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Contribution to the aphid fauna of the Ordu province with first record of an exotic aphid species, *Euceraphis gillettei* Davidson, 1915, in Turkey

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Abstract: During the last 2 decades, aphid species have widely distributed outside their original geographical regions. North America originated *Euceraphis gillettei* was determined as a new contribution to the Turkey aphid fauna and in turn regarded as an exotic aphid species in Turkey. In addition, all of the determined species are new records for study area. Findings of the present study are in accordance with the predictions made by various aphidologist recently, which it is not going to be a surprise to add more species to the Turkish aphid fauna with a detailed study.

Key words: Aphid, *Euceraphis gillettei*, exotic, Ordu, Turkey

1. Introduction
The aphids (Hemiptera: Aphidoidea) are one of the important phloem sap-sucking insect groups. There are about 5300 described aphid species worldwide in 510 presently accepted genera on nearly 87,000 plant species belonging to 300 genera (Görür et al., 2019). There are 614 species listed for the Turkish aphid fauna (Şenol et al., 2021; Kök and Özdemir, 2021). Aphids are regarded as one of the important groups of exotic-alien species due to their unique ecological interactions related with their higher reproduction capacity and close interactions with their host plants. In addition, increased global trade including agricultural and ornamental products, and recent climatic changes have resulted in an introduction and an establishment of invasive aphid species into different regions of the world. The mean rate of introduction into Europe since 1800 has been shown to be 0.5 species per year (Coeur d’acier et al., 2010). As a result of the higher introduction rate, it has been shown that 102 alien species of Aphididae established in Europe. It means that 7.4% of the European aphid fauna is alien origin and the most of them originated from Asia (43.1%) and North America (43.1%) respectively (Coeur d’acier et al., 2010). Turkey is in the Mediterranean Basin of the Palearctic region; only 3% of Turkey aphid fauna is native to Turkey while there are about 35 North America originated species were determined (Akyıldırım et al., 2013). Recently some more studies were conducted to derive information about the current composition of Turkey aphid fauna and potential invasive elements (Şenol et al., 2015; Kök and Özdemir, 2021; Oğuzoğlu et al., 2021). The aim of the paper is to provide prior knowledge aphid species composition of the study area and to discuss finding for future indications.

2. Material and methods
Study was conducted during June–August 2021 to determine possible aphid species and host plants in Akkuş District of the Ordu province. *Fagus orientalis, Carpinus orientalis, Pinus sylvestris, Alnus glutinosa, Rhododendron ponticum, Quercus robur* are the most abundant plant species in addition to various types of herbaceous and agricultural plants. Altitude is about 1300m, mean temperature is about 11.5 °C and mean precipitation is about 1000mm. The specimens were studied in the laboratory based on the methods offered by Martin (1983) to make permanent slides. Species were determined according to the key provided. Taxonomical placement, biology, host plant and distribution of each determined species were checked throughout recent studies. Voucher specimens

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## Table 1. Determined aphid species and their host plants.

<table>
<thead>
<tr>
<th>Aphid species</th>
<th>Host plant</th>
<th>Observed and general features of defined aphid species</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Adelges</em> (<em>Gilletteella</em>) <em>cooleyi</em> (Gillette, 1907)</td>
<td><em>Picea orientalis</em></td>
<td>Feed on and cause gall formation on shoot tips of the <em>Picea</em> spp., it can be easily distinguished with heavy white wax and characteristics gal shape, stunting heavily shoots-tips and resulting in death. It was very abundant in the study area (Figure 1a).</td>
</tr>
<tr>
<td><em>Aphis</em> (<em>Aphis</em>) <em>fabae</em> Scopoli, 1763</td>
<td><em>Phaseolus vulgaris</em>, <em>Vicia faba</em></td>
<td>Feed on various host plants, make huge colonies, and result in deformation. Mostly visited by ants. They are common in the study area as they are a cosmopolite species.</td>
</tr>
<tr>
<td><em>Aphis</em> (<em>Aphis</em>) <em>craccivora</em> Koch, 1854</td>
<td><em>Trifolium pratense</em>, <em>Accacia</em> sp.</td>
<td>Feed on different parts of various host plants, heavily colonize, mostly visited by ants, produce a huge amount of honeydew, cause stunting. They are common in the study area.</td>
</tr>
<tr>
<td><em>Aphis</em> (<em>Aphis</em>) <em>spiraecola</em> Patch, 1914</td>
<td><em>Malus</em> sp.</td>
<td>Feed on leaf and young shoots of host plants including the <em>Malus</em> spp., heavily colonize host plants, mostly visited by ants, cause stunting especially at the tip of shoots. They are common in the study area.</td>
</tr>
<tr>
<td><em>Aphis</em> (<em>Aphis</em>) <em>pomi</em> De Geer, 1773</td>
<td><em>Malus</em> sp.</td>
<td>They show similar characteristics and effects as <em>A. spiraecola</em> (Figure 1b)</td>
</tr>
<tr>
<td><em>Anuraphis</em> <em>farfarae</em> (Koch, 1854)</td>
<td><em>Tussilago farfara</em></td>
<td>They colonize junction part of the aerial and root of the host plant, rarely found in root elongated through soil, they become very active when met with sunlight. They colonize the host plant growing in humid conditions (Figure 1c).</td>
</tr>
<tr>
<td><em>Brevicoryne</em> <em>brassicae</em> (Linnaeus, 1758)</td>
<td><em>Brassica oleracea</em></td>
<td>Feed on almost all parts of the host plant, heavily colonize, cause slight deformation. They are common in the study area.</td>
</tr>
<tr>
<td><em>Brachycaudus</em> (<em>Prunaphis</em>) <em>cardui</em> (Linnaeus, 1758)</td>
<td><em>Carduus</em> sp.</td>
<td>Feed on mainly stem and young shoots of various herbaceous host plants, heavily colonize, mostly visited by ants. They are common in the study area.</td>
</tr>
<tr>
<td><em>Brachycaudus</em> (<em>Brachycaudus</em>) <em>helichrysi</em> Kaltenbach, 1843</td>
<td><em>Anthemis</em> sp.</td>
<td>They show similar characteristics and effects as <em>B. cardui</em>. Species cause deformation on leaves when they feed on primary host plant such as various <em>Prunus</em> spp. They are common in the study area.</td>
</tr>
<tr>
<td><em>Chaitophorus</em> <em>populeti</em> (Panzer, 1801)</td>
<td><em>Populus tremula</em></td>
<td>Feed on mainly young shoots of the <em>Populus</em> spp., it can be easily recognized by sharp olive green-black colour, heavily colonize and intensely visited by ants. It has been realized that they prefer to feed on basically host plants grown in shady environments (Figure 1d).</td>
</tr>
<tr>
<td><em>Chromaphis</em> <em>juglandicola</em> (Kaltenbach, 1843)</td>
<td><em>Juglans regia</em></td>
<td>Feed on the undersides of leaves of the <em>Juglans regia</em>, produce significant amount of honeydew, rarely visited by ants. They are common in the study area.</td>
</tr>
<tr>
<td><em>Cinara</em> (<em>Cinara</em>) <em>brauni</em> Börner, 1940</td>
<td><em>Pinus</em> sp.</td>
<td>Feed on mainly young shoots and tips of the host plant, they especially colonize young plants that get direct sunshine, visited by ants. Rarely found in the study area.</td>
</tr>
<tr>
<td><em>Cinara</em> (<em>Cinara</em>) <em>cedri</em> Mimeur, 1936</td>
<td><em>Cedrus libani</em></td>
<td>Feed on branches of the <em>C. libani</em>, heavily colonize, produce a huge amount of honeydew, mostly visited by ants. They are common in the study area.</td>
</tr>
<tr>
<td><em>Cinara</em> (<em>Cinara</em>) <em>pilicornis</em> Hartig, 1841</td>
<td><em>Picea orientalis</em></td>
<td>Feed mainly on young shoots of the host plant, determined colonies were not crowded, and rarely visited by ants. They are not common in the study area (Figure 1e).</td>
</tr>
<tr>
<td><em>Dysaphis</em> (<em>Dysaphis</em>) <em>devecta</em> (Walker, 1849)</td>
<td><em>Malus</em> sp.</td>
<td>They turn apple leaves to distinctive red by causing pseudo gal formation, heavily colonize, stunting leaves and let them dry. Rarely found in the study area.</td>
</tr>
</tbody>
</table>
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Table 1. (Continued).

<table>
<thead>
<tr>
<th>Eriosoma lanuginosum (Hartig, 1839)</th>
<th>Malus sp.</th>
<th>Feed on trunk and branches of the Malus spp., it was thought that this species was minimized by biological control, but it is abundant in the study area, it can be easily recognized with shiny white wax, cause some abnormal growth on branches like a cancer tumor.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eucalipterus tiliae (Linnaeus, 1758)</td>
<td>Tilia tomentosa</td>
<td>Heavily colonize undersides of host plants, produce huge amount of honeydew, they are very active, common in the study area.</td>
</tr>
<tr>
<td><em>Euceraphis gillettei</em> Davidson, 1915</td>
<td>Alnus glutinosa</td>
<td>Alate individuals were observed on undersides of the Alnus glutinosa that grows in humid conditions, heavily colonized the whole tree but about 2 alate individuals detected on each leaf, they are very active when the leaf is touched, no ant attendance was recognized, there was a slight honeydew production (Figure 1f).</td>
</tr>
<tr>
<td>Hyalopterus pruni (Geoffroy, 1762)</td>
<td>Prunus domestica</td>
<td>Heavily colonize undersides on the Prunus spp., produce huge amount of honeydew, rarely visited by ants, cause slight stunting, rare in the study area (Figure 1g).</td>
</tr>
<tr>
<td>Hyperomyzus (Hyperomyzus) pallidus Hille Ris Lambers, 1935</td>
<td>Sonchus sp.</td>
<td>Feed on young shoots and stems of host plant, it can be carefully scanned to find as their colour is very similar to host plant, heavily colonize, sometimes make mix colony with the Uroleucon sonchi even though it was not observed in the study area.</td>
</tr>
<tr>
<td>Maculolachnus submacula (Walker, 1848)</td>
<td>Rosa canina</td>
<td>It has been realized that this species feeds near the bottom bark of the Rosa canina, so it can be difficult to find, visited by ants, rare in the study area.</td>
</tr>
<tr>
<td>Myzocallis (Myzocallis) carpini (Koch, 1855)</td>
<td>Carpinus orientalis</td>
<td>Feed on undersides of leaves, do not make crowded colony, 2–3 individuals found on each leaf, it was recognized that they generally feed on the plant grown in shady environment, rare in study area even if host plant is abundant.</td>
</tr>
<tr>
<td>Myzus (Myzus) varians Davidson, 1912</td>
<td>Prunus persica</td>
<td>Heavily colonize undersides of leaves, cause deformation, produce slight honeydew, rarely visited by ants, rare in the study area.</td>
</tr>
<tr>
<td>Neobetulaphis pusilla Basu, 1964</td>
<td>Alnus glutinosa</td>
<td>Heavily colonize undersides of the young Alnus glutinosa leaves, visited by ants, produce slight honeydew, abdominal pattern is distinctive and easily recognized. Rare in the study area even if host plant is abundant (Figure 1h).</td>
</tr>
<tr>
<td>Phyllaphis fagi (Linnaeus, 1761)</td>
<td>Fagus orientalis</td>
<td>Feed on undersides of leaves of the lower part of Fagus species, recognized significant stunting at leaves, sometimes result in drying and death, it can be easily recognized by white wax and caused deformation, it is common in the study area.</td>
</tr>
<tr>
<td>Thelaxes suberi (Del Guercio, 1911)</td>
<td>Quercus sp.</td>
<td>Mainly feed on young shoots and tips of the Quercus spp., heavily colonized, especially Q. robur in study area, rarely visited by ants, common in the study area (Figure 1i).</td>
</tr>
</tbody>
</table>

*Exotic and new record for aphid fauna of Turkey

of the identified species were stored at the Biotechnology Department of Niğde Ömer Halisdemir University.

3. Results and discussion

As a result of the evaluation of 65 samples on various host plants, 26 aphid species were determined from Akkuş District of Ordu Province that is placed in Middle Black Sea Region (Table), and colony appearances of some defined species are given in Figure.

Twenty-six aphid species are recorded from the study area. Among them, *Euceraphis gillettei* Davidson, 1915 was considered as an exotic-alien species for Turkey. *E. gillettei*, the American alder aphid, is North America originated, widely distributed over North America feeding on *Alnus* spp[1,4]. It is not known how *E. gillettei* arrived to Turkey, most probably it was established by trading host plant products from abroad. Coeur d’acier et al. (2010) pointed out that there is no intentional introduction of

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aphids into Europe and therefore it has been considered that *E. gillettei* arrived to Turkey accidentally, even there is no supporting evidence. It has been considered that by arriving Turkey accidentally species established in study area as *Alnus* spp. composes about 1% of the forest area in Turkey, including the study area (Güdül et al., 2019). There are some studies showing that a reasonable number of the determined exotic-alien species in Europe are North America originated (Coeur d’acier et al., 2010; Wieczorek et al., 2019) supporting the existence of North America originated species in Turkey. Remaining 25 aphid species were new records for the study area, since no study has been published yet. Observed distinctive characteristics and general appearance of defined species are briefly given in Table 1.

4. Conclusion
It has been proposed that if the current composition of fauna of any geographic area-locations has not been observed and evaluated properly, there are going to be
some scientific problems to make predictions about how recent climatic fluctuations are going to affect biodiversity. Aphids are an ecologically and agriculturally important group of insects to study and make future projections for climate change impacts as they are directly affected by these changes (Kindlmann et al., 2010). In addition to dramatic climatic changes, increased international trade including agricultural, industrial, and ornamental plants around the world also influences aphid distribution all over the world and might result in an increased rate of invasive species, as it was clearly shown in Europe during the last 100 years (Coeur d’acier et al., 2010). A similar invasive species pattern existed in Turkey, and a considerable number of invasive species were recorded in Turkey with a nonignorable number of North America originated aphid species (Akyıldırım et al., 2013; Şenol et al., 2015). Turkey’s aphid fauna consists of 614 species and about 3% of them are Turkey originated. Recent studies both in Turkey and other countries clearly indicate the importance of detailed collaborative studies to observe the current composition of all countries aphid fauna and possible shifts in future as a result of invasive species impacts (Petrović-Obradović et al., 2010; Brewer et al., 2019; Borbély et al., 2021). These changes are not only going to affect biodiversity, but also influence agricultural productivity all over the world, therefore more attention has to be paid to invasive aphid species.

References


