

Invasion by the oak lace bug, *Corythucha arcuata* (Say) (Heteroptera: Tingidae), in Turkey

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Abstract: *Corythucha arcuata* (Heteroptera: Tingidae) is an important pest species that causes severe damage to oak species by sucking up the cellular sap material and leaving its eggs on the underside of leaves. Considered a Nearctic species with a wide distribution, especially in the United States and southern Canada, it has recently been reported beyond the North American continent, specifically in Italy, Switzerland, and Turkey. Since its first report from Bolu, in 2003, the oak lace bug has rapidly dispersed throughout Turkey—to Düzce, Zonguldak, Sakarya, Kocaeli, Eskişehir, Ankara, Çankırı, and Bilecik provinces. The present study determined that the oak lace bug has infected 28,000 km² of Turkey.

Key words: *Corythucha arcuata*, invasive species, oak lace bug, pest species, *Quercus*, Tingidae

Türkiye’de, *Corythucha arcuata* (Say) (Heteroptera: Tingidae), meşe böceklerinin istilası

Özet: *Corythucha arcuata* (Heteroptera: Tingidae) özellikle meşe türlerinin hücre içi sıvısını emerek ve yumurtalarını yaprakların alt yüzeylerine bırakarak bitkiye zarar veren önemli bir pest türüdür. Önceleri Neartik bir tür olarak Amerika Birleşik Devletleri ile Kanada’nın güneyinde dağılım gösteren bu tür Amerika kıtası dışından İtalya, İsviçre ve Türkiye’den kaydedilmiştir. Bolu’dan 2003 yılında ilk defa rapor edilmesinden bu yana *C. arcuata*’nın Düzce, Zonguldak, Sakarya, Kocaeli, Eskişehir, Ankara, Çankırı ve Bilecik’te yayıldığı gözlenmiştir. Bu çalışma ile *C. arcuata*’nın dağılımının ülkemizde yaklaşık 28.000 km² lik bir alanı kapsadığı bulunmuştur.

Anahtar sözcükler: *Corythucha arcuata*, istilacı tür, meşe böceği, zararlı tür, *Quercus*, Tingidae

Introduction

Corythucha is a genus of the family Tingidae (Heteroptera), which is represented by 49 lace bug species in North America (Froeschner and Miller, 2002). The subfamily Tinginae is represented by 78 species in Turkey (Önder and Lodos, 1983). One of

the members of the genus *Corythucha* is *C. arcuata* (Say), commonly known as the oak lace bug, which is considered a native species to North America. Until 2000, *C. arcuata* was known only in the Nearctic area, with a particular distribution in the United States and southern Canada; however, the

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presence of this species beyond the North American continent was reported from northern Italy (Bernardinelli and Zandigiaco, 2000). Its observation in 2003 in Bolu, Turkey, and in Switzerland showed that this species had begun to spread to other countries (Mutun, 2003; Forster et al., 2005).

Oak lace bugs are small, rectangular, dorsoventrally flattened insects. Adults have transparent, lace-like textured wings that are held flat over the insect's body. Wing tips and outer margins extend beyond the body. The adults are cream colored with black or brown patches. The apical cross-bar is weak and ill-defined (Drake and Ruhoff, 1965). Nymphs are gray to black, with some white spots from the third nymphal stage, and many spines are present on their bodies. They are seen as clustered among their dark feces and cast nymphal skins on lower leaf surfaces. Unlike nymphs, the head is covered entirely by the pronotal hood in adults. On the pronota there are 3 carinae and the large paranota has brownish spots. Hemelytra are areolate and some brown spots are present across the apex. There are small spines along the costal margin of the hemelytra, the border of the paranota margins, and the apex of the hood (Gibson, 1918).

Oak lace bugs overwinter as adults on or near their host in the crevices of bark, branches, or other protected places. Overwintered adults move to oak leaves as soon as leaves begin to appear in spring. Adults begin feeding on young leaves of the host plant and females deposit their black and elongate eggs on the underside of leaves, ranging in number from 15 to more than 100 per female (Baker and Brown, 1994). The average number of eggs laid in Italy was about 100 eggs per cluster (Bernardinelli, 2000). From egg to adult, *C. arcuata* passes through 5 nymphal stages; full development takes 4-6 weeks. In northern Italy there are 3 generations per year (Bernardinelli, 2001).

In the Nearctic region oak lace bugs are known to feed on oaks (Fagaceae), especially *Quercus acuminata*, *Q. alba*, *Q. macrocarpa*, *Q. muehlenbergii*, *Q. prinoides*, *Q. prinus*, and *Q. rubra*, in addition to occasional feeding on *Castanea*, *Acer*, *Pyrus*, *Malus*, and *Rosa* (Drake and Ruhoff, 1965; Drew and Arnold, 1977); however, oak lace bugs in Italy were reported to

prefer the European *Q. petraea*, *Q. robur*, *Q. pubescens*, and *Q. cerris* over the North America *Q. rubra*. In addition to these major host species, *Rubus idaeus* and *R. ulmifolius* are also suitable host plants (Bernardinelli, 2006). They feed by piercing the leaf epidermis from the underside of the leaves with their piercing-sucking mouthparts and draw out the cellular sap material. With heavy infestation leaves may appear discolored before drying up and falling off. Adults and nymphs feed on the lower surface of the leaves, producing many characteristic black spots, while on the upper surface of leaves chlorotic discoloration is the typical symptom. In cases of heavy infestation the pest can cause defoliation. The present study provides evidence that *C. arcuata* is spreading to a large area with oak trees in Turkey.

Materials and methods

Field observation for the presence of *C. arcuata* infestation began in the area where it was first observed near Bolu, in a 186-ha area; observation was then expanded to the nearby region and then extended to Düzce, Zonguldak, Sakarya, Kocaeli, Eskişehir, Ankara, Çankırı, and Bilecik provinces. Field studies and sampling were carried out between May 2002 and September 2006 in those provinces. In all, 98 sites were investigated for *C. arcuata* infestation and the survey area was superimposed on a topographic map of Turkey using the DIVA-GIS program. The coordinates of the sampling sites were obtained with a geographical positioning system (GPS) device (GARMIN GPS 45). Oak lace bugs were often detected when their damage to the leaves of the host plants became evident. When the damage was detected, we looked for adults and nymphs by examining the affected leaves. As such, the study areas were first screened for the presence of any signs of feeding. Following observation of the signs of feeding on potential host trees, we verified the presence of *C. arcuata* by looking for adults and nymphs, discarded nymphal skins, eggs, eggshells, and black fecal spots on the lower surface of leaves. Branches with infested leaves were cut from host trees with clippers, placed in plastic bags, and brought to the laboratory for further study. Body length and width of 152 adults were measured using a stereomicroscope (Olympus SZ-PT60) and the data were transferred to the Microsoft

Excel program. The number of eggs on each infested leaf was also determined (286 leaves were observed) and voucher specimens were deposited at the Abant İzzet Baysal University, Department of Biology, Bolu.

Field observation for the presence of *C. arcuata* infestation was carried out in Bolu, Düzce, Zonguldak, Sakarya, Kocaeli, Eskişehir, Ankara, Çankırı, and Bilecik provinces (Figure 1).

Results

Most of the localities investigated (totaling an area of about 28,116 km²) were affected by the presence of the insect (Table). Signs of feeding, adults, nymphs, and eggs were observed on *Q. petraea*, *Q. robur*, and *Q. pubescens* trees (Figure 2). In all the examined sites, *C. arcuata* specimens were found (Figure 3). Due to heavy feeding during heavy infestations yellowish to brownish spots were obvious on the upper surface of infected oak tree leaves. The underside of the affected leaves had adults, nymphs, shed skins, and dark

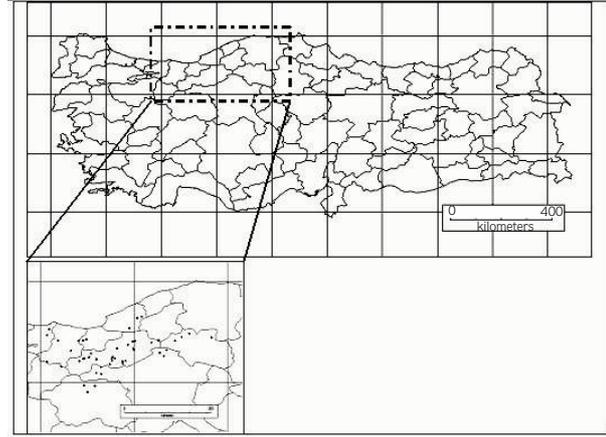


Figure 1. Study area and infested sites in Turkey.

excrement scattered all around the leaves. Since the first report of *C. arcuata* in Bolu, in 2003, it has been observed in nearby cities with appropriate host species.

Table. Study sites, geographical location of the sampling sites, size of infected areas, and infested tree species.

Province	Location	Area (km ²)	Infested <i>Quercus</i> Species
Bolu	N 40°42'854" E 31°30'820"	11,051	<i>Q. petraea</i> , <i>Q. robur</i> , <i>Q. pubescens</i> , <i>Q. v irgiliana</i>
Düzce	N 40°50'076" E 30°54'720"	865	<i>Q. petraea</i> , <i>Q. robur</i> , <i>Q. pubescens</i>
Zonguldak	N 41°16'781" E 32°04'071"	3629	<i>Q. petraea</i>
Sakarya	N 40°46'258" E 30°34'803"	1817	<i>Q. petraea</i> , <i>Q. robur</i> , <i>Q. pubescens</i>
Kocaeli	N 40°24'316" E 30°08'277"	1626	<i>Q. petraea</i> , <i>Q. robur</i> , <i>Q. pubescens</i>
Eskişehir	N 40°10'034" E 31°18'100"	1652	<i>Q. pubescens</i> , <i>Q. robur</i>
Ankara	N 40°35'458" E 32°33'166"	2715	<i>Q. petraea</i> , <i>Q. robur</i> , <i>Q. pubescens</i>
Çankırı	N 40°38'543" E 32°41'940"	3454	<i>Q. petraea</i> , <i>Q. robur</i> , <i>Q. pubescens</i>
Bilecik	N 40°18'774" E 30°26'588"	1307	<i>Q. petraea</i> , <i>Q. robur</i> , <i>Q. pubescens</i>



Figure 2. Oak lace bug nymphs, adults, excrement, and egg clusters from the lower surface of an oak leaf.



Figure 3. An adult oak lace bug.

In all, 152 adult *C. arcuata* (70 males, 82 females) were measured; mean length was 3.1 mm (range: 3.0-3.5 mm; SE: 0.014 mm) and mean width was 2.1 mm (range: 2.0-2.9 mm; SE: 0.011). Barrel-shaped shiny

black eggs were laid in clusters and varied in number from leaf to leaf; mean eggs per leaf was 49 (range: 12-120) (Figure 4). Adult specimens and black excrement were also noted on hawthorns (*Crataegus* spp.), but we did not observe the eggs, nymphs, or exuviae on the leaves of other plant or tree species examined during this study. Therefore, we think that they only landed on these plants and did not use them for feeding or laying eggs. During our search for oak lace bugs between September and the end of May we observed overwintering male and female adults under the loose bark of oak trees. Our results show that this oak pest species is new to Turkey and is rapidly spreading to suitable places in the area.

Discussion and conclusion

Turkey is one of the richest regions for oak species in the world (Yaltırık, 1984). Eighteen different *Quercus* species are reported from Turkey, in addition to many subspecies and natural hybrids. *Quercus pubescens* and *Q. robur* have a limited range of distribution in Turkey, whereas *Q. petraea*'s is much wider (Davis, 1982). The oak lace bug is a new pest species in Turkey. This species is known to prefer *Q. petraea*, *Q. pubescens*, and *Q. robur* (Bernardinelli, 2006). Although the native range of *C. arcuata* is the United States and Canada, the latest findings reveal

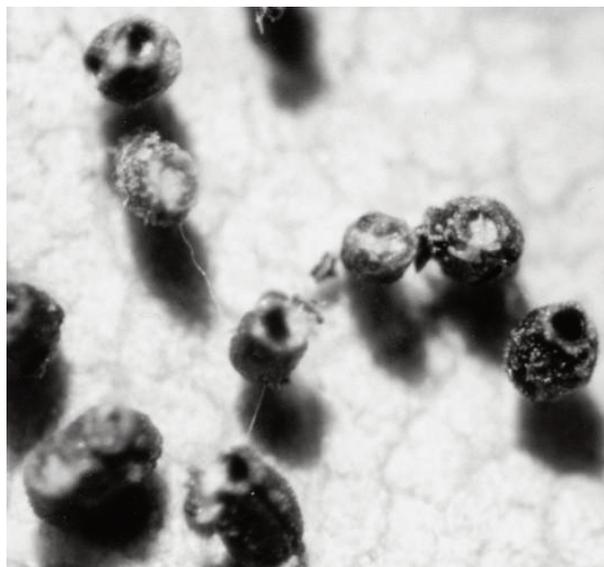


Figure 4. Oak lace bug eggs.

that this oak-specific pest has expanded its range into Europe and Turkey. Under favorable environmental conditions, *C. arcuata* has high colonization success. When it was first found in Turkey, in 2003, it had a limited distribution in Bolu; however, during the following 4 years the species expanded its distribution range to about 28,116 km² in nearby provinces. In our study areas we observed the signs of heavy *C. arcuata* infestation on *Q. petraea*, *Q. pubescens*, and *Q. robur*, as well as on possible hybrids between these oak species. The results of the present study regarding preferred host tree species are in agreement with those of Bernardinelli (2006) in Italy and Forster et al. (2005) in Switzerland.

Adult oak lace bugs observed in Turkey are very similar in size to those in Italy (3.0-3.5 mm long x 1.6 mm wide) (Bernardinelli and Zandigiacomo, 2000) and Switzerland (3.0 mm long) (Forster et al., 2005).

Adult oak lace bugs are not good fliers due to their small size; they are carried by wind or other factors to spread over medium-range distances. Anthropogenic factors, such as passive transport via transportation vehicles, may promote its distribution to other regions where oak species are the main forest trees. Therefore, continuous monitoring of the ongoing dispersal of this insect pest in Turkey is necessary, as Turkey may serve as a gateway to adjacent countries for future invasions. In an infested area of more than 7000 km² in the Lombardy and Piedmont regions near the Swiss border in Italy accidental introduction of *C. arcuata* is indicated (Bernardinelli, 2000). We also think that

this species has been accidentally introduced via human transport to the areas observed in the present study, as the study areas are located near major highways. Other parts of Turkey should be screened to determine the urgency of the situation. From an environmental point of view, if other parts of Turkey have been infested by the oak lace bug as rapidly as in the studied areas, a protection program would be warranted. In cases of heavy oak lace bug infestation in North America some control measures were used, including the use of insecticidal soaps, and products containing acephate, dimethoate, carbaryl, malathion, cyfluthrin, and bifenthrin. In addition to chemical control, assassin bugs, spiders, and lady beetles were used as natural enemies to control oak lace bug populations (Dreistadt and Perry, 2006). The present study may provide new insights into its distribution and the speed with which the species is spreading to large areas of Turkey. Future studies should concentrate on investigating the ecology in an attempt to manage the rapid spread of this invasive species. This may afford us the opportunity to control this species and its dispersal to other parts of Turkey and neighboring countries.

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