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## SOME FOREST TREES FOR HONEYDEW HONEY PRODUCTION IN TURKEY

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Honey is an important source of nutrients and energy and an effective remedy against various human diseases. Honeydew honey is produced from honeydew of phloem-feeders that honeybees gather. In this study, we focused on honeydew producers and diversity of host tree species which are involved in honeydew production in Turkey. A total of 24 honeydew producers by host tree species are identified in Turkey. Of these, 13 coniferous trees and 11 deciduous trees. The main honeydew producer in Turkey is a scale insect, *Marchalina hellenica* Gennadius (Hemiptera: Margarodidae) living mainly on pines (Turkish red pine, Aleppo pine, and rarely on stone pine, Anatolian black pine and Scots pine). Honeydew producer insects can be treated as serious pests of conifer and broadleaf trees. The aphids and the scale insects such as *Ceroplastes floridensis*, *Cinara cedri*, *C. laportei*, *Eulachnus rileyi*, *Icerya purchasi*, *Kermes vermilio*, *Lichtensia viburni* and *Saissetia oleae* are known as pests in several European, Asian and African countries. Despite their potential harm to their host plants, insect species producing honeydew play an important role in honey production in Turkey. Turkish honey production is exported to EU countries and, furthermore beekeeping is an important part of agricultural sector in Turkey.

**Keywords:** honeydew honey, aphids and cochineals, forest trees, Turkey.

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### INTRODUCTION

One of the sources of honey in Turkey is so-called honeydew honey, which is produced by bees collecting sugar-contained matters on tree twigs. Honeydew is a sugar-rich sticky liquid, secreted by insect, mainly by aphids and scale insect, as they feed on plant sap. Aphids excrete the rest of the sugar substances after digesting the necessary nutrients. Bees convert this intense sugary substance into honey called honeydew honey (Schmutterer, 1953, 1956; Pechhacker, 1977; Zander, Koch, 1994). Honeydew honeys are known and appreciated by their particular characteristics of strong colors and flavors. The composition criteria for honeydew honeys in respect of fructose and glucose content,

as well as with regard to electrical conductivity are different than the composition criteria for floral honeys (Sancho et al., 2008). Scientifically and philosophically precise definitions of honeydew are elusive and references can vary widely. Manna, honeydew and nectar are the words used throughout the Ancient World to describe sweet desirable liquid or crystalline substance sometimes referred to as «food of the gods» (Jones, 2008).

Honeydew honey refers to honey produced by the bees from the secretions of aphides and other bugs, feeding on plant sap. This honey is considered to be a delight in some areas of the world because of its taste and because its rarity. Honey is produced mainly in Turkey, Greece, Germany, Austria, and Spain. In Turkey the dominant tree species for pro-

duction of the honeydew are pines, mainly *Pinus brutia*, and then firs, cedars, oaks, junipers and olives (Ermin, 1950; Crane, Walker, 1985; Gürkan, 1988; Morales et al., 1988; Kunkel, 1997; OGM, 2009; Rybak-Chmielewskahszczesna et al., 2013; Ülgentürk et al., 2013a). Overall, the season of honey production is longer in comparison to flower honey production season because the former begins in the second half of August and lasts till the end of October. This prolonged honey production season is essential for income of beekeepers living in marginal areas and thus important for the intensive agriculture (MAYBİR, 2008; OGM, 2009). Anatolia's geographical location, land formation, climate varieties, variety of plant and insect species, provide different agricultural forestry systems and various insect-plant combinations.

This study reviews the diversity of insects producing honeydew and their host tree species involved in honeydew production in Turkey.

#### HONEYDEW HONEY PRODUCTION IN TURKEY

Honey is one economically important production. Turkey is one of the 10 largest producers of honey and particularly the largest producer of pine honey, with approximately 15 000 t of production each year (Sunay, 2008). Pine honey constitutes one fourth of all the honey produced in Turkey. Pine honey is a honeydew honey based on honeydew production by a scale insect *Marchalina hellenica* living mainly on Turkish pine *Pinus brutia* and stone pine *P. pinea* (OGM, 2009; Ayan et al., 2014) (Fig. 1, 2).

Droplets of honeydew are collected by honeybees and used to make honeydew honey. There are 35 species from Hemiptera order as well as *Marchalina hellenica* which produce sugar contained secretion from phloem sap of various plants (Tables 1, 2) (Ülgentürk et al., 2013a).

The most important characteristic of pine honey is its consistency and durability for many years. The forest land of 1000 m<sup>2</sup> produces approximately 20–25 kg pine honey (Mere, 2010). The pine honey from forests forms about 25 % of all the honey produced in Turkey (OGM, 2013). The major pine honey areas for the pine honey productions are in the provinces of İzmir, Aydın, Kuşadası, Dilek Peninsula, Milas, Bodrum, Muğla, Marmaris, Datca, Fethiye, Kas, Balıkesir, Manisa and Canakkale in Mediterranean and Egean regions in Turkey. About 80 % of all pine honey in Turkey comes from the

province of Muğla (Mere, 2010) where nearly ten thousand beekeepers derive their livelihood from pine honey production. *M. hellenica* is the most common and abundant species there. According to the data from years 1991–2011, yield of pine honey varied from 7 970 to 15 000 t of the total honey production per year (Firatli et al., 2010; TÜİK, 2013; Ülgentürk, 2013a). In Greece annual honey production amounts approximately to 15 000 t of which about 65 % is derived from honeydew (Bacandritsos, 2004). In general, the majority of Turkish honey production is exported to the EU countries providing in average \$ 9–12 million of income. Due to its impact on the economy and employment, beekeeping is an important part of agricultural sector in Turkey, especially in the Muğla province (Ülgentürk et al., 2013a).

Thirteen conifer and eleven broadleaf species were determined as the hosts of the insects producing honeydew. Among them, twenty plant species are native and three are exotic: *Pinus pinaster*, *Quercus suber* and *Acacia* sp. (see Tables 1, 2).

Regarding to the producers of honeydew, *Marchalina hellenica* seems to be the most significant species for pine honey production. Its stable population is a basic condition for honeydew collection by honeybees (Gürkan, 1988; Gounari, 2006; Ülgentürk et al., 2012a, b, c). Apart from Turkey, *M. hellenica* has been recorded in Greece and Italy (Bacandritsos, 2004; Kandemir, 2009). The cedar of Lebanon, *Cedrus libani*, has been recorded as a new host plant of *M. hellenica*. The infested cedars are found exceptionally in urban areas (Ülgentürk, 2013a). The relation between cedar and *M. hellenica* should be studied more deeply because the infested cedar trees could become an important alternative for honeybees at higher altitudes (Ülgentürk, 2013a).

Other sap sucking insects such as the aphids *Cinara cedri*, *C. palaestinensis*, *C. pilicornis*, *Eulachnus rileyi*, *Schizolachnus pineti* and the scales *Palaeococcus fuscipennis* and *Phenacoccus yerushalmi* were recorded on pine trees (see Table 1).

Aphids generally live on pine needles and twigs producing honeydew from early spring to late autumn. Contribution of the scales *P. fuscipennis* and *P. yerushalmi* to honeydew production is rather insignificant but *P. fuscipennis* is common in pine forests of eastern Mediterranean and Marmara regions, especially in areas where *M. hellenica* is very rare. In addition, the fir, *Abies cilicica* is determined as a new host plant of *P. fuscipennis* (Ülgentürk, 2013a).





**Fig. 1.** The scale insect *Marchalina hellenica* (Hemiptera: Margarodidae) on pine trees – a main honeydew producer in Turkey. Photo: Y. Yanmadık, Muğla province in Aegean region, autumn period.



**Fig. 2.** Domestic honeydew production in forest region of Turkey.

**Table 1.** Honey producing insects from the family Hemiptera colonizing conifers in Turkey\*

Insect species	Insect Family	Tree species	Tree species E/N**
<i>Cinara cedri</i> Mimeur	Aphididae	<i>Cedrus libani</i> A. Rich., <i>Pinus brutia</i> Ten.	N N
<i>C. palaestinensis</i> Hille Ris Lambers	»	Idem	N
<i>C. (Cedrobium) laportei</i> Remaudiere	»	<i>C. libani</i> A. Rich.	N
<i>C. pilicornis</i> Hartig	»	<i>P. brutia</i> Ten.	N
<i>Eulachnus rileyi</i> Williams	»	Idem	N
<i>Schizolachnus pineti</i> Fabricius	»	»	N
<i>Coccus hesperidum</i> Linnaeus	Coccidae	<i>Abies nordmanniana</i> subsp. <i>bornmuelleriana</i> Mattf., <i>C. libani</i> A. Rich., <i>P. pinaster</i> Aiton, <i>P. pinea</i> L., <i>Taxus baccata</i> L.	N N E N N
<i>Ceroplastes floridensis</i> Comstock	»	<i>C. libani</i> A. Rich.	N
<i>Marchalina hellenica</i> Gennadius	Margarodidae	<i>C. libani</i> , A. Rich. <i>P. brutia</i> Ten., <i>P. halepensis</i> Miller, <i>P. nigra</i> J. F. Arnold.	N N N N
<i>Palaeococcus fuscipennis</i> Burmeister	»	<i>A. cilicica</i> (Ant. et Kotschy) Carr.	N
<i>Phenacoccus arambourgi</i> Balachowsky	Pseudococcidae	<i>C. libani</i> A. Rich.	N
<i>P. yerushalmi</i> Ben-Dov	»	<i>P. halepensis</i> Miller, <i>P. pinaster</i> Aiton, <i>P. sylvestris</i> L.	N E N
<i>Planococcus vovae</i> Nasonov	»	<i>Juniperus oxycedrus</i> L., <i>J. horizontalis</i> Moench, <i>J. excelsa</i> M. Bieb.	N N N

Note. \*According to (Yeşil et al., 2005; Aytar, 2006; Ülğentürk et al., 2012b; Ülğentürk, 2013a). \*\*E – exotic species; N – native species.

**Table 2.** Honeydew producing insects from the family Hemiptera colonizing broadleaf trees Turkey\*

Insect species	Insect family	Tree species	Tree species E/N**
<i>Lachnus roboris</i> (Linnaeus)	Aphididae	<i>Quercus suber</i> L.	E
<i>Filippia follicularis</i> (Targioni Tozzetti)	Coccidae	<i>Olea europaea</i> L.	N
<i>Lichtensia viburni</i> Signoret	»	<i>O. europaea</i> L.	N
<i>Saissetia oleae</i> (Olivier)	»	<i>O. europaea</i> L., <i>Ceratonia siliqua</i> L.	N N
<i>Parthenolecanium rufulum</i> (Cockerell)	»	<i>Q. cerris</i> L., <i>Quercus</i> sp.	N N
<i>Acanthococcus roboris</i> Goux	Eriococcidae	<i>Q. cerris</i> L.	N
<i>Icerya purchasi</i> Maskell	Monophlebidae	<i>Acacia</i> sp.	E
<i>Puto israelensis</i> Ben-Dov	Pseudococcidae	<i>Quercus</i> sp.	N
<i>Kermes vermilio</i> Planchon	Kermesidae	Idem	N
<i>Kermes palestiniensis</i> Balachowsky	»	»	N
<i>Kermes greeni</i> Bodenheimer	»	»	N

Note. \*According to (Bodenheimer, 1953; Kaydan, 2004; Ülğentürk et al., 2013a, b; Akça et al., 2016; Kaplan, Turanlı, 2016). \*\*E – exotic species; N – native species.





Fig. 3. Distribution of the honeydew producing insect species in Turkey.

In the Mediterranean region, *Cinara cedri* on *Cedrus libani* is the second important honeydew producer. It excretes large quantities of honeydew from April to late June and from September to late October. The honey made from this honeydew could be an appropriate alternative for pine honey production (Ülgentürk et al., 2012c).

Only the scale insect, *Puto israelensis*, is known to produce sufficient amount of honeydew on broadleaf trees. *P. israelensis* usually reaches high population density and produces honeydew during the whole spring. Additionally, *Parthenolecanium rufum* was recorded on oaks (Ülgentürk et al., 2013b). The distribution of honeydew producing insect species in the different regions of Turkey is given in Fig. 3.

Despite their economic importance, honeydew producing insects can be treated as serious pests of conifer and broadleaf trees. They suck sap piercing stems, leaves, root and other tender plant part-sand. It can cause growth-stunting, deformation on leaves, stems or roots. The insect species *Ceroplastes floridensis*, *Cinara cedri*, *C. laportei*, *Eulachnus rileyi*, *Icerya purchasi*, *Kermes vermilio*, *Lichtensia viburni* and *Saissetia oleae* are reported as pests

in many European, Asian and African countries (Table 3) (Aytar, 2006; Grafton-Cardwell, 2003; Haber, Mifsud, 2007; FAO, 2009; Catalogue of life, 2011; Byron et al., 2015).

## CONCLUSION

In Turkey, the pine honey is mostly produced from honeydew of *M. hellenica* and 85 % of this yield has been exported to the EU countries (Firatlı et al., 2005). In spite of the existence of other honeydew producing insects in Turkey, the data about their participation in honeydew production are rather limited.

During the half-century, the number of bee colonies increased by 3 million, while the forest areas used by bees decreased by 5 million ha, and pastureland areas by 16 million ha (Firatlı et al., 2010). For this reason, the Ministry of Forest and Water Affairs and the General Directorate of Forestry has prepared an action plan on so-called bee forest. This plan is focused to honey production, which will subsequently assure not only enhancement of income for local residents but also certain protection of forest lands. Importantly, the main part of the

**Table 3.** Pest status of insects producing honeydew in Turkey

Insect species	Pest status in countries	References
<i>Acanthococcus roboris</i>	TNB: Hungary, Turkey	Kozár et al., 2013
<i>Ceroplastes floridensis</i>	TNPC: Egypt, Kenya, America, Turkey, China, Cyprus, India, Israel, Australia, France, Greece, Italy, Spain, Brazil	Sharma, Buss, 2011
<i>Cinara cedri</i>	TNPC: Algeria, Argentina, Belgium, France, Hungary, Cyprus, DNPC: Lebanon, Turkey	Aytar, 2006
<i>Cinara (Cedrobium) laportei</i>	TNC: Algeria, France, India, Israel, Italy, Morocco, Spain, South Africa, Lebanon, Turkey	Idem
<i>C. palaestinensis</i>	TNC: Greece, Turkey	Tsitsipis et al., 2007
<i>C. pilicornis</i>	TPC: Argentina, Turkey	FAO, 2008
<i>Coccus hesperidum</i>	TNPC: Iraq, Iran, Turkey	Aliakbarpour et al., 2010; Ülgentürk et al., 2012b; Abdul-Rassoul, 2016
<i>Eulachnus rileyi</i>	TPC: Argentina, Chile, Kenya, Malawi, Turkey TNPC: Colombia	FAO, 2009
<i>Filippia follicularis</i>	TNB: Greece, Turkey	Pellizzari et al., 2011
<i>Icerya purchasi</i>	TNB: Slovakia, USA, Hungary, Czech Republic, Turkey	Grafton-Cardwell, 2003; Kollár et al., 2016.
<i>Kermes vermilio</i>	TNB: Algeria, Corsica, Crete, France, Greece, Italy, Morocco, Portugal, Sardinia, Sicily, Spain, Turkey	Catalogue of life, 2011
<i>K. palestiniensis</i>	TNB: Turkey, Greece, Israel	Idem
<i>K. greeni</i>	TNB: Turkey, Israel, Syria	»
<i>Lachnus roboris</i>	TPB: Slovakia TNB: Poland, Turkey	Kollár et al., 2009; Lubiarz, Cichocka, 2014; Akça et al., 2016
<i>Lichtensia viburni</i>	TNB: Czech Republic, France, Germany, Russia, Italy, Yugoslavia, England, Wales, Spain, Portugal and USA, Turkey	Haber, Mifsud, 2007
<i>Marchalina hellenica</i>	TNPC: Australia, Italy DNPC: Greece, Turkey	Ülgentürk et al., 2012b
<i>Palaeococcus fuscipennis</i>	TNPC: America, Turkish Republic of Northern Cyprus, Israel, Turkey	Mendel et al., 1991; Fagan et al., 2002; Şişman, Ülgentürk, 2010; Ülgentürk et al., 2013a
<i>Parthenolecanium rufulum</i>	TNB: Bulgaria, Italy, Turkey TNPB: Poland	Rainato, Pellizzari, 2009; Goliszek et al., 2011; Trencheva, Tomov, 2014; Kaplan, Turanlı, 2016
<i>Phenacoccus arambourgi</i>	TNC: Lebanon, Turkey	Ülgentürk et al., 2012c
<i>Ph. yerushalmi</i>	TNC: Greece, Turkey	Ben-Dov et al., 2006
<i>Planococcus vovae</i>	TNC: Iran, Cyprus, Turkey	Kaydan, 2004; Talebi et al., 2008; Şişman, Ülgentürk, 2010
<i>Puto israelensis</i>	TNB: Israel, Cyprus, Turkey	Catalogue of life, 2011
<i>Saissetia oleae</i>	TNB: USA, Europe, Asia, Africa, Australia	Byron et al., 2015
<i>Schizolachnus pineti</i>	TPC: Slovakia, Turkey	Kollár et al., 2009

Note. T – introduced pest; D – indigenous pest; N – naturally regenerated forest; P – planted forest; C – coniferous trees; B – broadleaf trees.

plan is based on honeydew production made by the scale insect, *M. hellenica*. Other honeydew producing insect species and their potential contribution to honeydew honey produce in Turkey need deeper research.

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## ИСПОЛЬЗОВАНИЕ НЕКОТОРЫХ ЛЕСНЫХ ДЕРЕВЬЕВ ДЛЯ ПРОИЗВОДСТВА ПАДЕВОГО МЕДА В ТУРЦИИ

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Приводятся материалы исследования насекомых и лесных видов древесных растений, имеющих важное значение для производства падевого меда в Турции. Мед в основном используется в качестве источника питательных веществ и энергии, а также при лечении различных заболеваний. Мед классифицируют на цветочный и падевый. Цветочный мед получают из нектара цветущих растений, тогда как падевый – из медвяной росы, выделяемой насекомыми и собираемой пчелами. Медвяная роса представляет собой сахара, содержащиеся в экскрециях насекомых, питающихся соками растений (из флоэмы деревьев), таких как тли, белокрылки, мучнистые и мягкие червецы. Медвяная роса играет важную роль при производстве падевого меда, который очень востребован как на внутреннем, так и на международном рынке. Ведущими поставщиками падевого соснового меда в мире являются Турция и Греция. Основной производитель медвяной росы в Турции – насекомое *Marchalina hellenica* Gennadius, обитающее в основном на деревьях сосны турецкой *Pinus brutia* Ten. и сосны алеппской *Pinus halepensis* Miller, реже на деревьях сосны кедровой скальной *Pinus pinea* L., сосны черной *Pinus nigra* J. F. Arnold и сосны обыкновенной *Pinus sylvestris* L. В Турции имеются и другие производители медвяной росы, но их доля в продукции падевого меда незначительна, биология не изучена и до настоящего времени о них ничего не было известно. Всего в результате нашего исследования обнаружено 12 производителей медвяной росы, обитающих на деревьях хвойных пород, и восемь – на деревьях лиственных пород.

**Ключевые слова:** падевый мед, растительные тли, лесные деревья, Турция.