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Scale insects on ornamental plants in confined spaces

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ABSTRACT

Very favourable conditions for development of hemipteran insects representing the suborder Sternorrhyncha and the superfamily Coccoidea, can be found in public utility buildings, where ornamental plants are kept for decoration. Initially, the small, individual larvae on such plants usually pass unnoticed, but in the course of several months the numbers of scale insects grow and the leaves of plants yellow and, finally, are shed. The research was carried in the years 2002-2007 in public utility buildings in Lublin, Warsaw and greenhouses of the Botanical Garden of Maria Curie-Sklodowska University in Lublin. Insect material for study was collected from pot plants and plants growing in containers and in soil, representing various ornamental plants. In the course of the study of ornamental plants from public utility buildings in Lublin and Warsaw 6 scale insect species were identified, representing such families as Pseudococcidae: *Planococcus citri* (Risso, 1813)*, Pseudococcus maritimus* (Ehrhorn, 1900) and Coccidae: *Saissetia oleae* (Oilivier, 1791)*, Saissetia coffeae* (Walker, 1852)*, Coccus hesperidum* Linnaeus, 1758. These scale insect species are among the most numerous and the most dangerous scales encountered in Polish greenhouses. An efficient method of eliminating scale insects from public utility buildings seems to be the biological method, since no chemicals can be applied on such buildings.

KEY WORDS: Scale insects, public utility buildings, greenhouses

INTRODUCTION

In newly built public utility buildings (e.g. hotels, offices, hospitals) there are designed external atria frequently turned into luscious gardens (Zielińska, 2006). Introduction of greenery is a useful way of improving the conditions of dwelling in such buildings, as it provides a beneficial microclimate and a substitute for natural environment, positively affecting people who work there. Plants, through their metabolism, moisturize the air and capture particles of various pollutants from the air (e.g. formaldehyde, benzene, trichloroethylene, xylene), as well as reduce noise. Together with ornamental plants, single larvae of small insects are often brought inside. Among such accidental and unwelcome inhabitants of our plants there are scale insects, hemipteran insects representing the suborder Sternorrhyncha of the superfamily Coccoidea. Due to the small sizes of their larvae and difficulties with noticing them feeding on the plants, these insect may, in short time, develop large populations. Contrary to popular belief, accidentally transferred scale insect species are not restricted in their occurrence solely to greenhouses, but can also be encountered in the immediate surroundings of human beings, i.a. in flats and houses, hospitals, schools and hotels. Into Poland they are quite frequently brought together with plant material from the Netherlands and other countries (Łabanowski & Sojka, 2006). Studies of scale insects on ornamental plants under covers in Poland have been conducted so far by Dziedzicka (1987; 1988ab; 1989), Komosińska-Czwartacka (1961; 1968), Łagowska (1982, 1995) and Łabanowski & Soika (2004). The appearance of scale insect populations in the above mentioned buildings poses a problem, since chemical protection should not be applied in there, and the procedure for biological protection has been developed only with respect to the species representing the family Pseudococcidae (Wiech *et al*., 1998).

MATERIAL AND METHODS

Insects for study were collected in the years 2002 - 2007 from potted plants and plants growing in containers and in soil, representing various ornamental plants in public utility buildings in Lublin, Warsaw and greenhouses of the Botanical Garden of Maria Curie-Sklodowska University in Lublin (Botanical Garden of UMCS). The samples were collected throughout the year. Scale insects were collected from leaves, shoots and roots. In order to identify the species from every studied plant, on which the insects were encountered, several individuals were collected and kept in 70% ethyl alcohol, until they were turned into permanent microscopic samples utilizing the method developed by Williams & Kosztarab (1972). In the course of collecting scale insect notes were made of the locations where they fed and their numbers, calculating the ratio of individuals per leaf or

per 10 cm of a shoot. Species identification was conducted mainly on the basis of permanent microscopic slides and, in several cases, on the basis of an analysis of undissected females under a binocular.

The range of ornamental plants introduced into public utility buildings is growing. The study results presented in this article aim to provide a list of arthropods which, given specific conditions, develop large populations and become a potential threat to the plants. The article discusses scale insect species encountered on ornamental plants in public utility buildings.

RESULTS AND DISCUSSION

Family: Pseudococcidae

Planococcus citri (Risso, 1813)

Place of collection: a hotel hallway in Warsaw, greenhouses of the Botanical Garden of UMCS in Lublin; collected: L_1, L_2♀, ♀

Host plants: *Coffea arabica* L.*, Citrus paradisi* Macfad.*, Citrus reticulate* Blanco*, Ficus benjamina* L.*, Ficus carica* L. *Laurus nobilis* L.*, Passiflora quadrangularis* L.*, Schefflera arboricola* (Hayata),

Distribution: a cosmopolitan species originating from the tropical and subtropical zones (Ben-Dov *et al*., 2011)

P. citri is a typical polyphage encountered on plants representing over 60 botanical families (Ben-Dov *et al*., 2011). In warm climate, it develops 10 generations per year (Müller, 1974), and 3-4 generations on plants under cover (Müller, 1974).Worldwide, especially in the tropical and subtropical zones, the species is harmful to the plantations of coffee, citrus fruit, bananas, and cotton, and especially to vine plantations, where it is responsible for the rotting and withering of grapes (Dziedzicka, 1988a; Tereznikova, 1975). Rosciglione & Castellano (1985) discovered that it carried Grapevine Virus A (GVA) from grape vine onto *Nicotiana clevelandii* A. Gray. Larvae and females of *P. citri* weaken plants by sucking up their juices, hamper growth of plants and cause their deformations, and may also be responsible for deaths of plants. The species forms large colonies in greenhouses, settling in shoot forks, at the bases of leaf blades and at growing points. A citrus mealybug secretes large amounts of honeydew, on which sooty mould fungi develop, hampering the metabolic processes of plants and frequently leading to their deaths (Dziedzicka & Karnkowski, 1993).

In the course of the research discussed here, this scale insect was found on plant stems and, in lower numbers, also on leaves of the examined plants. In a hotel hallways in Warsaw large numbers were found on the 2.5m tall *F. benjamina* plants. Because their presence resulted in yellowing of leaves and their shedding by the plants infested with this pest, and the application of chemical

substances for reducing the number of the insects was impossible in such a building as a hotel, the problem was successfully solved by introducing a predatory mealybug ladybird (*Cryptolaemus montrouzieri* Mulsant, 1850). Also during the research conducted in the greenhouses of the Botanical Garden of UMCS in Lublin, it was observed by Golan & Górska-Drabik (2006) that once the biological method of pest destruction was applied, the most significant reduction of the number of pests was observed among mealybugs. Once a predatory ladybird species *C. montrouzieri* was introduced, the population of mealybugs was decimated. *C. montrouzieri* was found helpful in destroying all developmental stages of mealybugs. The species, however, has a tendency to migrate and multiply within a greenhouse, and it should be observed that wherever the number of individuals present is decreasing, the greenhouse ought to be insulated, if possible, to avoid their migration outside (Ronse, 1990; Łagowska, 1995). Another effective natural enemy of *P. citri* is a parasitic hymenopteran insect *Leptomastix dactylopii* Howard, 1885*,* which lays eggs in the bodies of larvae of this scale insect species. Both these species of natural enemies to *P. citri* are usually introduced onto plants under covers. Thus, they may also be utilized in confined spaces. Wiech *et al*. (1998) observed that, in greenhouses of the Botanical Garden in Kraków, mealybugs were successfully controlled by introducing *L. dactylopii*. This hymenopteran species was frequently re-introduced into the greenhouse throughout the respective five years of the study, which allowed for an effective eradication of numerous populations of the pest in question.

Podsiadło (2006) observed large colonies of a citrus mealybug on such popular ornamental plants as *Stephanotis floribunda* Brongn. and *Hoya carnosa* R. Br., but at the same time the first of these species was rarely inhabited by scale insects. Another typical and popular plant which is grown to ornament office buildings, private flats and schools is a schefflera (*S. arboricola*). Scheffleras used for decoration are usually plants ca. 0.5m tall, and it is very difficult to find larvae of any scale insect species on them. It has been observed, however, that after the plants have been allowed to grow for several months, one of the scale insect species typically feeding on a schefflera is rather certain to appear in large numbers.

As for the other plant species listed above as its host plants (*C. arabica*, *C. paradisi*, *C. reticulate*, *F. carica*, *L. nobilis*, *P. quadrangularis*, *S. arboricola*), the citrus mealybug was observed on these plants in the greenhouses of the Botanical Garden of UMCS in Lublin.

***Pseudococcus maritimus* (Ehrhorn, 1900)**

Place of collection: office rooms in Warsaw, greenhouses of the Botanical Garden of UMCS in Lublin; collected: L_1, L_2♀, ♀

Host plants: *Abutilon striatum* (Gillies)*, Citrus grandis* Merr., *Passiflora auriculata* Kunth, *P. quadrangularis, S. arboricola*

Distribution: the species has been encountered in the Nearctic, Neotropical Oriental and Palearctic regions (Ben-Dov *et al*., 2011). In Poland its presence has been recorded exclusively on plants under covers (Dziedzicka, 1988b).

The species is a polyphage inhabiting plants which represent 37 botanical families (Ben-Dov *et al*., 2011). However, from the economic point of view it is known mainly as a pest of grape, pear and apricot trees in California (Bartlett, 1978; Flaherty *et al*., 1982).

In California, the species in question develops two generations per year, with eggs wintering either in egg follicles or as the first larval stage (Ben-Dov *et al*., 2011). Larvae and females mainly suck up juices from leaves; adult females wander towards shoot forks, where they produce egg follicles, with an average number of ca. 57 eggs (Ben-Dov *et al*., 2011; Flaherty *et al*., 1982). In the course of their development, females undergo four developmental stages. In order to monitor mealybugs, especially in field cultivars, pheromone traps are applied. Among their natural enemies, which have been observed in grape vine plantations, there are the parasitic hymenopteran species *Pseudaphycus angelicus* (Howard, 1898), and species representing the genus *Pachyneuron* spp. Predatory larvae of *Chrysopa carnea* (Stephens, 1836) and *C. oculata* (Say, 1839) feed on the early larval stages of mealybugs in grape vine plantations. Also in grape vine plantations, Grimes & Cone (1985) observed the imagoes of *Coccinella transversoguttata* Faldemnann, 1835 feeding on *P. maritimus*, which were encountered on grapes (Grimes & Cone, 1985).

In a greenhouse of the Botanical Garden in Lublin, *P. maritimus* was found on *A. striatum, C. grandis*, *P. auriculata* and *P. quadrangularis*. In office rooms in Warsaw it was found on *S. arboricola*. The species inhabited leaf stems in very large numbers, forming crowded populations (10-40 individuals/cm). The largest numbers of insects representing this species were recorded on both species of passiflora.

Rhizoecus cacticans (Hambleton, 1946)

Place of collection: greenhouses of the Botanical Garden of UMCS in Lublin; collected: L_1, L_2♀, ♀

Host plants: *Huernia leachii* Lavranos and *Stapelia grandiflora* L.

Distribution: the species has been encountered in the Australasian, Nearctic, Neotropical and Palaearctic regions (Ben-Dov *et al*., 2011). In Poland its presence has been recorded exclusively on plants under covers (Dziedzicka, 1988b).

The species is a polyphage inhabiting plants representing 20 botanical families (Ben-Dov *et al*., 2011). In the countries with temperate climate it may cause vast destruction in ornamental plant nurseries under covers (Dziedzicka, 1990; Zahradník, 1990). It can be found in the root systems of plants (Ben-Dov *et al*., 2011).

This species of scale insect was collected solely in the greenhouses of the Botanical Garden, from roots and the root necks of *H. leachii* and *S. grandiflora*. In Poland it has also been found on the roots of *Echinocactus* spp., and *Lobivia* spp. (Dziedzicka, 1988b).

Family: Coccidae

***Saissetia oleae* (Oilivier, 1791)**

Place of collection: office rooms and hotels in Lublin, hotel greenery in Warsaw; collected: L_1, L_2♀, ♀

Host plants: *Asparagus falcatus* L., *Nerium oleander* L., *Anturium* spp., *Monstera deliciosa* Liebm., *Philodendron* spp., *Phalaenopsis* spp.

Distribution: a cosmopolitan species, which has been encountered in the Nearctic, Neotropical, Oriental and Palearctic regions (Ben-Dov *et al*., 2011). In Poland its presence has been recorded exclusively on plants under covers (Dziedzicka, 1988a).

This is a polyphagous species, encountered on the representatives of over 70 botanical families worldwide (Ben-Dov *et al*., 2011). It is also common in confined spaces in Poland (Kawecki, 1985). Among other plants, the species has been collected from: *Citrus* spp., *N. oleander, Ficus* spp., *Agave american* L. (Schmutterer, 1952; Tereznikova, 1981; Łagowska, 1982). The body of females is from 2.5 to 6 mm in size, convex, ranging in colour from light to dark brown. On the dorsal side there is visible a characteristic, protruding, H-shaped pattern, which allows to differentiate the species easily from another, similar species belonging to the same genus, i.e. *S. coffeae* (Tereznikova, 1981). The species has two morphological varieties: a Californian and a Mexican one. In field cultivars of citrus fruit and olives in Israel, Greece, California, Spain and Peru it has been known to develop one or two generation a year (Ben-Dov *et al*., 2011). In confined spaces it has been observed to develop up to three generations (Schmutterer, 1952). Females are characterized by high fertility rates, and in the course of a lifetime may lay between 1200 and 2500 eggs underneath their bodies (Tereznikova, 1981). Young larvae are hatched after 15-20 days since the time of egg-laying and wander off, becoming distributed all over their host plant (Schmutterer, 1952). In the course of development of females there have been observed larval stages (Tereznikova, 1981).

A black scale is a dangerous pest of citrus fruit and olive cultivars all over the world, but mainly in the Mediterranean region (Bodenheimer, 1951; Bartlett, 1978). In Poland and other countries with temperate climate it inhabits ornamental plants under covers. The species can be most frequently encountered in shoots and the bottom sides of leaf blades, as well as near the stems and main veins of leaves. The feeding of females and larvae results in withering of the overground parts of plants and may lead to plant deaths. Similarly to other soft scale insects, both lar-

val stages and young females secrete large amounts of honeydew, on which sooty mould fungi develop (Koteja, 1996).

In the course of the research discussed here, the species in question was collected from ornamental potted plants in office rooms and hotels in Lublin and Warsaw. It inhabited leaves and shoots of these plants. The largest number of its representatives was encountered on *N. oleander*, where it was found on shoots rather than on leaves, forming large populations. In office rooms it was collected from *Anturium* spp., *M. deliciosa*, *Philodendron* spp. and *N. oleander.* As for the hotel plants in Warsaw, the species in question was found on *Anthurium* spp. and *Monstera* spp. Individual larvae were encountered on orchids belonging to the genus *Phalaenopsis*. The individuals rapidly multiplied and it was not easy to control their numbers. Rapid growth of black scale populations is certainly due to the high fertility rates of the species, as well as the fact that several generations develop in a year. Whenever first individuals of this scale insect species are found on an ornamental plant, the most advisable course of action is to remove the affected leaves and burn them.

***Saissetia coffeae* (Walker, 1852)**

Place of collection: a shopping mall in Warsaw, a greenhouse of the Botanical Garden of UMCS in Lublin, a private flat; collected: L_1, L_2♀, ♀

Host plants: *Asparagus* spp., *Citrus paradisi*, *Citrus reticulate*, *Dracena deremensis* (L.) Ker Gawl., *Dracena* spp., *Ficus benjamina*, *F. carica*.

Distribution: a cosmopolitan species with distributional range covering six zoogeographical regions of the world: Afrotropical, Australasian, Nearctic, Neotropical, Oriental, and Palaearctic (Ben-Dov *et al*., 2011)

Females reproduce by parthenogenesis (Ben-Dov *et al*., 2011). According to various researchers, in the case of this species the number of generations per year depends on climate conditions. For instance, 8 generations a year have been observed in Peru, several overlapping ones in Cuba, 1-2 generations in Florida, and 2 or more in California (Ben-Dov *et al*., 2011). Under laboratory conditions up to 6 generations a year have been observed (Blumberg & Swirski, 1977). In greenhouses, *S. coffeae* develops 5 generations per year. A female lays ca. 2000 eggs (Dziedzicka, 1990). The development of females is characterized by three larval stages (Saakjan-Baranova, 1964).

The species is polyphagous. Females are characterized by an oval, convex, smooth, shining body, from 2 to 5 mm in size (Tereznikova, 1981). It is encountered in ornamental plant nurseries under covers all over Poland. Dziedzicka (1988a) observed *S. coffeae* in all investigated greenhouses, on over 60 plant species. Schmutterer (1952) recorded the presence of *S. coffeae* on 42 plant species representing 16 botanical families, including *C. arabica, Anthurium regale* Linden*, Asparagus sprengeri* Regel*, Piper nigrum* L. Łagowska (1982) reported

it from 9 ornamental plant species. In the course of the research conducted by Golan & Górska-Drabik (2006) in a greenhouse in the Botanical Garden in Lublin, the authors encountered brown scales on: *C. arabica, Camellia sinensis* (L.) Kuntze*, Myrtus communis* L.

In the course of the research discussed here, in a greenhouse in the Botanical Garden this scale insect species was collected from *C. paradisi, C. reticulata,* in a shopping mall it was collected from *Asparagus* spp. and *Dracena* spp; and in a private flat – from *Dracena demensis.* The insects inhabited leaves in the direct proximity of veins, forming quite large populations (7-18 individuals/dracena leaf). On the genus *Citrus*, brown scales were encountered not only on leaves but also on young shoots.

In the countries with tropical climate brown scales settle mainly on coffee shrubs, but also on tea shrubs, citrus trees and mango trees (Hill, 1983). It is a dangerous pest of ornamental plants, especially cycads, frequently encountered also on ferns (Ben-Dov *et al*., 2011; Łagowska, 1982; Schmutterer, 1952; Tereznikova, 1981). Saliva of brown scales, injected into the plant system during feeding causes physiological and morphological changes in the plant, resulting in hindered growth, deformations and shedding of leaves. In India the species in question has been responsible for widespread damage in grape vine plantations. The first stage larvae are frequently spread by humans, birds, ants and the wind (Deklen, 1965).

Coccus hesperidum Linnaeus, 1758

Place of collection: a shopping mall and office rooms in Lublin, a hotel in Warsaw; collected: L_1, L_2♀, ♀

Host plants: *Dieffenbachia picta* Schott*, Ficus benjamina*, *Ficus elastica* Roxb. ex. Homem., *Hedera helix* L., *Nerium oleander*.

Distribution: a cosmopolitan species with distributional range covering five zoogeographical regions of the world: Afrotropical, Nearctic, Neotropical, Oriental, Palaearctic.

Females of *C. hesperidum* are either flat or slightly convex, and asymmetrical. Their body is 3-4 mm long, with varying colours: yellow, greenish or brown. It has been observed that the colour of females often resembles the colour of this part of the plant where they feed. The species is a typical polyphage inhabiting plants which represent over 80 botanical families. It originates from East Asia (Tereznikova, 1981; Saakjan-Baranova, 1964). The number of generation per year depends on thermal conditions. In the tropical zone there are 6-7 generations, while in the subtropical zones just 3-4 generations (Saakjan-Baranova; 1966). According to various authors, the fertility of females ranges from 70 to 1000 larvae (Dingler, 1923; Tereznikowa, 1981). The time of development from a larva to an imago depends on external conditions and, according to various authors, lasts 2 months on average (Borchsenius, 1957; Golan, 2008; Metcalf, 1962).

The species is known worldwide as a dangerous pest of citrus fruit plantations, destroying mangoes, kiwis and papayas, as well as tea shrubs and many species of tropical plants. It is a dangerous pest of ornamental plants grown under covers (Ben-Dov *et al*., 2011). In Poland it can be encountered in most greenhouses and belongs to the group of pests which are the most numerous and the most difficult to control in ornamental plant nurseries under covers. Brown soft scales are found in quite large numbers on such plants, on which they form colonies (Golan, 2008).

The species hinders plant growth and causes yellowing of leaves. It secretes the largest quantities of honeydew of all soft scale insects (Copland & Ibrahim, 1985). On the honeydew develop saprophytic fungi responsible for hindering the processes of photosynthesis and transpiration. What is more, the honeydew reduces turgor and hampers plant growth by reducing photosynthesis. The saprophytic fungi form an ugly, dark layer and by disturbing assimilation processes cause withering and shedding of leaves. The sticky honeydew is also conducive to the accumulation of dust and dirt, which further lower the ornamental value of attacked plants.

In the course of the discussed research, the species was collected from ornamental plants growing in a shopping mall and in an office building in Lublin (*D. picta*, *F. elastica*, *N. oleander*), as well as in a hotel hallway in Warsaw (*F. benjamina* and *H. helix*).

CONCLUSIONS

As has been observed by many researchers, scale insects are accidentally brought to Poland together with plant material and citrus fruit. They have the greatest chances of survival and development in plant nurseries under covers. Very good environmental conditions for scale insects can also be found in public utility buildings, where they inhabit ornamental plants. Individual, small larvae are usually difficult to notice on such plants, and after several months the numbers of scale insects grow, resulting in the yellowing and shedding of leaves by the attacked plants. The scale species collected in the course of the research discussed in the present article belong to the most numerous and the most dangerous scale insect species encountered in Polish greenhouses (Łagowska, 1995; Dziedzicka, 1988ab). According to subject literature, the family Pseudococcidae is represented in Poland by 5 greenhouse species, and the family Coccidae by 9 scale insect species (Koteja, 1996; Dziedzicka & Madro, 1999). The research conducted on ornamental plants in public utility buildings in Lublin and Warsaw resulted in identifying 3 species representing each of the two families: Pseudococcidae and Coccidae. No scale insects representing the family Diaspididae have been encountered, even though in Poland it belongs to the families which are represented in the largest numbers by greenhouse species (27 species) (Koteja, 1996). All scale

insect species identified in the course of the research are cosmopolitan and polyphagous species, which can be encountered in practically any Polish greenhouse (Dziedzicka, 1988b).

Some scale insect species encountered in Poland secrete large quantities of honeydew, especially ones representing such families as Coccidae and Pseudococcidae. Honeydew is not only harmful to plants, but also diminishes their decorative value. In confined spaces, where people dwell and work, chemical control of pests is to be avoided, and in the opinion of the authors of this article, such control would not prove very effective. As for biological control, in plant nurseries under covers it is implemented by introducing a predatory ladybird species *Cryptolaemus montrouzieri*, which also in the course of the research discussed here was proved efficient in limiting the numbers of mealybugs on *Ficus benjamina* in one of Warsaw hotels. This ladybird species is often frequently introduced in Polish botanical gardens. The parasitoid *Leptomastix dactylopii* may also be found helpful as a means of biological plant protection, since it lays eggs directly in the larvae of *Planococcus citri*. Therefore, it seems that utilizing the natural enemies of scale insects is a good direction to take while striving at the reduction of their numbers. Biological protection is an efficient and valuable solution, especially in public utility buildings, where other forms of pest control cannot be applied.

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Czerwce na roślinach dekoracyjnych w pomieszczeniach zamkniętych

STRESZCZENIE

Bardzo dobre warunki dla rozwoju pluskwiaków z podrzędu Sternorrhyncha i nadrodziny Coccoidea występują w budynkach użyteczności publicznej, gdzie wystawiane są rośliny ozdobne służące do ich dekoracji. Jednakże najczęściej pojedyncze, małe larwy nie są zauważane, a po upływie kilku miesięcy liczebność czerwców rośnie, rośliny żółkną i zrzucają liście.

Badania prowadzono w latach 2002 – 2007 w pomieszczeniach użyteczności publicznej w Lublinie i Warszawie oraz w szklarni Ogrodu Botanicznego UMCS w Lublinie. Owady do badań zbierano z różnych gatunków roślin ozdobnych doniczkowych i sadzonych w pojemnikach oraz w gruncie. Badania prowadzone na roślinach ozdobnych w budynkach użyteczności publicznej w Lublinie i Warszawie wykazały obecność po 3 gatunków należących do rodzin *Pseudococcidae: Planococcus citri* (Risso, 1813)*, Pseudococcus maritimus* (Ehrhorn, 1900) i Coccidae: *Saissetia oleae* (Oilivier, 1791)*, Saissetia coffeae* (Walker, 1852)*, Coccus hesperidum* Linnaeus, 1758. Stwierdzone gatunki czerwców należą do najbardziej licznych i najgroźniejszych czerwców obserwowanych w polskich szklarniach. W budynkach użyteczności publicznej skuteczną metodą stosowaną w celu zwalczania czerwców, gdzie inne formy ograniczania liczebności szkodników nie mogą być stosowane wydaje się być walka biologiczna.