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Biological observations for invasive and exotic insect species *Anoplophora chinensis* (Forster, 1771)

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Abstract: In recent years, invasive and exotic insect species have been frequently found in Turkey. *Anoplophora chinensis* (Forster, 1771) was first recorded in Şile (Istanbul province) county, Turkey, in June 2014 and later in Zeytinburnu (the garden of the Abdi Ipekçi Sports Complex and the surrounding) in July in the same year. This study was conducted in these two counties in particular between June 2014 and July 2016 with the aims of making remarks on an earlier misidentification of *Anoplophora* species and determining the life cycle and the host plants in Istanbul, Turkey. It was noted that the record of *A. glabripennis* in Istanbul was a misidentification of *A. chinensis*. It took 1 year to complete its generation. The primary host plant of this insect was found to be *Acer negundo*.

Keywords: Cerambycidae, *Anoplophora chinensis*, *Acer negundo*, *Fagus orientalis*, Istanbul, Turkey

İstilacı yabancı böcek türü *Anoplophora chinensis* (Forster, 1771) için biyolojik gözlemler

Özet: Son yıllarda istilacı yabancı böcek türleri Türkiye'de sıklıkla görülmeye başlanmıştır. *Anoplophora chinensis* (Forster, 1771) Türkiye'de ilk kez Haziran 2014'te Şile'de (İstanbul ili) kaydedilmiştir. Daha sonra Zeytinburnu'nda (Abdi İpekçi Spor Salonu bahçesi ve çevresinde) aynı yılın Temmuz ayında tespit edilmiştir. Araştırma özellikle bu iki ilçede Haziran 2014 ile Temmuz 2016 tarihleri arasında gerçekleşmiştir. Bu araştırmada; *Anoplophora* türü için yanlış tanımlamanın düzeltilmesi, yaşam döngüsünün tanımlanması, konukçu bitkileri belirlenmesi amaçlanmıştır. Araştırma sonucunda; İstanbul Zeytinburnu'nda *Anoplophora glabripennis* olarak kaydı verilen türün yanlış tespit edildiği bu bölgedeki türün *A. chinensis* olduğu belirlenmiştir. Tür gelişimini bir yılda tamamlamaktadır. Bu böceğin birinci derecede konukçusu İstanbul'da *Acer negundo* olarak belirlenmiştir.

Anahtar Kelimeler: Cerambycidae, *Anoplophora chinensis*, *Acer negundo*, *Fagus orientalis* Istanbul, Turkey

1. INTRODUCTION

Globalization of trade and travel on an unprecedented scale is breaking down the natural barriers between countries and continents. For this reason exotic species are spreading to new areas beyond their natural distribution. Invasive species are increasingly recognized as one of the major threats to biodiversity (Hizal et al., 2012a). This insect species have begun to appear frequently in Turkey in recent years (e.g. Arslangündoğdu and Hızal, 2010; Hızal ,2012b; Çetin et al., 2014). One of the most destructive wood borers, that was first recorded in Turkey in 2014 and which was first seen in the Istanbul province of Turkey, is the citrus longhorned beetle (*Anoplophora chinensis* (Forster, 1771)) (Hızal et al., 2015).

Anoplophora chinensis is a member of the genus *Anoplophora* (Coleoptera-Cerambycidae). According to Lingafelter and Hoebeke (2002) this genus consists of 36 species. *A. malasiaca* was identified as synonymous with *A. chinensis* by Lingafelter and Hoebeke (2002) but the name *A. malasiaca* is still commonly used in Japon (Haack et al., 2010).

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Synonyms: *Anoplophora chinensis* Breuning 1944, *Anoplophora malasiaca* (Thomson 1865), *Anoplophora malasiaca malasiaca* Samuelson 1965, *Anoplophora perroudi* Pic 1953, *Anoplophora sepulchralis* Breuning 1944, *Callophora afflicta* Thomson 1865, *Callophora luctuosa* Thomson 1865, *Calloplophora abbreviata* Thomson 1865, *Calloplophora malasiaca* Thomson 1865, *Calloplophora sepulcralis* Thomson 1865, *Cerambyx chinensis* Forster 1771, *Cerambyx farinosus* Houttuyn 1766, *Cerambyx pulchricornis* Voet 1778, *Cerambyx sinensis* Gmelin 1790, *Lamia punctator* Fabricius 1777, *Melanauster chinensis* Matsumura 1908, *Melanauster chinensis* (Forster), *Melanauster chinensis macularius* Kojima 1950, *Melanauster chinensis var. macularia* Bates 1873, *Melanauster chinensis var. macularis* Matsushita 1933, *Melanauster chinensis var. Sekimacularius* Seki 1946, *Melanauster macularius* Kolbe 1886, *Melanauster malasiacus* Aurivillius 1922, *Melanauster perroudi* Pic 1953 (URL-1).

The native range of *Anoplophora chinensis* includes China, Korea and Japan. There are occasional records from Indonesia, Malaysia, the Philippines, Taiwan and Vietnam (Lingafelter & Hoebeke, 2002; URL-1).

Anoplophora chinensis (Forster, 1771) was recorded for the first time in Turkey in Şile county (Istanbul province) in June 2014 (Hızal et al., 2015). Later we identified this species in Zeytinburnu (The garden of the Abdi İpekçi Sports Complex and the surrounding) in July of that year.

Aims of the study are as follows: the correction of a misidentification for *Anoplophora* species, an identification of the life cycle, host plants in Istanbul, Turkey.

2. MATERIALS AND METHOD

The study was conducted in Şile, where is the first known area of infestation, in Zeytinburnu, where widespread damage occurs, and concluded at laboratories between June 2014 and July 2016. We sampled 11 localities in Şile and 16 localities in Zeytinburnu (Figure 1). We had collected adult insect specimens from infested trees and documented the host tree species. The collected specimens from Zeytinburnu were placed in cages with *Acer negundo* and *Fagus orientalis* trunks, where 8 individuals (4♂; 4♀) and 5 individuals (2♂; 3♀), were placed respectively. Adult insects were feed *Acer negundo* branches and leaves. One side of the trunk were waxed with paraffin and is covered by stretch film in order to maintain the moisture level of the trunk. The latter side of the trunk is placed in a container filled with sand (Figure 2). Then we have sprayed water on the trunk and sand in weekly intervals. Remaining specimens were prepared as museum materials. Finally data collected from field and laboratory observations were analysed to determine the biology of the species.

Figure. 1. Study points in Şile and Zeytinburnu
Şekil 1. Şile ve Zeytinburnu'nda çalışma yapılan noktalar

Figure 2. Cages where specimens collected from study area are placed (Photograph Erdem Hızal)
Şekil 2. Araziden toplanan örneklerin konulduğu kafesler (Fotoğraf Erdem Hızal)

3. RESULTS AND DISCUSSION

3.1 Correction for misidentification

A. chinensis is large and strong. Specimens are between 18 and 40 mm long. The shiny black elytra are marked with white spots. The females are longer than the males. The male's antennae are approximately twice as long as the body. The female's antennae are slightly longer than the body. The beetle has 11 antennae segments. The black antennae segments are marked with white or light blue bands. The anteriorly and posteriorly narrowed pronotum has a pair of stout spines extending from its sides. This species is similar to *Anoplophora glabripennis* but *Anoplophora chinensis* has numerous short tubercles on the base of the elytra (Figure 3).

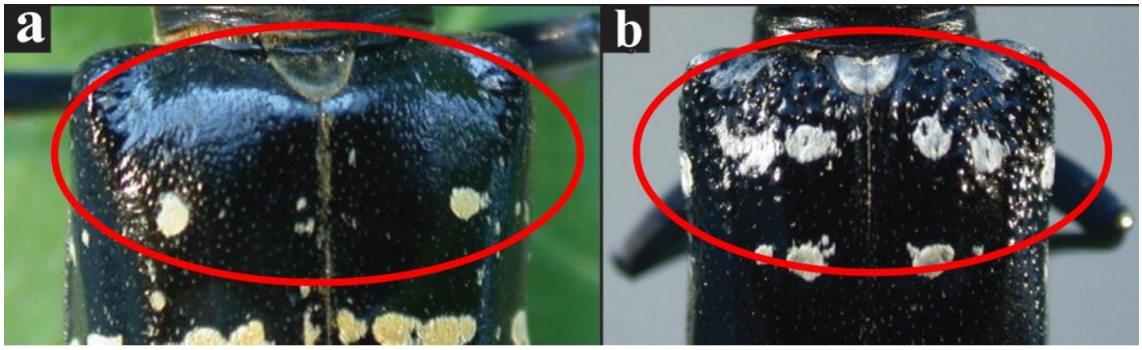

Figure 3. a (*A. glabripennis*), b (*A. chinensis*) (Haack et al., 2010).
Şekil 3. a (*A. glabripennis*), b (*A. chinensis*) (Haack et al., 2010).

We collected and studied specimens in Figure 4. *A. chinensis* is the most important destructive pest of fruit trees, especially of the *Citrus* genus. Most of the damage is caused during the larval stages, when the larvae feed on and tunnel through the woody portion of the host plant trunk. Later instar larvae are able to burrow deep into the wood. The larva creates irregular tunnels that interfere with the water and nutrient transportation roads within the trunk of the host plant. Host plants can die from an intensive attack. Adult *A. chinensis* feed on the leaves and bark of twigs (Figure 5).

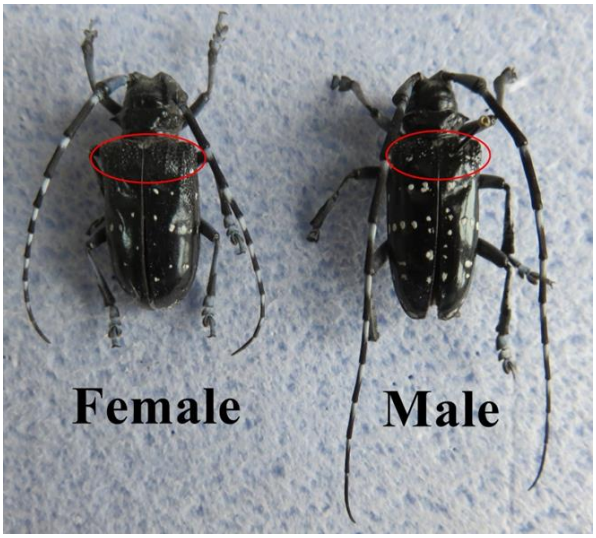

Figure 4. *A. chinensis* female, male and tubercles on elytra (Photograph Erdem Hızal)
Şekil 4. *A. chinensis*'in dişisi, erkeği ve kanat örtüsü üzerindeki tüberküller (Fotoğraf Erdem Hızal)

Figure 5. Emergence holes on *Aesculus hippocastanum* and adult (a,b); Impact of *A. chinensis*'s larva on *A. negundo* in the study area (c,d,e) (Photograph Erdem Hızal)
Şekil 5. *Aesculus hippocastanum* üzerindeki çıkış delikleri ve ergin (a, b) Çalışma alanında *A. chinensis* larvasının *A. negundo* üzerinde yaptığı zararlar (c, d, e) (Fotoğraf Erdem Hızal)

Şile county research; In 2015 despite extensive survey, we found no specimens of this insect either in the nursery or elsewhere in the location.

Zeytinburnu county research; According to Ayberk et al., 2014, the species found in Zeytinburnu was *Anoplophora glabripennis*. Following two years of our research in Zeytinburnu, which we collected and studied specimens, all of our specimens were of *Anoplophora chinensis* (Figure 4). It became clear that the beetles identified as *A. glabripennis* by this publication were in fact *A. chinensis*. In the photographs used in this publication the tubercles on the elytra can

be clearly seen (Figure 6). During the period of our research, *A. glabripennis* were not recorded in Istanbul and Turkey.

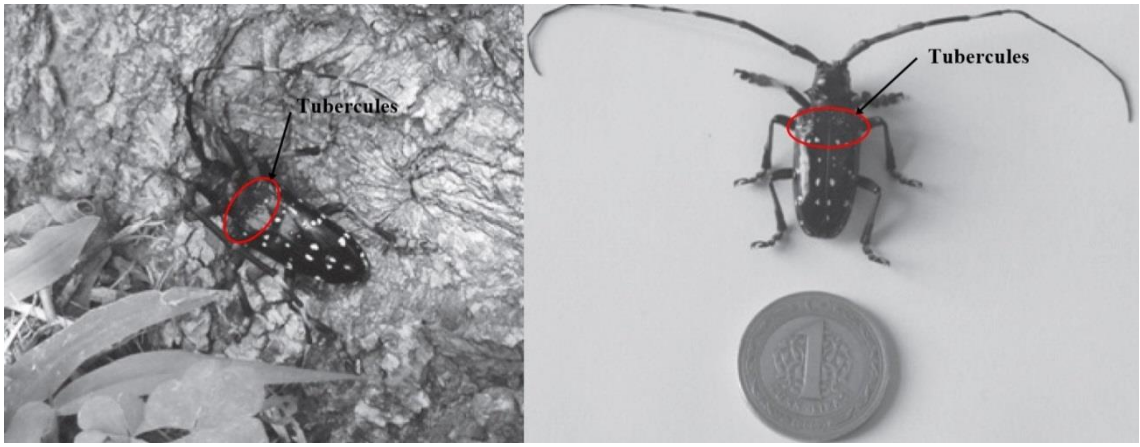

Figure 6. Tubercles seen on elytra in photographs from Ayberk et al., 2014
Şekil 6. Ayberk ve ark. 2014'teki fotoğrafta yer alan örneklerde elytra üzerindeki tüberküller

3. 2. Life Cycle

The life cycle obtained from field and laboratory studies is given in Figure 7.

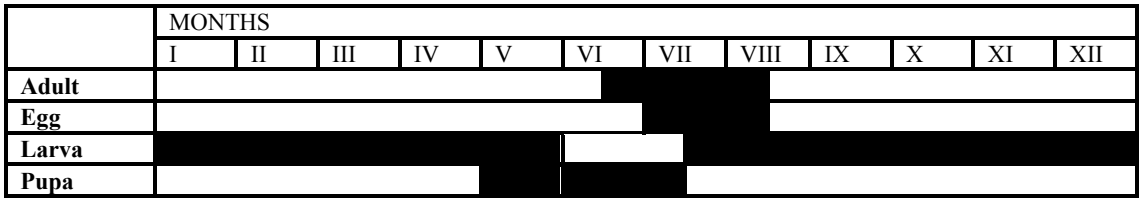

Figure 7. The life cycle of *A. chinensis*
Şekil 7. *A. chinensis*'in yaşam döngüsü

A. chinensis took one year to complete its generation. Adults are seen from the middle of June to the middle August. Adults, which are fed with the host tree branch and leaves, are laying eggs from the begining of July until the middle of August. The larvae, which have been emergence eggs since mid-July, complete their development until May of the following year and enter the pupa. Pupa period is from May to mid July

A. chinensis specimens laid 32 eggs in *Acer negundo* trunk and 28 eggs in *Fagus orientalis* trunk. 3 eggs completed their development in *Acer negundo* trunk and 1 egg completed it's development in *Fagus orientalis* trunk in laboratory.

3. 3. Host Plants

From our study the primarily host plant of this beetle was found to be *Acer negundo*. Other host plants identified were *Acer palmatum*, *Aesculus hippocastanum*, *Platanus orientalis*, *Populus nigra* and *Salix babylonica* (Table 1).

According to Ayberk et al., (2014), their specimens were *A. glabripennis*. But in our study the collected specimens in Zeytinburnu were of *A. chinensis*. We found no *A. glabripennis* specimens in Zeytinburnu. The photographs in their publication were also of *A. chinensis*. Ministry of Food Agriculture and Livestock (General Directorate of Food and Control) results of the surveys carried out throughout Istanbul and Turkey till today still indicates that *A. glabripennis* is not present in Turkey (URL-2 / URL-3).

Table 1. *Anoplophora chinensis*'s host plants
Tablo 1. *Anoplophora chinensis*'in konukçu bitkileri

Year	Location	Host Plant	Specimens
2014/1	40°59'38"N 28°55'08"E	*Acer negundo*	5 (2♀+3♂)
2014/2	40°59'38"N 28°55'06"E	*Acer negundo*	3(1♀+2♂)
2014/3	40°59'40"N 28°55'01"E	*Acer negundo*	3(♀)
2014/4	40°59'41"N 28°54'57"E	*Acer negundo*	2(1♀+1♂)
2015/1	40°59'39"N 28°55'10"E	*Acer negundo* *Salix babylonica*	12(5♀+7♂)
2015/2	40°59'42"N 28°55'14"E	*Populus nigra*	1(♂)
2015/3	40°59'43"N 28°55'12"E	*Acer palmatum*	2(♀)
2015/4	40°59'46"N 28°55'13"E	*Platanus orientalis*	2(1♀+1♂)
2015/5	40°59'56"N 28°55'11"E	*Acer negundo*	2(♂)
2015/6	41°00'00"N 28°55'8"E	*Acer negundo*	8(2♀+6♂)
2015/7	41°00'8"N 28°55'7"E	*Acer negundo*	4(3♀+1♂)
2015/8	40°59'38"N 28°55'27"E	*Acer negundo*	2(♂)
2015/9	40°59'48"N 28°55'25"E	*Aesculus hippocastanum*	1(♀)
2015/10	41°00'1"N 28°55'23"E	*Acer negundo*	2 (♀+♂)
2015/11	40°59'41"N 28°54'38"E	*Acer negundo*	1(♀)
2015/12	40°59'41"N 28°54'51"E	*Acer negundo*	1(♀)

The absence of new specimens in the study carried out in the province of Şile in 2015 indicates that the eradication studies carried out by the Istanbul Agricultural Quarantine Directorate of the Ministry of Food, Agriculture and Livestock have been successful.

A. chinensis generally takes one year to complete it's life cycle, although two years is common (Haack et al., 2010) From our study *A. chinensis* took one year to complete its generation.

Anoplophora chinensis is a very polyphagous cerambycid. In its native area, this xylophagous insect can attack healthy trees. It is as a serious pest of *Citrus* species. In Europe *A. chinensis* has completed development on *Acer*, *Aesculus*, *Alnus*, *Betula*, *Carpinus*, *Citrus*, *Cornus*, *Corylus*, *Cotoneaster*, *Crataegus, Fagus, Lagerstromia, Liquidambar, Malus, Platanus, Populus, Prunus, Pyrus, Quercus, Rhodendron*, *Rosa*, *Salix*, *Sorbus* and *Ulmus* species. *Acer* was the most commonly infested tree genus in Europe (Herard et al., 2005; Haack et al., 2010, URL-1). From our study the primary host plant of *A. chinensis* is *A. negundo*.

Only one egg, which laid in the *Fagus orientalis* trunk, completed its development. Since the moisture of the trunk was poorly representing the actual humidity of a *Fagus orientalis* trunk in the forest. However we believe that this species is still a significant pest to *Fagus orientalis* trees in forests.

4. CONCLUSIONS

A. *chinensis* is a quarantine pest for the Republic of Turkey Ministry of Food, Agriculture and Livestock. *A*. *chinensis* is subject to eradication. Each infested area is monitored periodically to identify newly attacked trees, which are cut and incinerated without delay. From the first year of detection of the infestations in Istanbul, major eradication efforts have been implemented in each infested site. However, a few *A*. *chinensis* adults and variable numbers of newly infested trees were discovered each year in most sites, even where the initial size of the infestation was limited. Eradication is not an easy process. It requires heavy and constant monitoring with tree cutting and destruction over several years. Most of the known host plants of *A*. *chinensis* naturally occur in Turkey. For this reason *A*. *chinensis* has very important consequences for the management of the natural forest areas of Turkey.

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