

The species has spread in the world in connection with the cultivation of citrus crops. On citrus, chlorotic spots are formed around the suction points on leaves and fruits. Heavy infestation causes stunting of corresponding plant parts or leads to their litter, citrus fruits become deformed. Woody plants infested for long time wilt, young shoots die. Miller & Davidson (1990) consider *Ch. aonidum* as a serious pest of global importance. Beardsley & Gonzales (1975) rank it among the 43 economically important Diaspididae pests. Pellizzari & Germain (2010) report *Ch. aonidum* as one of the ten widely found Diaspididae on citrus in Europe. In addition to citrus crops, it causes economically significant damage to coconut palms, date palms, olive trees, cinnamon, mango, banana, avocado, eucalyptus, guava, grape, papaya and tea in the world (Miller & Davidson, 1990; Fasulo & Brooks, 1993; Waterhouse, 1997; MacFarlane, 1999; Waterhouse & Sands, 2001; Watson, 2005).

In Italy, *Ch. aonidum* was first registered on plants of *Dracaena* sp. and *Kentia* sp. in greenhouses. It has been acclimatized on outdoor plants of the genus *Citrus* in Calabria since 2006 (Pellizzari & Vacante, 2007). In 2000 it was recorded in Athens in Greece on the genus *Dracaena* and it is considered there as an occasional citrus pest because of a difficult acclimatization (Stahas & Kozar, 2005). To the Netherlands, the species was introduced on plants of *Dracaena reflexa* var. *angustifolia* from Costa Rica and Honduras (Jansen, 2004). Recently *Ch. aonidum* has been recorded as a new pest in greenhouses in

Hungary (Reiderne & Kozar, 1994) and added to the quarantine organisms list (Burger & Ulenberg, 1990). In Poland (Skierniwice), it was observed on ornamental plants of *Dracaena reflexa* var. *angustifolia* and *D. deremensis* in greenhouses in 2004–2006 (Łabanowski, 2009). The first record from Slovenia dates back to 2008; *Ch. aonidum* was found in a shopping centre on plants of *Dracaena reflexa* var. *angustifolia* from the Netherlands (Beloglavec *et al.*, 2009). The species causes more or less important aesthetic damage on ornamental plants which is difficult to evaluate economically.

The wide host range makes it difficult to control *Ch. aonidum* using insecticides. After reducing its population density, a repeated attack often follows. In cases of repeated attacks Ripa & Larral (2008) suggest a sulphur insecticide application. Melton & Shives (1998) applied dimethoate and kinopren to control *Ch. aonidum*. The insecticides are often effective only after frequent applications which, however, significantly reduce natural enemies of *Ch. aonidum* (Fasulo & Brooks, 1993). The latter include 22 parasitoids and 14 predators which can act as biological control. Among them, Hymenoptera prevail, particularly the ectoparasitic *Aphytis holoxanthus* (DeBach, 1960) and endoparasitic *Pteroptrix smithi* (Compere, 1953) (Aphelinidae) are often used. Steinberg *et al.* (1986) argue that both parasitoids together control *Ch. aonidum* effectively during the year. Cilliers (1971) cited *Comperiella bifasciata* Howard, 1906 (Encyrtidae) as parasitoid, which was tested as a pest antagonist in laboratory. Later it failed in competition with *A. holoxanthus* in citrus orchards. *Aphytis chrysomphali* (Mercet, 1912) was recorded as a natural enemy on citrus trees in Spain. As a result of parasitation, females of *Ch. aonidum* are not fertilized and the next generation abundance is reduced (Schweig & Grunberg, 1936). In Greece, *Ch. aonidum* was kept on cucumbers and potatoes in order to study the coccinellid predator *Rhyzobius lophanthae* (Blaisdell, 1892) and its morphology and biology. Santos & Gravena (2005) investigated the ability predation of the coccinellid *Coccidophilus citricola* Bréthes, 1905. Evaluation of these antagonists effectiveness has not been available yet.

CONCLUSIONS

The occurrence of *Chrysomphalus aonidum* on ornamental plants in the Czech Republic is reported here for the first time. This species had been occasionally imported into the country on citrus fruits in the past (Zahradník, 1959). Plants imported from abroad and offered in garden centres can be considered as source of this pest. A similar way of the pest introduction has been detected in other European countries (Italy, Netherlands, Poland, Greece, and Slovenia).

Trading with potted ornamental plants and extending citrus growing areas generally contribute to the spread of *Ch. aonidum*. In connection with transportation of plants and other materials, *Ch. aonidum* can be introduced also to northern areas where it can become a significant pest of ornamental plants in greenhouses or households. Low winter temperatures are a limiting factor in the species acclimatization. Seasons, typical of temperate conditions, make it difficult for *Ch. aonidum* to acclimatize outdoor. In the Czech Republic, *Ch. aonidum* can thus become a pest of indoor and greenhouse plants only.

SUMMARY

First records of the alien species *Chrysomphalus aonidum* (Linnaeus, 1758) (Hemiptera: Coccoidea: Diaspididae) on ornamental plants in the Czech Republic are described. The species was registered in 2008–2010, on plants of *Dracaena reflexa* var. *angustifolia*, in garden centres of northern and southern Moravia (Opava, Ostrava, Brno) and also found on the same plants in households (Brno, Ostrava). *Ch. aonidum* had been occasionally introduced into the Czech Republic with citrus fruits formerly, but it had not been found on cultivated plants.

The number of generations of *Ch. aonidum* depends on the host plant species, the location of the plant and environmental conditions; 2–6 generations per year were observed outdoor while in heated greenhouses and tropical areas the development is continuous throughout the year and generations overlap. *Chrysomphalus aonidum* is a widely polyphagous species that attacks both ornamental and naturally growing monocotyledonous and dicotyledonous plants. It has been detected on 192 genera of 77 unrelated families, including crops, ornamental plants and forest trees. *Chrysomphalus aonidum* probably originates in tropical south-eastern Asia. It is widespread outdoor in most tropical and subtropical areas, and stabilized outdoor in southern Europe. In northern regions including central Europe it has been recorded only in greenhouses. The species is widespread in the world in connection with the cultivation of citrus crops. Chlorotic spots are formed around the suction points on leaves and fruits of host plants. Heavy infestation causes stunting of corresponding plant parts or leads to their litter, fruits may become deformed. Woody plants infested for a long time wilt, young shoots die.

The wide host range makes it difficult to control *Ch. aonidum* using insecticides. After reducing its population density, a repeated attack often follows. Insecticides are thus effective usually only after their frequent application which, however, significantly reduces natural enemies of *Ch. aonidum*.

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