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SCALE INSECTS (*Hemiptera*, *Sternorrhyncha*, *Coccoidea*) ON ORNAMENTAL PLANTS IN THE FIELD IN POLAND

Katarzyna Goliszek, Bożena Łagowska, Katarzyna Golan
University of Life Sciences in Lublin

Abstract. Thirty-three species were recorded from various ornamental field plants, representing 23.08% of the native Polish scale insects fauna. These species belong to 6 families, namely: *Asterolecaniidae*, *Coccidae*, *Diaspididae*, *Eriococcidae*, *Kermesidae* and *Pseudococcidae*. The best represented families were the *Diaspididae* (13 species) and *Coccidae* (12 species). For each species, the type of habitats, host plants, pest status and zoogeographical region of origin are given. Scale insects were found on cultivated deciduous trees and shrubs (24 species) and on ornamental coniferous trees and shrubs (8 species) in parks, botanic and household gardens, housing settlements and along avenues. The most numerous and economically important species is *Parthenolecanium corni,* followed by *Carulaspis juniperi* and *Leucaspis lowi*. Special attention should be paid to invasive *Pulvinaria floccifera* on *Ilex aquifolium* (L.) and unidentified *Parthenolecanium* sp. on rhododendron plants. These scale insects were observed in massive density on their hosts and can survive the winter in Poland.

Key words: sucking insects, pests, invasive species, trophic groups, zoogeographical element, economic significance

INTRODUCTION

Scale insects as plant pests have a special significance in the subtropical and tropical zones, where they cause a lot of damage in the cultivation of citrus, olives, coffee, cocoa, tea and grapevines. In recent years an increase in the economic significance of this group of insects has also been observed in the countries of moderate climate. This phenomenon is caused by a few factors, namely global warming and increasingly milder winters as well as a growing number of household gardens and a greater demand for interesting plant species, not infrequently foreign to our fauna, in addition to free import

Corresponding author – Adres do korespondencji: Katarzyna Goliszek, Bożena Łagowska, Katarzyna Golan, Department of Entomology, University of Life Sciences in Lublin, ul. Leszczyńskiego 7, 20-069 Lublin, Poland, e-mail: katarzyna.goliszek@up.lublin.pl, bozena.lagowska@up.lublin.pl, katarzyna.golan@up.lublin.pl

of fruit and ornamental trees and bushes. Plants import is conducive to the introduction of scale species that are foreign to the native fauna and that more and more often survive our winter in good condition.

The list of scale insects in Poland contains 143 species (excluding glasshouse ones) which are associated with Gymnospermae, Dicotyledones (numerous trees and bushes, perennial herbs) and Monocotyledones (mainly *Poaceae*). It is estimated that about 20 species among them can cause harm of economic importance, mainly on fruit and ornamental trees and bushes [Koteja 1996].

The first studies devoted to the occurrence of scale insects on ornamental plants in Poland come from the 1930's and they are limited to giving the species name of the scale insect, the host plant and the place of their habitat [Szulczewski 1926, 1931].

Fragmentary data on the species composition of scale insects on ornamental plants can also be found in papers dealing with the fauna of scale insects in particular geographical regions of Poland [Szulczewski 1949, Dziedzicka 1988, Koteja 1984]. However, those studies usually omitted the anthropogenic environments. It was only in the 1970's when systematic research began on the fauna of scale insects on ornamental plants, mainly in the city environment, which took into consideration the methodology of quantitative studies. Initially, they only concerned scale insects from the family of armored scale insects (*Diaspididae*) [Komosińska 1974, 1976], while the other groups of scale insects were considered in a later period [Komosińska 1986a, 1986b, 1987b, Łagowska 1986, 1987, 1998, Łagowska and Golan 2001]. A separate group consists of studies on the occurrence of scale insects in nurseries and lairs [Łabanowski 2006, Łabanowski and Soika 1996, 1997, 1999, Soika and Łabanowski 1997, 2003, 2004].

The purpose of the present paper was to isolate a community of scale insects occurring on ornamental trees and bushes in natural conditions and to establish their economic importance in Poland.

MATERIAL AND METHODS

The qualitative and quantitative analysis of scale insects occurring on field ornamental plants in Poland was based on the author's collection data and on bibliographical sources. The own studies were carried out during the years 2008–2010 in Lublin and its vicinity. The material was collected on coniferous and deciduous trees and shrubs growing in housing settlements, parks, household gardens and along avenues. Bark pieces or fragments of twigs with coccids were taken from the examined plants. In total, 594 samples were collected and 311 microscopic slides were made for species identification.

The quantitative analysis of the studied material was performed making use of the ecological indicators:

– frequency of species – understood as the percentage of host plants on which a given species was found;

– density – this index determinated the number of specimens per plant. Density was defined according to a five-degree scale: class I – up to 10 individuals per plant; class II – from 11 to 50 individuals per plant; class III – from 51 to 100 individuals per plant; class IV – from 101 to 500 individuals per plant; class V – massive density.

Table 1. A list of scale insects (*Hemiptera: Sternorrhyncha: Coccoidea*) occurring on ornamental plants in the field in Poland

Tabela 1. Lista czerwców (*Hemiptera: Sternorrhyncha: Coccoidea*) występujących na roślinach ozdobnych w Polsce

Species Gatunki	Nurseries Szkółki	Avenues Tereny przyuliczne	Housing settlements / Osiedla mieszkaniowe	Parks Parki	House gardens Ogrody przydomowe	Indefinite/ Nieokreślone	Zoogeographical element / Element zoogeograficzny
Asterolecaniidae							
Asterodiaspis variolosa (Ratzeburg)		+	+	+			Ko
Coccidae							
Eulecanium ciliatum (Douglas)			+	+			Pa
Eulecanium douglasi (Sulc)						+	Ho
Eulecanium tiliae (L.)	+	+	+	+ *	+ *		Ho
Palaeolecanium bituberculatum (Sign.)				+			Pa
Parthenolecanium corni (Bouché)	+	+ *	+ *	+ *	+ *	+	Ko
Parthenolecanium fletcheri (Ckll.)	+	+	+ *	+ *	+ *		Ho
Parthenolecanium rufulum (Ckll.)	+			+	+		Pa
Parthenolecanium sp.					+ *		Pa
Physokermes piceae (Schrank)	+			+ *	+ *		Pa
Pulvinaria floccifera (Westwood)	+				+ *		Pa
Pulvinaria vitis (L.)	+			+*			Pa
Sphaerolecanium prunastri (Fonsc.)		+	+	+			Pa
Diaspididae							
Aulacaspis rosae (Bouché)				+		+	Ko
Carulaspis juniperi (Bouché)	+		+	+	+ *		Ko
Chionaspis salicis (L.)	+	+	+	+			Pa
Diaspidiotus gigas (Thiem et Gern.)		+	+				Pa
Diaspidiotus marani (Zahr.)		+		+			Pa
Diaspidiotus ostreaeformis (Curt.)		+	+	+			Ko
Diaspidiotus zonatus (Frauenfeld)		+					Pa
Dynaspidiotus abietis (Schrank)	+				+	+	Pa
Lepidosaphes newsteadi (Sulc)						+	Pa
Lepidosaphes conchiformis (Gmel.)		+	+	+			Ho
Lepidosaphes ulmi (L.)	+	+	+ *	+	+ *		Ko
Leucaspis lowi (Colvee)					+	+	Pa
Leucaspis pini (Hartig)			+ *	+	+ *	+	Ko
Eriococcidae							
Acanthococcus aceris (Sign.)		+		+			Pa
Eriococcus spurius (Modeer)		+		+ *			Ho
Pseudochermes fraxini (Kaltenbach)	+	+	+	+			Pa
Kermesidae							
Kermes quercus (L.)				+	+ *		Pa
Pseudococcidae							
Phenacoccus aceris (Sign.)		+	+ *	+ *	+ *		Ho
Phenacoccus piceae (Low)					+ *		Pa
Planococcus vovae (Nass.)	+	+		+	+ *		Pa

+ – data from cited literature, * – own results: Ho – Holarctic Region, Ko – Cosmopolitan Region, Pa – Palearctic Region

+ – dane z cytowanej literatury, * – badania własne: Ho – region holarktyczny, Ko – region kosmopolityczny, Pa – region palearktyczny

While assessing the harmfulness of the species, results of earlier published papers were also considered. Their authors [Komosińska 1986a, 1986b, 1987b, Łagowska 1986, 1998, Łagowska and Golan 2001, Golan et al. 2001] made use of the same methods of collection as those described above to establish the intensity of the occurrence of scale insects on ornamental plants (the same ecological indexes and the same scale to assess the density of scale insects).

RESULTS

Thirty-three species were recorded from various ornamental field plants, representing 23.08% of the native Polish scale insects fauna. These species belong to 6 families, namely: *Asterolecaniidae*, *Coccidae*, *Diaspididae*, *Eriococcidae*, *Kermesidae* and *Pseudococcidae*. The best represented families were the *Diaspididae* (13 species) and *Coccidae* (12 species) (tab. 1).

Most of the species feeding on field ornamental plants in Poland originate from the Palaearctic Region (19 species) followed by the Cosmopolitan Region (7 species). Six species are considered to be holarctic in distribution.

The greatest number of scale insect species was observed in parks (24 species), whereas in avenues and housing settlements 17 and 15 species were noted, respectively. Four species occurred in all types of urban vegetations and those were: *Eulecanium tiliae* (L.), *Parthenolecanium corni* (Bouché), *P. fletcheri* (Cockerell) and *Lepidosaphes ulmi* (L.) (tab. 1).

Scale insects were found on cultivated deciduous trees and shrubs (24 species) and on ornamental coniferous trees and shrubs (8 species). Only one species was observed on both deciduous and coniferous woody plants (tab. 2).

Table 2. Trophic structure of scale insects (*Hemiptera, Coccoidea*) occurring on ornamental plants in the field in Poland

Tabela 2. Struktura troficzna czerwców (*Hemiptera, Coccoidea*) występujących na roślinach ozdobnych w Polsce

Hosts Rosliny żywicielskie	Trophic groups – Grupy troficzne						Total Ogółem	
	polyphagous polifagi		oligophagous oligofagi		monophagous monofagi			
	number of species	%	number of species	%	number of species	%	number of species	%
Deciduous trees and shrubs Drzewa i krzewy liściaste	15	93.75	4	50	5	55.56	24	72.73
Coniferous trees and shrubs Drzewa i krzewy iglaste	-	-	4	50	4	44.44	8	24.24
Deciduous and coniferous trees and shrubs Drzewa i krzewy liściaste i iglaste	1	6.25	-	-	-	-	1	3.03

Table 3. Frequency and density of selected scale insect (*Hemiptera, Coccoidea*) species* on ornamental plants in the field in Poland

Tabela 3. Frekwencja i zagęszczenie wybranych gatunków czerwców (*Hemiptera, Coccoidea*) na roślinach ozdobnych

Species Gatunki	Trophic group Grupy troficzne	Hosts Rośliny żywicielskie	Frequency Frekwencja %	Density classes Klasy zagęszczenia
A. rosae (Bouché)	O	*Rosaceae*; mainly on *Rosa canina* (L.)	< 5	I – IV
A. variolosa (Ratzeburg)	M	*Fagaceae;* mainly on *Quercus robur* (L.), *Q. rubra* (L.)		I – IV
D. abietis (Schrank)	P	*Pinaceae, Cupressaceae*		I – II
D. gigas (Thiem. et Gern.)	O	*Salicaceae*; mainly on *Populus sp.*		II – V
E. ciliatum (Douglas)	P	*Betulaceae, Caprifoliaceae, Corylaceae, Fagaceae, Rosaceae*		I – II
E. spurius (Modeer)	O	*Ulmaceae*		I – IV
E. tiliae (L.)	P	*Betulaceae, Corylaceae, Rosaceae, Tiliaceae, Ulmaceae*		I, II, IV
K. quercus (L.)	M	*Fagacea*; mainly on *Q. robur*		I – IV
L. ulmi (L.)	P	*Aceraceae, Buxaceae, Caprifoliaceae, Cornaceae, Elaeagnaceae, Olaeaceae, Platanaceae, Rosaceae, Salicaceae*		I – V
P. rufulum (Ckll.)	P	*Fagaceae*; mainly on *Q. robur*		I, II, IV
Parthenolecanium sp.	unknown	*Ericaceae;* only on *Rhododendron sp.*		III
P. vovae (Nass.)	M	*Cupressaceae;* mainly on *Juniperus sp.*		I, II, V
P. vitis (L.)	P	*Betulaceae, Corylaceae, Rosaceae*		I – II
S. prunastri (Fonsc.)	O	*Caprifoliaceae;* mainly on *Symphoricarpos sp.*		I, II, IV, V
L. conchiformis (Gmel.)	O	*Oleaceae*, *Tiliaceae*	5–10	II – V
L. pini (Hartig)	P	*Pinaceae;* mainly on *Pinus sp.*		I, II, IV, V
Ph. piceae (Schrank)	M	*Pinaceae*; mainly on *Picea sp.*		I – III
P. fraxini (Kaltenbach)	M	*Oleaceae;* mainly on *Fraxinus excelsior* (L.), *F. pennsylvanica* (Marsh.)		I – V
Ch. salicis (L.)	P	*Aceraceae, Betulaceae, Oleaceae, Rosaceae,Salicaceae*, *Tiliaceae*	10–20	I, III, IV, V
D. ostreaeformis (Curt.)	P	*Aceraceae, Betulaceae, Oleaceae, Rosaceae,Tiliaceae, Ulmaceae*		I – V
Ph. aceris (Sign.)	P	*Aceraceae, Betulaceae, Fagacea, Oleaceae, Rosaceae, Sapindaceae, Tiliaceae*		I – IV
P. fletcheri (Ckll.)	O	*Cupressaceae*; mainly on *Thuja sp.*		I – IV
C. juniperi (Bouché)	M	*Cupressaceae*; mainly on *Juniperus sp*., *Thuja sp.*	> 20	I – V
L. lowi (Colvee)	P	*Pinaceae*; mainly on *Pinus sp.*		I, II, IV, V
P. corni (Bouché)	P	*Aceraceae, Adoxaceae, Berberidaceae, Betulaceae, Buxaceae, Caprifoliaceae, Cornaceae, Elaeagnaceae, Fabaceae, Hydrangeaceae, Magnoliaceae, Oleaceae, Platanaceae, Rosaceae, Salicaceae, Sapindaceae, Tamaricaceae, Taxaceae, Tiliaceae, Ulmaceae*		I – V

M – monophagous – monofag, P – polyphagous – polifag, O – oligophagous – oligofag

*The table includes only those scale insect species the intensity of which was established according to the method described in the present paper – Tabela zawiera jedynie te gatunki czerwców, których intensywność była badana zgodnie z metodami opisanymi w niniejszej pracy.

The scale insects living on ornamental plants in Poland are referred to three groups: polyphagous (16 species), oligophagous (8 species) and monophagous (9 species). Only oligophagous and monophagous scale insects species are related to coniferous trees and shrubs (tab. 2).

Three species [*Carulaspis juniperi* (Bouché), *Leucaspis lowi* (Colvée), *P. corni* (Bouché)] out of the scale insects presented in table 3 appeared with high intensity on their hosts, which means that they were characterized by fairly high frequency (over 20%) and their colonies were found in higher density classes, i.e. in the fourth and fifth (tab. 3). Another four species [*Chionaspis salicis* (L.)*, Diaspidiotus ostreaeformis* (Curt.)*, P. fletcheri* (Cockerell) and *Phenacoccus aceris* (Sign.)] also settled the plants in the higher classes of density, but they showed the frequency between 10% and 20%. The colonies of *Ch. salicis* and *D. ostreaeformis* occurred in the fourth and fifth density classes mostly, whereas *P. fletcheri* and *Ph. aceris* settled their hosts mainly in the first and second classes of density.

The most numerous group included the scale insects which were characterized by the frequency between 5% and 10% (4 species) and by the frequency below 5% (14 species). In these groups, most species occurred on plants in all five density classes. Only four species (*Eulecanium ciliatum* (Douglas), *Pulvinaria vitis* (L.), *Dynaspidiotus abietis* (Schrank), *Physokermes piceae* (Schrank) were always found in the first and second density classes (tab. 3).

DISCUSSION

The list of scale insects occurring on ornamental field plants in Poland comprises 33 species, which makes 23.08% of the Polish fauna of scale insects. This is quite a numerous group comparing to Lithuania, where 15 scale insects species were recorded on ornamental plants in the field [Malumphy et al. 2009].

The list of scale insects recorded on ornamental plants in Poland undergoes constant changes. Names of species that were considered synonymous to other, usually polyphagous, scale insects disappear. Results of taxonomic studies showed that only one polyphagous species *P. vitis* [Łagowska 1996] occurs in Poland, whereas *P. pomeranicum,* belonging to the *Coccidae* and commonly occurring on yew-trees, is synonymous to *P. corni* [Stepaniuk 2009]. At the same time, new species appear, mostly introduced in Poland in the nursery material. Among the species introduced to Poland, special attention should be paid to *Pulvinaria floccifera* (Westwood). In Europe, it has been recorded mainly in greenhouses and is considered as a serious, polyphagous pest of ornamentals belonging to 25 plant genera [Kosztarab and Kozar 1988]. Until recently, *P. floccifera* has been recorded on ornamental plants in greenhouses only in Poland [Koteja 1972]. In the 1990's this species was discovered on *Ilex aquifolium* (L.) [Łabanowski and Soika 1999] at the outlet of nursery material imported from Holland. However, for the last few years it has also been observed on field ornamental bushes and it appears to be already established. Preliminary observations indicate that the timing of the life cycle of *P. floccifera* in natural conditions in Poland is similar to that in the neighbouring countries in Europe [Golan et al. 2010].

Also, *Parthenolecanium* sp. observed on rhododendrons seems to be a serious pest in Poland. Massive occurrence of the *Coccidae* on rhododendrons was found by Soika and Łabanowski [2004], who identified them as *Eulecanium franconicum* (Lindinger). Probably, it is wrong designation of the species. The *Coccidae* occurring on rhododendrons is morphologically very similar to the commonly occurring *P. corni* and its identification is possible only on the basis of young, mounted females. Old adult females with eggs under their bodies were collected by the Authors in July 2010 on twigs and the bottom leaf surface in great numbers. In the case of *P. corni*, females with eggs occur exclusively on parts of ligneous plants. Euonymus scale insect [*Unaspis evonymi* (Comstock)] was also introduced in Poland on Japanese spindle from Italy [Łabanowski and Soika 1998]. In South Europe, this scale insect is known as a pest to many species of ornamental spindle [Kozarzhevskaya 1992]. So far, the presence of this pest on ornamental spindle and its ability to overwinter in Poland have not been confirmed, which is why it has not been included in the list of scale insects on ornamental plants cultivated in the field.

Studies conducted so far show that scale insects clearly prefer urban environment and they colonize ornamental trees and bushes. According to Komosińska [1974], communities of *Diaspididae* in urban communities were characterized by higher frequency, a higher percentage of colonies of massive density and the most differentiated population structure of the species as compared to the natural environments. Similar results were presented by the Author while comparing communities of scale insects in different types of city green areas with the community occurring in forest environment [Komosińska 1987a]. Łagowska [1987] also found a greater intensity of the *Coccidae* on deciduous trees and bushes than in forests.

Observations showed that out of the 33 species living on field ornamental plants, only *C. juniperi*, *L. lowi* and *P. corni* appeared with high frequency and density on their hosts. *P. corni* and *C. juniperi* are both found on the world list of dangerous pests [Davidson and Miller 1990]. The economic significance can be attributed to the species which were not frequent, but appeared in considerable density on their host plant. It should be emphasized that such trees and shrubs become a source of infection for the neighbouring plants.

CONCLUSIONS

The list of scale insects occurring on ornamental field plants in Poland comprises 33 species, which makes 23.08% of the Polish fauna of scale insects. The families best represented were the *Diaspididae* and *Coccidae*.

The largest group of *Coccoidea* associated with ornamentals in Poland was formed by the polyphagous species living on deciduous trees and shrubs. The most numerous group of scale insects was observed in parks.

Out of the 33 species living on the field ornamental plants, only *C. juniperi*, *L. lowi* and *P. corni* appeared with high frequency and density on their hosts. *P. corni* and *C. juniperi* are both found on the world list of dangerous pests.

Among the introduced species, special attention should be paid to *P. floccifera* on *Ilex aquifolium* and *Parthenolecanium* sp. observed on rhododendrons. These two polyphagous species were observed in massive density on their hosts and they can survive the winter in Poland.

The economic significance can be also attributed to the species which are not frequent, but appear in considerable density on their host plant, become a source of infection for the neighbouring plants.

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CZERWCE (*Hemiptera*, *Sternorrhyncha*, *Coccoidea*) WYSTĘPUJĄCE NA ROŚLINACH OZDOBNYCH W POLSCE

Streszczenie. Czerwce jako szkodniki roślin mają znaczenie w krajach klimatu tropikalnego i subtropikalnego, gdzie powodują straty w uprawach cytrusów, oliwek, kawy, kakao, herbaty i grejpfrutów. W ostatnich latach obserwuje się wzrost znaczenia gospodarczego tej grupy owadów również w krajach o umiarkowanym klimacie. Zjawisko to jest spowodowane kilkoma czynnikami, a mianowicie globalnym ociepleniem klimatu i coraz łagodniejszymi zimami, wzrastającą liczbą ogrodów przydomowych i rosną-

cym zapotrzebowaniem na ciekawe, często obce dla naszej fauny gatunki roślin oraz swobodnym importem drzew i krzewów owocowych i ozdobnych. Celem niniejszej pracy było określenie wielkości populacji czerwców występujących na drzewach i krzewach ozdobnych, rosnących w warunkach naturalnych oraz ich znaczenia gospodarczego w Polsce. Analizę ilościową i jakościową czerwców przeprowadzono na podstawie zebranego przez autorów materiału dokumentacyjnego oraz danych z piśmiennictwa. Badania przeprowadzono w latach 2008–2010 w Lublinie oraz jego okolicach. W wyniku przeprowadzonej analizy na roślinach ozdobnych w Polsce stwierdzono występowanie trzydziestu trzech gatunków czerwców (23.08% rodzimej fauny *Coccoidea*). Czerwce te należą do sześciu rodzin: *Asterolecaniidae*, *Coccidae*, *Diaspididae*, *Eriococcidae*, *Kermesidae* and *Pseudococcidae*. Wśród nich najliczniej reprezentowane były rodziny *Diaspididae* (13 gatunków) i *Coccidae* (12 gatunków). W pracy dla każdego gatunku czerwca określono typ zbiorowiska, w którym wystąpił, rośliny żywicielskie, znaczenie ekonomiczne oraz jego przynależność zoogeograficzną. Stwierdzone gatunki czerwców obserwowano w parkach, ogrodach botanicznych, ogrodach przydomowych, osiedlach mieszkaniowych, a także wzdłuż alei na ozdobnych drzewach i krzewach liściastych (24 gatunki) i iglastych (8 gatunków). Gatunkiem czerwca o największym znaczeniu gospodarczym, który w badaniach wystąpił najczęściej, był *Parthenolecanium corni.* Również *Carulaspis juniperi* i *Leucaspis lowi* wystąpiły w frekwencji i liczebności zagrażającej ich żywicielom. Szczególną uwagę należy zwrócić na gatunki inwazyjne: *P. floccifera* na ostrokrzewie kolczastym oraz nieoznaczony jeszcze *Parthenolecanium* sp. na rododendronach. Czerwce te wystąpiły na swoich żywicielach w dużym zagęszczeniu i są w stanie przezimować w Polsce.

Słowa kluczowe: pluskwiaki, szkodniki, gatunki inwazyjne, grupy troficzne, element zoogeograficzny, znaczenie gospodarcze

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