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Pest species of Coccoidea (Hemiptera; Coccomorpha) in forest of Turkey

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Abstract: Forest area of Turkey is 22.6 million hectares, which constitutes 28.8% of the overall land area. 47% of the forests is coniferous, 32% is broad-leaved tree species and 21% mixed species. The Scale insects (Hemiptera: Coccomorpha) are cryptic and mostly invisible insects which are mostly small less than 5 mm long. Many scale insects are economically important pests of agriculture, horticulture, and forestry. Around 400 scale insect species are known in Turkey, totally 119 Coccoidea species are fed on forest trees and shrubs; among 45 species of them on conifers and 74 species on broad-leaves trees and shrubs. *Marchalina hellenica* Gennadius (Marchalinidae) is a famous and economically important species that resourced honeydew honey called "pine honey". This study examines scale insects, their distribution, host plants, natural enemies, damages, and role of forest biodiversity in Turkey.
Keywords: Scale insect, Biodiversity, Conifer, Biology, Damage

Türkiye ormanlarında zararlı Coccoidea (Hemiptera; Coccomorpha) türleri

Özet: Türkiye 22.6 milyon hektar orman alanına sahiptir. Türkiye'nin yüzöçümünün %28.8'ini kaplayan bu ormanların %47'sini iğne yapraklılar, %32'sini geniş yapraklı ağaçlar ve %21'ini karışık ormanlar oluşturmaktadır. Kabuklubitler (Hemiptera: Coccoidea), saklı yerlerde yaşayan, genellikle 5 mm'den daha küçük olduğu için gözden kaçırılan böceklerdir. Birçok kabuklubit türü tarım ve orman bitkilerinin ekonomik önemde zarar meydana getirmektedir. Türkiye'de varlığı bilinen 400 civarında kabuklubit türünden, 45 tür koniferlerde, 74 tür ise geniş yapraklı ağaç ve çalılarda olmak üzere, toplam 119 Coccoidea türü orman bitkilerinde beslenmektedir. *Marchalina hellenica* Gennadius (Marchalinidae) bunlardan en bilinen ve ekonomik öneme sahip bir tür olup, "çam balı" olarak bilinen salgıbalına kaynaklık etmektedir. Bu çalışmada Türkiye ormanlarında görülen kabuklubit türlerinin yayılışları, konukçuları, doğal düşmanları, zararları ve orman biyoçeşitliliğindeki rolleri incelenmiştir.
Anahtar kelimeler: Kabuklubitler, Biyoçeşitlilik, Konifer, Biyoloji, Zarar

1. Introduction

The total forest area of Turkey is 22,342,935 hectares and it consists of 29% of the country (TOD, 2019). Forests are generally located on mountainous areas and they are usually natural and semi-natural with high biodiversity value. Turkey has 9000 plant species of which 3649 (31.8%) is endemic (FAO, 2019). Most of these plants are located in forest areas. Approximately 800 woody taxa occur in the country's forests. The predominant species are *Pinus brutia* Ten., *Pinus halepensis* Mill., *Pinus nigra* Arnold, *Pinus pinea* L., *Pinus sylvestris* L., *Abies* spp. [*A. cilicica* (Ant. and Kotschy), *A. nordmannia* (Steven)], *Picea orientalis* (L.), *Cedrus libani* A. Rich (Pinaceae), *Cupressus sempervirens* L., *Juniperus* spp. (Cupressaceae), *Fagus orientalis* Lipsky, *Quercus* spp., *Castanea sativa* Mill. (Fagaceae), *Alnus* spp. and *Carpinus betulus* L. (Betulaceae). Main tree species of the Turkey forest are oaks (26.25%), Turkish pine (25.13%), Crimaen pine (19.02%), beech (8.55%), Scots pine (6.80%), juniper (4.29%), cedar (2.16%), fir (2.62%) and spruce trees (1.45%). These plants occur as pure stand or mix stand in forests (Anonymous, 2019).

Insects and plant diseases are the important factors that damage forest trees. Scale insects (Hemiptera; Coccomorpha) feed by sucking the sap of plants from either the phloem or parenchyma and cause reduced host vigor, reduced productivity, defoliation, premature falling of leaves and dieback of branches. In addition, feeding by these insects may cause discoloration and disfiguration and gall formations. They are often cryptic in habit and mostly small size (less than 5 mm long) therefore undetectable until plant damage is substantial. This point is very important in quarantine and plant protection. There are estimated to be almost 8000 Coccoidea species in the world (Garcia et al., 2016). They are economically important pests of agriculture, horticulture and forest plants (Kosztarab and Kozar, 1988).

2. Scale insects

Scale insects have protective covering such as powdery, waxy, and hardy scales. The wax is produced by epidermal glands (mostly cuticular pores, ducts). Scale insects have very specific morphological and biological features. Male scale insects display complete metamorphosis, whereas female is paedomorphic. Female scale insects have often sedentary habit and have four or five biological stages (egg, two or three nymph instars and adult). The female either lays eggs in a cavity under her body or in a waxy sac (ovisac). Crawlers (first instar nymphs) are mobile and play

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very important role in dispersing to other plants. Male scale insects have five or six biological stages (egg, two or three nymph stages, prepupa, pupa and adult). Adult males are tiny flies that not feed and live only a few days. Depending on species and the climate, the number of generations is variable between one to seven or eight in a year (Kosztarab and Kozar, 1988). Scale insects on forest plants are studied in Turkey by some authors (Bodenheimer, 1949; 1953; Schmitschek, 1953; Çanakçıoğlu, 1977; Selmi, 1979; Ülgentürk et al., 2004; Ülgentürk et al., 2012a,b). The number of forest trees used as park trees and new plant species imported as ornamental plants may lead to new insect species to enter the new regions. Insect species which are not cause a serious damage in their natural habitat may reproduce uncontrollably and inflict damage in a new ecosystem as they may not have natural enemies (Şahin and Ülgentürk, 2011). While *Torosaspis cedricola* (Balachowsky & Alkan) (Diaspididae), for example, sustaining their existence in low populations in natural cedar forests, it is the major pest of cedar trees in urban greenbelts (Dostbil and Ülgentürk, 2016; Ülgentürk et al., 2012a; Ülgentürk et al., 2019a). The maritime pine bast scale, *Matsucoccus feytaudi* Ducasse (Matsucoccidae), occurs in the western part of the Mediterranean basin and causes damage in South Eastern France and Italy, where it was accidentally introduced (Foldi, 2004).

Generally, mostly scale insects leave honeydew that covers all parts of the plant, and causing sooty mould. This may be indirectly detrimental to plants by excluding sunlight and interfering with photosynthesis in the leaves as well plants lose their aesthetic and economic value (Kosztarab and Kozar, 1988; Ülgentürk et al., 2019a,b). On the other hand, honeydew is important nutrient for many species such as insects, birds, and also humans. Honeydew is collected and used in producing of honeydew honey by honeybees. For examples honeydew of *Marchalina hellenica* Gennadius (Marchalinidae) is one of the important source of pine honey in Greece and Turkey (Gürkan, 2005Ülgentürk et al., 2012a ,). Pine honey has economic importance for many beekeepers and for forest villagers, as well. In addition to *M. hellenica,* many other hemipters are known as honeydew producer on cedar, chestnut, oaks, linden, and pine trees in Turkey (Ülgentürk et al., 2012b; Ülgentürk et al., 2013a, b; Ülgentürk et al., 2019b). Some scale insects are also known as the vector of plant diseases (Le Maguet et al., 2012). For example, the beech scale *Cryptococcus fagisuga* (Douglas) (Eriococcidae) feeds on beech trees (*Fagus* spp.). Attack by beech scale alone does not seriously damage beech trees; however, the feeding punctures in the bark allow beech bark disease, [*Nectria coccinea* var. *faginata* or *N. galligena* (Hypocreales: Nectriaceae)] a serious threat to the timber industry in Europe and in North America, to gain access to the cambium and phloem tissues (Houston, 1994).

Unfortunately, most of the studies which examine mostly host plants and distribution of scale insects occurring on forest areas in Turkey. There is very limited research on their biology, damage and natural enemies in forests. In this study, scale insects that feed on conifers (Table 1) and species that feed on broad-leaved trees and shrubs (Table 2) in Turkey are taken separately. Information of some important species on their biology, damage and natural enemies in urban green areas (forest, parks and gardens) are also given.

Table 1. Scale insects on conifer trees in Turkey

Species	Host plants	Distribution***	References
	Coccidae		
Ceroplastes floridensis Comstock	*C. libani*	Me	Ülgentürk et al., 2012b
Coccus hesperidum Linnaeus	*Abies bornmuelleriana* Mattif., *Cephalotaxus drupacea* Sieb & Zucc., *Cedrus libani* A. Rich, *C. atlantica* Manetti, *Picea orientalis* (L.) *Pinus brutia* Tenore, *P. maritima* Lam. *P. pinea* L., *P. sylvestris* L., *Taxus baccata* L.	Ae, Bs, Ma, Me	Çanakçıoğlu, 1977; Ülgentürk and Çanakçıoğlu, 2004
*C. pseudomagnoliarum (*Kuwana)	*P. sylvestris*	Bs, Ca	Çanakçıoğlu, 1977
Nemolecanium abietis Borchsenius	*A. bornmuelleriana, A. nordmanniana* (Steven)	Bs, Ca	Ülgentürk et al., 2019a
Nemolecanium aptii (Bodenheimer)	*A. nordmanniana*	Bs	Bodenheimer, 1953
Eulecanium sericeum Lindinger	*Abies cilicica* (Antoine & Kotschy), *A. bornmuelleriana*	Bs, Sea	Ülgentürk et al., 2019b
Physokermes hellenicus Kozár and Gounari	*A. bornmuelleriana, A. cilicica*	Bs, Ca, Me	Ülgentürk, 2016; Ülgentürk et al., 2019b
Physokermes piceae (Schrank)	*Picea abies* (L.), *P. pungens* Engelm., *P. pungens* var. *glauca* Beissn., *P. orientalis*	Bs, Ca, Ma	Çanakçıoğlu, 1977; Selmi, 1979; Ülgentürk and Özdemir, 2019
Poaspis intermedia Goux	*P. brutia*	Ma	Ülgentürk et al., 2012c
Pulvinaria floccifera (Westwood)	*Taxus baccata L., T. baccata* var. *fastigiata*	Bs, Ma	Bodenheimer, 1953; Selmi, 1979; Ülgentürk et al., 2008
	Diaspididae		
Aonidia mediterranea Lindinger	*Cupressus sempervirens* L., *Juniperus* sp. *Pinus* sp., *P. brutia*	Me, Ea	Yaşar, 1995; Kaydan et al., 2013
Aspidiotus nerii (Bouché)	*C. libani, P. abies, T. baccata*	Ma, Me	Selmi, 1979
Chionaspis kabyliensis Balachowsky	*C. libani*	Me	Ülgentürk et al., 2012b
Carulaspis juniperi (Bouché)	*Platyclaudus orientalis* (L.), *Calocedrus decurrens* (Torrey), *Chaemaecyparis lawsoniana* (A. Murray), *Cupressus* sp., *C. arizonica* Greene, *Juniperus sabina* var. *tamariscifolia* Ait.	Ae, Ca, Me	Kaydan et al., 2013; Ülgentürk et al., 2019a

Table 1. Scale insects on conifer trees in Turkey (continued)

Species	Host plants	Distribution***	References
Carulaspis minima (Signoret)	*Arceuthos drupacea* Ant. & Kotschy, *B. orientalis C. lawsonia, C.decurrens, Cupressus* spp., *C. sempervirens* L., *C. sempervirens* var. *horizontalis* (Mill.), *C. sempervirens* var. *pyramidalis* Nym., *C. goveniana* (Gordon), *C. arizonica Juniperus oxycedrus* L., *J. communis* L., *J. foetidissima* Willd., *J. sabina* L., J. *sabina* var. *nana* Syme., *J. excelsa, P. orientalis*	Ae, Bs, Ma, Me	Bodenheimer, 1949, 1952; Kaydan et al., 2013
Diaspidiotus jaapi Leonardi	*C. libani, P. brutia*	Ae	Ülgentürk et al., 2012b
Chrysomphalus dictyospermi (Morgan)	*T. baccata*	Ma	Selmi, 1979
Dynaspidiotus britannicus (Newstead)	*A. bornmuelleriana, A. equi-trojani* Ascher & Sint., *C. atlanticus, C. libani, P. pungens*	Bs, Ca, Ma	Selmi, 1979; Ülgentürk et al., 2019a
Dynaspidiotus abietis (Schrank)	*Abies* sp., *Pinus* sp.	Bs, Ca, Me, Ma	Özkazanç and Yücel, 1985; Yaşar, 1995
Dynaspidiotus abieticola (Koreneos)	*A. bornmuelleriana, A. concolor* (Gord.), *A. equi-trojani, C. libani, P. pungens*	Ca, Me	Yaşar, 1995; Ülgentürk et al., 2012b;
Gomezmenoraspis pinicola Leonardi	*P. brutia, P. pinea, P. sylvestris*	Ae, Bs, Me, Ma	Ülgentürk et al., 2012b; Kaydan et al., 2014
Gomezmenoraspis nr pinicola Leonardi	*C. libani*	Me	Ülgentürk et al., 2012c
Leucapis loewi Colvée	*Pinus* sp., *P. halepensis* Mill., *P. nigra, P. nigra* subsp.*pallasiana, P. pinea, P. sylvestris*	Ae, Bs, Ca, Ea, Me, Ma	Çanakçıoğlu, 1977; Selmi, 1979; Ülgentürk et al., 2004, 2019a
Leucaspis knemion Hoke	*Pinus sp., P. brutia*	Ma, Me	Bodenheimer, 1952; Ülgentürk et al., 2012b; 2019
L. pini Harting	*C. libani, P. brutia, P. halapennis, P. nigra P. pinea*	Ae, Bs, Me, Ma	Bodenheimer, 1952; Ülgentürk et al., 2012b,c; 2019
L. pusilla Löw	*P. brutia, P. elderica* Medv., *P. halepensis, P. maritima, P. nigra, P. nigra* subsp. *pallasiana, P. pandarosa* Dougl., *P. pinea, P. radiate* D.Don., *P. roxburghii* Sargenk, *P. sylvestris, P. strobe* L.,	Ae, Ca, Me, Ma	Bodenheimer, 1949,1952; Çanakçıoğlu, 1977; Selmi, 1979; Kaydan et al., 2014; Ülgentürk et al., 2012b,c; 2019
Lepidosaphes newsteadi (Sulc)	*Abies sp., A. bornmülleriana, A. pinsapo* Boiss., *P. pungens, P. nigra*	Bs, Ca, Ma	Kaydan et al., 2013, 2014
Lepidosaphes juniperi Lindinger	*Juniperus* sp., *J. excelsa* Bieb., *Cedrus libani, Pinnus nigra, P. brutia, T. occidentalis*	Ae, Bs, Ca	Kaydan et al., 2013; Ülgentürk et al., 2019a
Lepidosaphes ulmi Linneaus	*P. brutia*	Ae	Ülgentürk et al., 2012a
Lineaspis striata (Newstead)	*Arceuthobium* spp., *Cupresuss* sp. *C. sempervirens, Thuja* spp., *T. occidentalis*	Ca, Me	Yaşar, 1995; Ülgentürk et al., 2019a
Torosaspis farsianus (Balachowsky & Kaussari)	*C.arizonica, C. sempervirens var. horizontalis, C. sempervirens var. pyramidalis*	Me	Keçe Çalışkan and Ulusoy, 2017
T. cedricola Balachowski & Alkan)	*C. atlantica* Manetti, *C. atlantica* var. *glauca* Carr., *C. deodora* (Roxburg), *Cedrus libani*	Ae, Bs, Ca, Ea, Me, Ma, Sea	Yaşar 1995; Ülgentürk et al., 2012b, 2019a; Kaydan et al., 2014
	Eriococcidae		
Uhleria araucariae Maskell	*Araucaria* sp.	?	Kozar et al., 2013
Marchalinidae			
Marchalina caucasica Hadzibejli	*.nordmanniana, Piceae orientalis*	Bs	Ülgentürk et al., 2019b
Marchalina hellenica Gennadius	*C. libani, P. brutia, P. halepensis, P. pinea*	Ae, Bs, Me, Ma	Bodenheimer, 1953; Ülgentürk et al., 2012a; 2013a
	Matsucoccidae		
Matsucoccus josephi Bodenheimer & Harpaz	*Pinus* spp., *P. brutia, P. pinea*	Ae, Ma, Me	Ülgentürk et al., 2012c; Ülgentürk et al., 2016
M. pini Green	*Pinus sylvestris*	Ca	Ülgentürk et al., 2019a
	Monophlebidae		
Palaecoccus fuscipennis Burnmeister	*Pinus sp. P. brutia, P. pinea*	Ae, Ma, Me	Bodenheimer, 1953; Ülgentürk et al., 2012c
	Pseudococcidae		
Phenacoccus arambourgi Balachowsky	*C. libani*	Me	Ülgentürk et al., 2012b
Phenacoccus piceae Löw	*P. orientalis*	Bs	Ülgentürk and Özdemir, 2019
Phenacoccus yerushalmi Ben-Dov	*P. brutia, P. sylvestris*	Ae, Me	Ben-Dov et al., 2006; Ülgentürk et al., 2012c
Planococcus vovae (Nasonov)	*Cupressus sp. C. sempervirens, C. sempervirens var. horizontalis, C. sempervirens* var. *pyramidalis, C. goweniana, Juniperis excels* Bieb., *Libocedrus decurrens* Torr., *T. baccata, Thuja occidentalis* L.	Ae, Bs, Ca, Me, Ma,	Düzgüneş, 1982; Selmi, 1979; Ülgentürk et al., 2013b
Pseudococcus viburni (Signoret)	*C.drupacea*	Ma	Selmi, 1979

***Aegean (Ae), Blacksea (Bs), Mediterranean (Me), Marmara (Ma), Central Anatolia (Ca), Eastern Anatolia (Ea) and Southeastern Anatolia (Sea)

Table 2. Scale insects on broad-leaved trees, shrubs and other plants in Turkey

Species	Host plants	Distribution ***	References
	Acanthococcidae		
Acanthococcus aceris Signoret	*Quercus* sp., *Platanus orientalis* L.	Ea	Kaydan and Kozár, 2008
A. melnikensis Hodgson and Trencheva	*Myrtus communis* L.	Ae	Ülgentürk et al., 2013b
A. roboris Goux	*Castanea* sp., *Quercus* sp., *Q. cerris* L. , *Q. suber* L.	Ae, Bs Me	Kosztarab and Kozár, 1988; Kaydan and Kozar, 2008
A.salicis (Borchsenius)	*Salix alba* L.	Ea	Kozár et al.. 2013
Gossyparia spurius (Modeer)	*Quercus* sp., *Ulmus* spp., *Viscum album* L.	Ae, Ca, Ma	Çanakçıoğlu, 1977; Ülgentürk et al., 2003
Kotejacoccus turcicus Kaydan & Kozár	*Quercus* sp.,	Ea	Kaydan and Kozár, 2008
Neoacanthococcus atlihani Kaydan & Kozár	*Tamarix* sp.	2	Kaydan and Kozár, 2010
Orontesicoccus lauri (Erkılıç)	*Laurus nobilis* L.	Me	Erkılıç et al., 2011
	Asterolecaniidae		
Asterodiaspis bella (Russell)	*Quercus* sp., *Q. robor* L.	Ca, Ea,	Zeki et al. 2005; Ülgentürk et al., 2013a
A. hadzibeyliae Borchsenius	*Quercus* sp.	Ea	Ülgentürk et al., 2013a
A. ilicicola (Targioni Tozzetti)	*Quercus* sp., *Q. coccifera* L.	Ae, Me	Bodenheimer, 1953; Ülgentürk et al., 2013a
A. mina (Russell)	*Qercus* sp.	Bs, Ea	Kaydan et al., 2013; Ülgentürk et al., 2013a
A. minus Lindinger	*Q. coccifera*	Ca, Ma, Me	Bodenheimer, 1953
A.quercicola (Bouché)	*Quercus* sp., *Q. brantii* Lindl., *Q. robor*	Ca, Me	Zeki et al., 2005; Ülgentürk et al., 2013a
A. repugnans (Russell)	*Quercus* sp.	Bs, Ea	Ülgentürk et al., 2013a; Kaydan et al., 2014
A. variolasa (Ratzeburg)	*Quercus* sp., *Q. aegilops* L., *Q. coccifera, Q. robor* v. *fastiata*	Ae, Ca, Me, Ma	Yaşar, 1991; Ülgentürk et al., 2013a
	Coccidae		
Ceroplastes floridensis Comstock **	*Arbutus unedo* L., *L. nobilis, M. communis*	Ae, Me	Bodenheimer, 1953; Ülgentürk et al., 2013b
C. japonica Green*	*Acer negundo* L., *A. pseudoplatanus* L., *Aesculus hippocastanum* L., *Morus alba* L., *Nerium oleander* L., *Pistaciae terebinthus* L., *L. nobilis, Ulmus* sp.	Ma	Ülgentürk et al., 2008
Ceroplastes rusci (Linnaeus)**	*M. communis, N. oleander, P. palaestina* Boiss, *P. vera* L., *Populus* sp., *Olea europea* L., *Salix* sp.	Ae, Bs	Kaydan et al., 2013, 2014; Ülgentürk et al., 2013b
Coccus hesperidum L.**	*A.pseudoplatanus, Crateagus monogyna* Jacq, *L. nobilis, Lonicera caprifolium, N. oleander, P. atlantica, Quercus* spp.,	Ma	Bodenheimer, 1953; Ülgentürk et al., 2008
Eulecanium ciliatum (Douglas)*	*Quercus* sp., *Q. penduculiflora* K. Koch, *Jasminum fruticans* L., *Acer campestre* L., *A. pseudoplatanus, C. monogyna, C. oxycantha* L., *Ribes* sp., *Cydonia* sp., *Malus* sp.	Ca	Bodenheimer, 1953; Ülgentürk and Toros, 1999a; Zeki et al., 2005
Eulecanium cerasorum (Cockerell)*	*Q. robur*	Ca	Ülgentürk et al., 2013a
Eulecanium tiliae (Linnaeus)	*A. pseudoplatanus, A. hippocastanum, Crateagus* sp., *N. oleander, Quercus* sp., *Q. robur, Q. cercis, Q. penduculiflora* K. Koch, *Ulmus minor* Mill. (As *U. campestre), Tilia* sp.	Bs, Ma, Ca	Bodenheimer, 1953; Ülgentürk and Toros, 1999a; Ülgentürk et al., 2013b; Zeki et al., 2005
Filippia follicularis (Targioni-Tozzetti)	*Fraxinus americana* L., *F. excelsior* L., *Jasminium* sp., *Olaea* sp. *Olea europea* L. , *Phillyrea* sp., *Prunus avium* L., *P. dulcis* (Mill), *Quercus* sp. *Viburnum* sp., *V.m*	Ae, Bs, Ca, Me	Bodenheimer, 1953; Ülgentürk and Toros, 1999a; Ülgentürk et al., 2013b
Lichtensia viburni Signoret	*Ceratonia silique* L., *Hedera helix* L., *Phillyrea* sp., *Pistaciae* sp., *Viburnum tinus* L.	Ae	Yaşar, 1990; Ülgentürk et al., 2008;
Neopulvinaria innumerabilis Rathorn*	*Acer negundo, Catalpa bignonioides* Walter*C. monogyna, Gleditsia triacanthos* L., *Morus alba, Parthenocissus quinquefolia* (L.), *P.identalis, Quercus* sp., *Robinia pseudoacacia* L., *Spirea* sp., *Tilia* sp., *Vitis vinifera*	Ca, Ma	Ülgentürk and Ayhan, 2011
Parthenolecanium corni (Bouche)*	*Crateagus* sp., *Corylus avellana* L., *Fagus* sp., *Fraxinus* sp., *M. alba, Quercus* sp., *Salix* sp., *Ulmus* sp.	Bs, Ca, Me, Ma,	Bodenheimer, 1953; Ülgentürk and Toros, 1999a, Kaydan et al., 2014
P. rufulum (Cockerell)	*C. avellana, Quercus* sp.	Ae, Bs, Ca, Ma	Kaydan et al., 2013; Kaplan and Turanlı, 2016
Parthenolecanium tamaricis (Bodenheimer)	*Tamarix pallasi* Desv.	Ca?	Bodenheimer, 1953
Pulvinaria floccifera (Westwood)	*Prunus laurocerasus* L., *Camellia sinensis* (L.)	Bs, Ma	Alkan, 1957; Ülgentürk et al., 2008
P. terrestris Borchsenius	*Crateagus* sp.		Kaydan et al., 2013
Pulvinaria vitis (Linnaeus)	*Crateagus* sp., *Populus nigra* L., *P. tremula* L.,, *Quercus sp., Salix* sp., *S. alba, Ulmus* sp.	Ae, Bs, Ca, Ea, Ma, Me	Kaydan et al., 2013
Rhodococcus perornatus (Cockerell & Parrott)	*Rosa* sp., *R. cinnamomea* L., *R. canina* L., *R. damascena* Mill., *Rosa pimpinellifolia* L.	Ca, Me	Zeki et al., 2005
Saissetia oleae (Olivier)	*A. unedo, Phillyrea* sp., *O. europea, N. oleander*	Ae, Bs, Ma, Me	Kaydan et al., 2013, 2014

Table 2. Scale insects on broad-leaved trees, shrubs and other plants in Turkey (continued)

Species	Host plants	Distribution ***	References
	Cryptococcidae		
Cryptococcus fagisuga Lindinger	*F. orientalis*	Bs	Kozár et al. 2013
Pseudochermes fraxini (Kaltenbach)	*F. excelsior*	Ma	Bodenheimer, 1953; Kozár et al., 2013
	Diaspididae		
Aonidia lauri (Bouche)	*L. nobilis*	Ma Me, Sea	Kaydan et al., 2013
Aonidiella aurantii (Maskell)	*Cerotonia siliqua* L., *L. nobilis*	Me	Kaydan et al., 2013, 2014
Aspidiotus hedericola Leonardi	*L. nobilis, H. helix*	Ae, Me, Ma	Kaydan et al., 2013
A. nerii Bouché	*Acacia cultiformis* G. Donn., *A. cyanophilla* Lindley, *Aucuba japonica* Tunb., *H. helix, Jasminum* sp., *L. nobilis*	Ae, Bs, Me, Ma	Kaydan et al., 2013, 2014
Chionaspis etrusca Leonardi	*Tamarix* sp.	Ca, Ea, Me	Bodenheimer, 1953
Chionaspis salicis (Linnaeus)	*P. alba, P.x canadensis* Moench, *P. nigra* L., *P. tremula, Salix alba, S. babylonica* L., *Ulmus* sp.	Bs, Ca, Ea,	Kaydan et al., 2013, 2014
C. lepineyi Balachowsky	*Quercus* sp.	Ea	Kaydan et al., 2013, 2014
Chrysomphalus dictyospermi (Morgan)**	*B. sempervirens, C. siliqua, H. helix, Ilex aquifolium* L., *Jasminum sambac* (L.), *L. nobilis, M sylvestris, M. communis, N. oleander*	Ae, Ma	Yaşar, 1995; Erözmen and Yaşar, 2018
Comstockaspis perniciosus (Comstock)**	*Crateagus orientalis* M.Bieb, *Prunus spinose* L., *Spartium junceum* L.	Bs, Ca, Ea, Me	Kaydan et al., 2013, 2014; Kaydan et al., 2013, 2014
Diaspidiotus armenicus (Borchsenius)	*P. alba, P.nigra, Salix* sp., *Ulmus* sp.	Ea	Kaydan et al., 2013
D.caucasicus (Borchsenius)	*Populus sp., P. nigra* var. *pyramidilis, Quercus* sp., *Salix* sp.	Bs, Ca	Kaydan et al., 2013
D.gigas (Thiem& Gerneck)	*Populus nigra, Salix* sp.	Bs, Ea, Ma	Kaydan et al., 2013, 2014
D. lenticularis (Lindinger)	*Prunus avium* L.	Ma	Kaydan et al., 2013
D.kaussarii Balachowsky	*Fraxinus* sp., *M. sylvestris, P.orientalis*	Ea	Kaydan et al., 2013, 2014
D. marani (Zahradnik)	*Fraxinus sp., M. sylvestris, P. orientalis, P. avium, Ulmus americana* L.	Bs, Ca, Ea, Ma, Sea	Kaydan et al., 2013
D. ostreaeformis (Curtis)	*A. negundo, C. avellana, Liquidambar orientalis* Miller, *M. sylvestris, Populus sp., P. x. canadesis*-sp.	Ae, Bs, Ca, Ea, Ma, Sea	Kaydan et al., 2013
D. osborni (Newell & Cocckerell)	*Salix* sp.	Sea	Kaydan et al., 2013
D. pyri (Lichtenstein)	*Salix* sp.	Bs, Ca, Ea, Ma, Sea	Kaydan et al., 2013
D. uvae (Comstock)	*Celtis siliquasrum* L., *F. excelsior, P. orientalis, Paulownia tomentosa* (Thunb.) *Jacaranda mimosifolia* D.Don, *R. pseudoacacia*	Me	Keçe- Çalışkan and Ulusoy, 2017
D. wuenni (Lindinger)	*Alnus* sp., *Quercus sp.*,	Ea	Kaydan et al., 2013
D.zonatus (Frauenfeld)	*F. orientalis, Quercus* sp., *Q. coccifera, Salix* sp., *Ulmus americana*	Bs, Ca, Ea	Kaydan et al., 2013; 2014
Dynaspidiotus britannicus (Newstead)	*C.siliqua, Daphne* sp., *H. helix., L. nobilis, M. communis*	Bs, Ca, Me	Bodenheimer, 1953; Ülgentürk et al., 2012a; 2019
Epidiaspis leperii (Signoret)	*A. hippocastaneum, Pistacia* sp., *Prunus* sp., *R. pseudoacacia, Malus* sp., *Pyrus communis* L.	Ae, Bs, Ca, Ma	Kaydan et al., 2009; Erözmen and Yaşar, 2018
Gonaspidiotus minimus (Leonardi)	*Quercus coccifera, Q. dschrochensis, Q. ilex, Thuja* sp.	Ae, Me	Bodenheimer, 1952
Lepidosaphes granati Koroneos	*Quercus* sp., *P. orientalis, Ulmus* sp., *U. glabra*	Ea	Kaydan et al., 2009
Lepidosaphes malicola Borchsenius	*A. negundo, Farxinus excelsior, Populus* sp., *Quercus* sp., *Salix* sp.	Ea	Kaydan et al., 2013
L. ulmi (Linnaeus)**	*Acer* sp., *A. negundo, Fagus* sp., *Gleditschia* sp., *Ilex* sp., *Populus* sp., *Quercus* sp., *Rosa* sp., *R. canina, R. damescana, Salix* sp., *S. junceum*	Bs, Ca, Ea, Ma	Kaydan et al. 2013; Erözmen and Yaşar, 2018
Melanaspis inopinata (Leonardi)	*A.hippocastaneum, A. unedo, Bauhinia* sp., *C. siliquastrum, Fraxinus* sp., *P.avium, Ulmus* sp.	Ca, Ma	Bodenheimer, 1949; Ülgentürk and Toros, 1996; Ayten and Ülgentürk, 2007
Parlatoria oleae (Colvée)**	*Eriobotrya* sp., *Fraxinus* spp., *Rosa* sp., *M. sylvestris, Prunus* sp., *R. pseudoacacia*	Ae, Ca, Me, Ma	Kaydan et al., 2013
P. pergandii (Comstock)**	*C. siliqua, L. nobilis*	Me, Ae	Kaydan et al., 2013
Pseudaulacaspis pentagona (Targioni-Tozzetti)**	*Aesculus carnea* Briotii, *C. bignonioides, Cornus alba* L., *Forsythia x intermedia, F. americana, F. excelsior, M. alba, Prunus* sp., *Paulownia tomentosa* (Thunb.), *P. avium, P. cerasus, Quercus sp., Rhus typhina* L., *S.babylonica, S., Syringia vulgaris* L.	Ae, Bs, Ca, Ea, Ma, Me	Bodenheimer, 1949; Erkılıç and Uygun 1995; Mohammed et al. 2016
Salicicola archangelskyae (Lindinger)	*C.monogyna, C. oxyacantha, C. orientalis, F. excelsior*	Ae, Ca, Ea, Me	Yaşar, 1995; Kaydan et al., 2014
S. kermanensis (Lindinger)	*Populus* sp., *P. nigra, Quercus* sp.,	Ea	Yaşar, 1995
Targioni vitis (Signoret)	*A. hippocastaneum, Castanea crenata* L., *Quercus* sp.	Ca, Ma, Me	Kaydan et al., 2013
	Eriococcidae		
Eriococcus buxi (Boyer de Fonscolombe)	*Buxus sempervirens* L.	Bs, Ma	Kaydan and Kozár, 2008; Ülgentürk et al., 2008
	Kermesidae		
Kermes bacciformis Leonardi	*Quercus* sp., *Q. coccifera*	Me	Kaydan et al., 2013
Kermes sp. nr *bacciformis* Leonardi	*Quercus* sp.	Ea, Me	Ülgentürk et al., 2013
K. bekiri Bodenheimer	*Q. aegilops*	Ae	Bodenheimer, 1953
K. greeni Bodenheimer	*Q. coccifera, Q. ilex*	Ae, Me	Ülgentürk et al., 2013

Table 2. Scale insects on broad-leaved trees, shrubs and other plants in Turkey (continued)

Species	Host plants	Distribution	References
K. hermonensis Spodek & Ben-Dov	*Q. infectoria*	Sea	Kaydan et al., 2014
K. ilicis L.	*Q. coccifera*	Ma	Bodednheimer, 1953
K. muhlisi Bodenheimer	*Quercus* sp.	Me	Bodenheimer, 1953
K. roboris (Fourcroy)	*Quercus* sp.	Ea	Kosztarab and Kozar, 1988; Ülgentürk et al., 2013
K. sadrii Bodenheimer	*Q. aegilops*	Me	Bodenheimer, 1953
K. safinazae Özkök	*Quercus sp.*	Ca	Bodenheimer, 1953
K. vermilio Planchon	*Q. aucheri, Q. coccifera*	Ca	Bodenheimer, 1953; Ülgentürk et al., 2013
Nidularia balachowskii Bodenheimer	*Quercus* sp.	Ea	Bodenheimer, 1953
	Lecanodiaspididae		
Lecanodiaspis sardao Targioni-Tozzetti	*Cistus* sp., *C. albidus* L.	Ae, Bs, Ma	Bodenheimer, 1953; Ülgentürk et al., 2013; Kaydan et al., 2014
	Monophlebidae		
Icerya purchasi Maskell	*L. nobilis, N. oleander, R. pseudoacacia*	Ma	Kaydan et al., 2013
	Pseudococcidae		
Nipaecoccus filamentosus (Cockerell)	*R. pseudacacia*	Ma	Kaydan et al., 2013
N. delussusi (Balachowsky)	*Erica australis* L. (Ericaceae)	Bs	Kaydan et al., 2014
Phenacoccus aceris (Signoret)*	*Acer* sp., *A. campestre, A. negundo, A. platanoides, A. pseudoplatanus, Betula* sp., *Eunoymus japonicus A. hippocastanum, Carpinus betulae Juglans regia, R. pseudoacacia, Ficus carica, F. americana, F. excelsior, P. orientalis, Cotoneaster* sp., *C. oxyacantha, Cydonia oblonga* Mill., *M.communis, Mespilus germanica* L., *Prunus domestica, P. persica* (L.), *P. spinosa, P.communis, Quercus* sp., *Sorbus* sp., *Tilia* sp., *Ulmus* sp.	Ca, Ea	Düzgüneş, 1982, Kaydan et al., 2005
P. querculus (Borchsenius)	*Quercus* sp.	Bs, Ea	Kaydan et al., 2013
Planococcus citri (Risso)**	*L. nobilis, N. oleander*	Ma	Bodenheimer, 1953; Kaydan et al., 2013
Pseudococcus comstocki (Nasanov)**	*M. alba, P. orientalis*	Bs, Ea	Kaydan et al., 2013
Pseudococcus viburni (Signoret)	*N. oleander, P. laurocerasus, Salix* sp., *Quercus* sp., *Sambucus nigra L., Eriobotrya japonica* (Thunb.), *Magnolia grandiflora* L.	Bs, Ca, Ma	Düzgüneş, 1982; Kaydan et al., 2014
Planococcus vovae (Nasonov)	*L. nobilis*	Bs	Kaydan et al., 2014
	Putoidae		
Puto israelensis Ben-Dov	*Q. coccifera*	Ae, Me	Ülgentürk et al., 2013a
Puto superbus (Leonardi)	*Q. cercis*	Me	Kaydan et al., 2004

*Mostly in urban areas, **Mostly agriculture and horticulture areas, ***Aegean (Ae), Blacksea (Bs), Mediterranean (Me), Marmara (Ma), Central Anatolia (Ca), Eastern Anatolia (Ea) and Southeastern Anatolia (Sea)

2.1. Scale insects on conifer plants in Turkey

About 42 species of scale insects on conifer trees were reported in Turkey (Kaydan et al., 2013; Keçe and Ulusoy, 2017; Ülgentürk et al., 2019a,b; Ülgentürk and Özdemir 2019). Pine trees vary according to climate and region. They also have the richest fauna of scale insects (twenty species). In forests of Turkey, *Leucaspis pusilla* Löw, *Gomezmenornaspis cedricola* Leonardi, *M. hellenica, Matsucoccus josephi* Bodenheimer and Harpaz (Matsucoccidae) and *Paleococcus fuscipennis* Burnmeister (Monophlebidae) are the most common species on pines, however *Torosaspis cedricola* (Balachowsky & Alkan) on cedar trees (Ülgentürk et al., 2012a,b). Except *Leucapis* spp., the other species are fed on woody part of Conifer trees (Ülgentürk et al., 2012b). Although *M. hellenica* is accepted as useful since its honeydew is a resource of Pine honey, actually it is a phloem sap feeder and cause yellow spots, early falling of needles, die back branches and destroyed young pine trees (Ülgentürk et al., 2012b, Ülgentürk et al., 2013b). *M. hellenica* has one generation in a year and overwinters mostly third instar nymph in Aegean pine forest in Turkey (Bodenheimer, 1953; Gürkan, 2005, Ülgentürk et al., 2011). Many predators play an important role on plant health, through regulating *M. hellenica* populations. Among those predators *Neoleucopis kartliana* (Tanasijtshuk) (Diptera: Chamaemyiidae) is the most efficient and common predator of *M. hellenica* (Ülgentürk et al., 2013c). Recently, *M. caucasica* Hadzibejli was found on *Abies nordmanniana* and *Piceae orientalis* in Blacksea forest (Ülgentürk et al., 2019b). The Israel Pine Blast Scale *M. josephi* was recorded on *P. brutia, P. halepensis* and *P. pinea* in forest of southern and Western Anatolia (Ülgentürk et al., 2013c). Afterwards Ülgentürk et al. (2016) determined that *M. josephi* has at least 4 generations per year and overwinters as second stage (cyst) underneath the bark of pine trees. Male and female with eggs were observed four times in March-April, May-June, July-August and the end of September. The adult females were settled for oviposition on the lower stems at the base of needle-bunches, on old cones and underneath the bark. Female produced a loose white ovisac and deposited 188-293 eggs. *Elatophilus hebraicus* Pericart (Hemiptera: Anthocoridae) is common and effective predator in Turkey (Ülgentürk, 2016). *P. fuscipennis* is a common monophlebid in Mediterranean and Aegean pine forests in Turkey (Ülgentürk et al., 2011). Like other monophlebids, it feeds on phoem and secretes honeydew (Ülgentürk et al., 2012a).

The range of cedar (*Cedrus* spp.) forest presently covers about 600,000 ha in Turkey (Boydak and Çalıkoğlu, 2008).

Cedar trees are generally used for commercial purpose in Turkey. The most common and harmful pest of cedar is *T. cedricola* whereas totally 13 scale insect were recorded on cedar trees in Turkey (Ülgentürk et al., 2012a; Ülgentürk et al., 2013b). High population of *T. cedricola* has a very harmful effect on cedar trees, especially young cedar trees in urban green areas. High levels of sulphur dioxide and dust limit the activity of natural enemies in urban planting cedar (Dostbil, 2012). *T. cedricola* has 2 generations in a year and overwinters as fertilized female on needles of cedar (Dostbil and Ülgentürk, 2016). *Dynaspidiotus britannicus* (Newstead) (Diaspididae) feeds on cedar, fir and spruce species while *T. cedricola* occurs only cedar species in Turkey. *D. britannicus* has two generations and overwinters as second nymph instar on needle of cedar (Ayhan and Ülgentürk, 2011). *Physokermes hellenicus* Kozar and Gounari (Coccidae) is distributed both natural fir forest and urban belts. It hibernates as third nymph stage and has one generation in a year in urban areas of Ankara (Ülgentürk, 2016). On the other hand, *Physokermes piceae* (Schrank) is found only on urban spruce trees of Ankara, Eskişehir and İstanbul (Çanakçıoğlu, 1977; Ülgentürk et al., 2008). *P. piceae* is the main pest of spruce in parks and gardens of Ankara (Ülgentürk and Toros, 1999a; Ülgentürk et al., 2019a). It has one generation in a year and overwinters as second nymph stage (Turguter and Ülgentürk, 2006). Both species have potential of honeydew honey production in Turkey. *Aphycoides clavallatus* (Dalman) (Hymenoptera: Encyrtidae) is dominant parasitoids of *P. piceae* and *P. hellenicus* in Ankara. *P. hellenicus* is associated with a few number predators namely; *Anthribus nebulosus* Forster (Coleoptera: Anthribidae), *Chilocorus renipustulatus* Scriba (Coleoptera: Coccinellidae), *Atroctotomus* sp. (Hemiptera: Anthocoridae) in Turkey (Ülgentürk, 2001; 2016). *Anthribus fasciatus* Forster (Coleoptera: Anthribidae) was the most abundant natural enemy of *P. hellenicus* in Greece (Papanastasiou et al., 2018).

Phenacoccus piceae Löw (Pseudococcidae) has very large population on oriental spruce urban areas, while it is rare in natural forest of Blacksea region (Ülgentürk and Özdemir, 2019). About ten scale insect species are known on fir in Turkey. *Eulecanium sericeum* Lindinger, *Nemolecanium abietis* and *M. caucasica* are recently determined on fir in Blacksea Region (Ülgentürk et al., 2017). There are only five scale insect species that were recorded on juniper, among them *Planococcus vovae* (Hemiptera: Pseudococcidae) attracts notice by its honeydew production (Ülgentürk et al., 2013b).

A pest of yew trees [*Taxus* spp., (Taxaceae)] *Pulvinaria floccifera* (Westwood) (Coccidae) overwinters as the second nymph instar and has two generations per year in İstanbul. *Chilocorus bipustulatus* (L.) and *Exochomus quadripustulatus* (L.) (Coleoptera: Coccinellidae) are recorded as the predators and *Coccophagus lycimnia* (Walker) (Hymenoptera: Aphelinidae) as the parasitoid of *P. floccifera* (Selmi, 1979). *Parthenolecanium pomeranicum* (Kawecki) (Coccidae) is seldom scale insect on yew trees in Turkey (Ülgentürk and Toros, 1999a).

2.2. Scale insects on broad-leaved trees and shrubs in Turkey

Main broad–leaved trees of the Turkey forest are oak species (Anonymous, 2019). Over 40 scale insect species on oak trees were recorded in Turkey. Only 20 species are belonging to Asterolecaniidae (8) and Kermesidae (12) families, and are feeding only on oak trees (Table 2). First record of scale insect on oaks was *Kermes ilicis* L. (Kermesidae) on *Quercus coccifera* which is called as Kermes oak (Fahringer, 1922). *K. ilicis* were used commonly to dying silk and wool materials in Mediterranean and Middle East Regions in ancient times (Bodenheimer, 1953). Recently *Kermes hermonensis* Spodek & Ben-Dov was detected on *Quercus infectoria* Oliv. in Diyarbakır (Kaydan et al., 2014). Beside chesnut and hazelnut, *Parthenolecanium rufulum* (Coccidae) is a pest of oaks in Turkey (Ecevit et al., 1987). It has one generation in a year and overwinters as second nymph instar on branches (Kaplan et al., 2016). *Parthenolecanium corni* (Bouché) (Coccidae) is polyphagous species that is common on fruits, ornamental and forest trees including oaks, beech, ash, maple, elm, polar and willow (Kaydan et al., 2013). On the other hand, *Eulecanium ciliatum* (Douglas) (Coccidae) is a widespread soft scale insect on Aceraceae (*Acer campestre* L., *A. negundo* L., *Acer pseudoplatanus* L.), and Rosaceae (*Crateagus monogyna* Jacq, *C. oxyacantha* L., *Ribes* sp., *Cydonia* sp.) in the parks and gardens of Ankara (Ülgentürk and Toros, 1999a). Following heavy infestations, branches dried up and sometimes the whole tree died. It has one generation per year and overwinters as second nymph stage on the host plants in Ankara (Ülgentürk and Toros, 1999c). The most common parasitoid of *E. ciliatum* was *Encyrtus infidus* (Rossi) (Hymenoptera: Encyrtidae) which made up of 66% of all parasitoids and the common predator was *Anthribus fasciatus* (Förster) Coleoptera: Anthribidae) in Ankara (Ülgentürk and Toros, 1999b). The mapple mealybug *Phenacoccos aceris* (Signoret) (Pseudococcidae) is a polyphagous species recorded mostly on urban plants in Turkey. It has one generation in a year and overwinters as third nymph stage in the bark and other hidden places on the plant. At the end of February and in early March, the nymphs started to move to the one year old twigs. The female started egg laying in the middle of April in both years. Hatching started at the beginning of the June and first-instars nymphs settled on the leaf and remained there until the end of September. After this period, the nymphs moved to the bark to overwinter. The population was affected by natural enemies and by environmental conditions throughout the year (Kaydan et al., 2006; Kaydanet al. 2015). This mealybug is supposed to be of European origin where occasionally becomes a pest on ornamental or fruit trees (Kosztarab and Kozár, 1988). *P. aceris* was verified as the vector of the Little Cherry Virus 2 (LChV-2) and GLRaV species, Grapevine virus A and Grapevine virus B (GVA and GVB) in Europe (Le Maguet et al., 2012; Garcia et al., 2016). *Melanaspis inopinata* Leonardi (Diaspididae) is a common pest on ash, horse chestnut and other park and forest plants (Ülgentürk and Toros, 1996; Kaydan et al., 2013). It has one generation annually, and overwinters as adult female in Ankara (Ayten and Ülgentürk, 2007). *Kermes* spp., *P. rufulum, P. corni, Puto israelensis* Ben-Dov are considered to be the sources of honeydew honey in oak forest in Turkey (Ülgentürk et al., 2013a, b).

Many species that are very common and serious pest on agriculture and horticulture plants are found on forest plants too. For example, olive scale insect *Parlatoria oleae* (Colveé) (Diaspididae) is an important pest on olive trees

and apple, pear, quince and other species of Rosaceae. It has two generations in a year and overwinters as female in Turkey (Uygun et al., 2010). White peach scale *Pseudaulacaspis pentagona* (Targioni Tozzetti) (Diaspididae) is a pest of economic importance for mulberry, peach trees and woody ornamentals and it is widespread all the fruit-growing areas of Turkey (Yaşar, 1995; Uygun et al., 2010). It feeds on the trunks, branches and twings. In heavy infestations, dieback and death of trees occur (Erkılıç and Uygun, 1995). It is recorded on twenty-two host plant species in Ankara (Mohammed et al. 2016). *Saissetia oleae* (Olivier) (Coccidae) is poliphagous and important pest species on citrus and olive orchards. *S. oleae* is recorded on wild olive and oleander in maquies of Aegean and Mediterranean forests (Uygun et al., 2010). *Planococcus citri* (Risso) (Pseudococcidae) is the most cosmopolitan mealybug species that infested over 300 plant species in tropics and subtropics as well as in greenhouse (Williams, 2004). It is considered as one of the most major pest of citrus orchards in Turkey, due to the fact that its chemical control has not been achieved successfully yet. It has 3 generations per year and can be controlled using the parasitoid *Leptomastix dactylopii* Howard (Hymenoptera: Encyrtidae) and the predator *Chryptolaemus montrouzieri* Mulsant (Coleoptera: Coccinellidae) in citrus orchards in Turkey (Uygun et al., 2010). A few numbers of scale insects on shrubs are determined in forest areas. *Rhodococcus perornatus* (Cockerell & Parrott) (Coccidae) is recorded on oil rose in horticulture and dog rose in forest areas (Ülgentürk et al., 1999). *Lecanodiaspis sardoa* Targioni Tozzetti (Leconaspidae) and *Acanthococcus melnikensis* (Hodgson & Trencheva) (Acanthococcidae) had large populations on *Cistus* sp. (Cistaceae) and *Myrtus* spp. (Myrtaceae), respectively. These plants are occurred in sunny places in or border of forests (Aydınözü, 2008). *Trabutina crassispinosa* Borchsenius and *T. mannipara* (Hemprich & Ehrenberg) (Pseudococcidae) are seldom scale insects while *Prodiaspis tamaricicola* (Malenotti) (Diaspididae) is very common on *Tamarix* spp. (Tamaricaceae) in Turkey (Kaydan et al. 2013; Kaydan and Kozar, 2008).

3. Conclusions

In this study is determined totally 137 scale insect in forest trees in Turkey. Among of them 43 scale insects [Coccidae (10), Diaspididae (22), Eriococcidae (1), Marchalinidae (2), Matsucoccidae (2), Monophlebidae (1) and Pseudococcidae (5)] are occured on conifer in Turkey. In addition, totally 95 scale insect species belonging to Acanthococcidae (8), Asterolecaniidae (8), Coccidae (18), Cryptococcidae (2), Diaspididae (34), Eriococcidae (1), Kermesidae (12), Lecanospidae (1) Monophlebidae (1), Psedocccidae (8) and Putoidae (2) are reported on broad-leaved trees and shrubs in forest and urban areas in Turkey. Most of them infest agriculture and horticulture plants. Insects in forests and other natural areas have the potential to become a source of contamination for cultured plants. On the other hand, natural enemies that we can use against insect pests of cultivated plants can maintain themselves only in natural areas. In this regard, knowledge on destructive and beneficial species no doubt will help us understand, protect and use the ecosystem without destroying it.

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