Research Article

Fauna and species diversity of thrips (Insecta: Thysanoptera) on Montpellier maple trees Acer monspessulanum in Zagros forests of Ilam province, Iran

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Abstract: Montpellier maple Acer monspessulanum L. is one of the trees in Zagros forests (Iran) which is host to several economically important thrips species. The purpose of this study was to find the fauna of thrips on Montpellier maple trees in Ilam province, western Iran, during 2015-2016. The abundance and species diversity of thrips were examined twice a month via standard sweep net and shaking flowers and leaves to white plastic tray at two location sites including Gachan and Manesht Mountains. Out of the 7062 thrips specimens that were collected, 16 thrips species were identified, which belonged to 10 genera and four families. The estimated domination coefficient showed that in both sites Taeniothrips inconsequens Uzel was eudominant and onion thrips, Thrips tabaci Lindeman was dominant species. There were 5 and 4 species classified as subdominant for Gachan and Manasht, respectively. Four predatory thrips were found on Montpellier maple trees including Aeolothrips intermedius Bagnall, Scolothrips longicornis Priesner, Haplothrips flavitibia Williams and H. globiceps. Of these, A. intermedius was the most abundant predator in both collection sites, whereas others showed a low population density. According to diversity index calculations, the Shannon diversity, Pielou’s evenness and Margalef’s species richness indices were 1.83, 0.68 and 1.67 for Gachan, and 1.48, 0.62 and 1.26 for Manesht, respectively.

Keywords: Thrips, diversity, population

Introduction

The Zagros forests with a semi-Mediterranean climate located in western Iran represent more than 40% of the country’s forests. There are different kinds of trees in Zagros with the dominant species of Oak trees Quercus brantti Lindl. (Purhashemi et al., 2004). The other species, Montpellier maple tree Acer monspessulanum L. is a deciduous shrub with leathery and three-lobed dark green leaves (van Gelderen and van Gelderen, 1999). In Zagros forests, several insects and mites are feeding on maple trees including mites (especially eriophyd and spider mites), aphids, caterpillars, and gall-forming cynipid wasps (Mirzaei and Mirab-balou, 2015).
Of the 6000 species of thrips (Order Thysanoptera) described worldwide, over 200 species have been recorded in Iran (Mirabalou, 2013), and this number continues to increase as new thrips species are collected. In Iran, only a few thrips species are recorded as serious pests (Minaei et al., 2007; Mirabalou and Chen, 2011). Most thrips including *Thrips tabaci* Lindemann feed on plants, attacking flowers, leaves, buds and fruits. Several species of thrips feed on fungus spores, and a few are beneficial predators (Poboźniak et al., 2007).

Measuring species diversity is an important aspect of environment to achieve the information on the extent to which humans alter the natural habitats (Sisk et al., 1994; Humphries et al., 1995). In addition, species diversity may be used to evaluate the occurrence of new species in a habitat (Mirabalou et al., 2017). Species diversity takes into account both species richness and species evenness (Brown et al., 2007). Perhaps the simplest and most frequently used measure of biological diversity is species richness. Species richness is simply a count of species, and it does not take into account the abundances of the species or their relative abundance distributions (Brown et al., 2007).

Some studies have been done on thrips species composition and diversity (Childers and Nakahara, 2006; Ganaha-Kikumura et al., 2012; Wang et al., 2014). Childers and Nakahara (2006) studied on thrips species within citrus orchards in Florida. They found 21 plant feeding species among which only *Frankliniella bispinosa* Morgan, *Chaetanaphthrips orchidii* Moulton, *Danothrips trifaciatus* Sakimura, and *Heliothrips haemorrhoidalis* Bouche have been considered economic pests on Florida citrus trees. Ganaha-Kikumura et al. (2012) studied the species composition of thrips on chrysanthemum in Okinawa. Their results were unexpected as *Thrips nigropilosus* Uzel was an important pest species of chrysanthemum while the frequency of *T. tabaci* was low, and *F. occidentalis* was not found. Wang et al. (2014) showed that based on comparisons of Shannon-Wiener diversity index, Pielou evenness index, and Simpson dominance index, the diversity of Chinese litter-dwelling thrips in the tropics was higher than that in the temperate areas.

Early detection of thrips is critically important because symptoms of their feedings often remain hidden until serious damage is done (Fueutes and Salazar, 2003). Thus, knowing the important thrips species for each region and their population densities on plants is important for their management. It is known that natural enemies such as thrips predators have crucial importance on the population density of thrips pest species (Fathi et al., 2008).

At present, there is no information on thrips associated with maple trees in Iran (Mirabalou, 2016). Therefore, this study was conducted to determine the species composition of thrips fauna on Montpellier maple trees in two location sites of Zagros forests (Gachan and Manesht Mountains), and to check which thrips species are the most dominant on these trees.

**Materials and Methods**

**Thrips collection**

Thrips specimens were collected on Montpellier maple trees (*A. monspessulanum*) of Manesht Mountain (N 33° 41' 33.36", E 46° 27' 28.08") and Gachan Mt. (N 33° 38' 43.08", E 46° 29' 9.96") located in Zagros forests, Ilam province (west of Iran) (Fig. 1). The survey was made twice a month from April to July during 2015-2016. Specimens of thrips were collected for 60 min on 10 trees from each location site by using standard sweep net (38 cm in diameter) and extracted from maple trees by beating the branches, flowers and leaves over a white plastic tray (500 × 400 mm). The thrips that fell onto the tray were then individually collected using a fine paint brush and transferred into vials with 75% ethanol alcohol and total numbers recorded.
Figure 1 Map of Iran (right), showing two location sites of study in Ilam province (left).

**Thrips identification**

The method for preparing and mounting thrips on slides for microscopic identification follows Mirab-balou and Chen (2010). Only adult thrips were identified to species and the larvae were not, because their identification is not possible.

**Data analysis**

Diversity was calculated by Shannon-Wiener's Index. This is the most commonly used index in ecology of communities (Ludwig and Reynolds, 1988) and allows comparisons between communities:

\[
H' = -\sum \frac{n_i}{N} \ln \frac{n_i}{N}
\]

In which, \(H'\) - Shannon-Wiener's Index, \(n_i\) - number of specimens of \(i\)-species per sample, \(N\) - total number of individuals of all the species, and \(s\) - number of species in community.

Evenness was calculated by Pielou's evenness index which has two contributing components including the number of species and the distribution of individuals among those species (equitability):

\[
J = \frac{H'}{\ln S}
\]

In which, \(J\) - Pielou's evenness index, \(H'\) - Shannon-Wiener's Index and \(S\) - total number of species collected in the sample (Pielou, 1975).

Species richness was estimated using the Margalef's richness index. Species richness is the number of species recorded and does not take into account relative abundances, instead includes the sum of individuals recorded for all the species in a specific sample plot:

\[
D_{mg} = \frac{(S-1)}{\ln N}
\]

In which, \(D_{mg}\) - Margalef's richness index, \(S\) - the number of species recorded and \(N\) - the total number of individuals in the sample (Margalef, 1958).

Domination coefficient informs what percentage out of the total amount of the collected specimens for a given area is constituted by specimens of a particular species. It was calculated by Kasprzak and Niedbala (1981) formula:

\[
D_i = \frac{n_i}{N} \times 100\%
\]
In which, $n_r$ number of specimens of a given species in a given area and $N$-number of all the specimens collected from a given area.

**Results**

Both terebrantian and tubuliferan thrips were found on trees collected at two collection sites. From the 7062 thrips specimens that were collected, 16 species were identified which belonged to 10 genera and four families (Table 1). A total of 921 terebrantian thrips were mounted onto glass slides for identification. Thirteen terebrantian species were identified, all belonging to the family Thripidae (except Aeolothrips intermedius Bagnall and Melanthrips fuscus Sulzer that belong to Aeolothripidae and Melanthripidae, respectively).

Total number of thrips specimens collected from Gachan and Manasht were 4360 and 2702, respectively. In both sites, the number of females was approximately 3.7 times more than males. The number of species found in Gachan (15) was more than Manasht (11). Overall, Taeniothrips inconsequens Uzel was the most abundant species at both collection sites, followed by onion thrips, *T. tabaci* (Table 1).

Four predatory thrips were found on Montpellier maple trees: *A. intermedius*, Scolothis longicornis Priesers, Haplothrips flavitibia Williams and *H. globiceps*. Of these, *A. intermedius* was the most abundant predator in both collection sites, whereas *S. longicornis*, *H. flavitibia* and *H. globiceps* showed a low population density (less than 30) during all sampling dates (Table 1).

According to diversity index calculations, the Shannon diversity, Pielou’s evenness and Margalef’s species richness indices were 1.83, 0.68 and 1.67 for Gachan, and 1.48, 0.62 and 1.26 for Manesht, respectively (Table 1). The estimated domination coefficient showed that in both sites *T. inconsequens* was eu-dominant and *T. tabaci* was dominant. There were 5 and 4 species classified as sub-dominant for Gachan and Manasht, respectively (Table 2).

**Table 1**

<table>
<thead>
<tr>
<th>Family</th>
<th>Species name</th>
<th>Gachan Mt.</th>
<th>Manesht Mt.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>♀</td>
<td>♂</td>
</tr>
<tr>
<td>Aeolothripidae</td>
<td><em>Aeolothrips intermedius</em></td>
<td>260</td>
<td>183</td>
</tr>
<tr>
<td>Melanthripidae</td>
<td><em>Melanthrips fuscus</em></td>
<td>44</td>
<td>30</td>
</tr>
<tr>
<td>Thripidae</td>
<td><em>Anaphothrips obscurus</em></td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td><em>Chirothrips manicatus</em></td>
<td>24</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td><em>Frankliniella intonsa</em></td>
<td>386</td>
<td>246</td>
</tr>
<tr>
<td></td>
<td><em>Frankliniella occidentalis</em></td>
<td>193</td>
<td>136</td>
</tr>
<tr>
<td></td>
<td><em>Frankliniella tenuicornis</em></td>
<td>47</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td><em>Scolothis longicornis</em></td>
<td>25</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td><em>Taeniothrips inconsequens</em></td>
<td>1805</td>
<td>1418</td>
</tr>
<tr>
<td></td>
<td><em>Tenothrips frici</em></td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td><em>Thrips meridionalis</em></td>
<td>150</td>
<td>111</td>
</tr>
<tr>
<td></td>
<td><em>Thrips tabaci</em></td>
<td>897</td>
<td>897</td>
</tr>
<tr>
<td></td>
<td><em>Thrips vulgatissimus</em></td>
<td>371</td>
<td>213</td>
</tr>
<tr>
<td>Phlaeothripidae</td>
<td><em>Haplothrips flavitibia</em></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td><em>Haplothrips globiceps</em></td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td><em>Haplothrips reuteri</em></td>
<td>129</td>
<td>87</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>4360</td>
<td>3424</td>
</tr>
</tbody>
</table>

Total number of observed species = 15, Shannon diversity index = 1.83, Pielou's evenness index = 0.68, and Margalef’s species richness index = 1.67.
Results. In this study, all Frankliniella n and Manasht at four was found at Gachan species ps and, Mirab-balou et al.__________________________________________________ J. Crop Prot. (2019) Vol. 8 (4) 
Table 2 ... vulgatissimus 6.55 9.71 8.24 9.19 
Haplothrips globiceps 0.11 0.29 0 0.28 
Haplothrips reuteri 3.64 2.05 3.40 2.65 

The thrips species collected had wings, and other trees. migration of the insects Gachan, and resulted probably from the weeds and other trees.

Two species, Anaphothrips obscurus Muller and Tenothrips frici Uzel were found accidentally on maple trees at Gachan, and resulted probably from the migration of the insects from the weeds and other trees. No male thrips were found for T. tabaci and A. obscurus (Table 1). In this study, all the thrips species collected had wings, nevertheless a wingless form of male of Chirothrips manicatus was found at Gachan Mountain

Table 3 Domination coefficient of adult thrips species collected on maple trees in four different months, Gachan Mt. in Ilam province, Iran.

<table>
<thead>
<tr>
<th>Thrips species</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aelothrips intermedius</td>
<td>0.57</td>
<td>3.42</td>
<td>5.38</td>
<td>13.64</td>
</tr>
<tr>
<td>Melanthrips fuscus</td>
<td>0.57</td>
<td>1.07</td>
<td>0.92</td>
<td>1.42</td>
</tr>
<tr>
<td>Anaphothrips obscurus</td>
<td>0.98</td>
<td>0</td>
<td>0.35</td>
<td>0</td>
</tr>
<tr>
<td>Chirothrips manicatus</td>
<td>1.26</td>
<td>0.39</td>
<td>0</td>
<td>0.85</td>
</tr>
<tr>
<td>Frankliniella intonsa</td>
<td>10.00</td>
<td>8.42</td>
<td>9.49</td>
<td>7.39</td>
</tr>
<tr>
<td>Frankliniella occidentalis</td>
<td>9.40</td>
<td>4.40</td>
<td>3.82</td>
<td>1.13</td>
</tr>
<tr>
<td>Frankliniella tenuicornis</td>
<td>3.31</td>
<td>0.35</td>
<td>0.12</td>
<td>1.04</td>
</tr>
<tr>
<td>Scolothrips longicornis</td>
<td>0.57</td>
<td>0.35</td>
<td>0.56</td>
<td>0.75</td>
</tr>
<tr>
<td>Tenothrips inconsequens</td>
<td>24.31</td>
<td>46.62</td>
<td>49.39</td>
<td>39.97</td>
</tr>
<tr>
<td>Tenothrips frici</td>
<td>0</td>
<td>0</td>
<td>0.35</td>
<td>0.56</td>
</tr>
<tr>
<td>Thrips meridionalis</td>
<td>7.33</td>
<td>3.03</td>
<td>2.4</td>
<td>1.99</td>
</tr>
<tr>
<td>Thrips tabaci</td>
<td>31.40</td>
<td>19.9</td>
<td>15.58</td>
<td>19.14</td>
</tr>
<tr>
<td>Thrips vulgarissimus</td>
<td>6.55</td>
<td>9.71</td>
<td>8.24</td>
<td>9.19</td>
</tr>
<tr>
<td>Haplothrips globiceps</td>
<td>0.11</td>
<td>0.29</td>
<td>0</td>
<td>0.28</td>
</tr>
<tr>
<td>Haplothrips reuteri</td>
<td>3.64</td>
<td>2.05</td>
<td>3.40</td>
<td>2.65</td>
</tr>
</tbody>
</table>
**Fauna and species diversity of thrips**

**Table 4** Domination coefficient of adult thrips species collected on maple trees in four different months, Manesht Mt. in Ilam province, Iran.

<table>
<thead>
<tr>
<th>Thrips species</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aeolothrips intermedius</td>
<td>0.58</td>
<td>1.86</td>
<td>2.49</td>
<td>6.30</td>
</tr>
<tr>
<td>Melanthrips fuscus</td>
<td>0.96</td>
<td>1.86</td>
<td>1.47</td>
<td>2.10</td>
</tr>
<tr>
<td>Frankliniella intonsa</td>
<td>6.78</td>
<td>7.27</td>
<td>1.36</td>
<td>2.94</td>
</tr>
<tr>
<td>Frankliniella occidentalis</td>
<td>2.32</td>
<td>1.35</td>
<td>5.33</td>
<td>4.48</td>
</tr>
<tr>
<td>Scolothrips longicornis</td>
<td>0.38</td>
<td>0.67</td>
<td>0.45</td>
<td>0.70</td>
</tr>
<tr>
<td>Taeniothrips inconsequens</td>
<td>15.17</td>
<td>50.46</td>
<td>60.29</td>
<td>48.47</td>
</tr>
<tr>
<td>Thrips meridonialis</td>
<td>4.06</td>
<td>1.86</td>
<td>3.51</td>
<td>2.38</td>
</tr>
<tr>
<td>Thrips tabaci</td>
<td>60.46</td>
<td>29.61</td>
<td>21.26</td>
<td>26.61</td>
</tr>
<tr>
<td>Thrips vulgarissimus</td>
<td>6.58</td>
<td>3.89</td>
<td>2.83</td>
<td>4.34</td>
</tr>
<tr>
<td>Haplothrips flavitibia</td>
<td>0.58</td>
<td>0.50</td>
<td>0.22</td>
<td>0.42</td>
</tr>
<tr>
<td>Haplothrips reuteri</td>
<td>2.13</td>
<td>0.67</td>
<td>0.79</td>
<td>1.26</td>
</tr>
</tbody>
</table>

**Discussion**

Sampling maple trees of two sites located in Ilam county resulted in identification of 16 thrips species which most of them were phytophagous and a few were predators. There are a number of studies on thrips fauna in different ecosystems. In the study by Hurej et al. (2014) 17 thrips species were identified on lupin plants. Pobożniak and Anna (2011) reported 22 species from the flowers and inflorescences of 37 species of herbs. Mirab-balou et al. (2017) collected 27 species belonging to 13 genera of thrips species in fruit orchards in Qazvin province, northwest of Iran. This difference in results of different studies could be related to differences in plant species, climate conditions, sampling methods and the duration of studies. Here we report one more thrips family (Melanthripidae) compared to the study by Pobożniak and Anna (2011).

Among phytophagous thrips, T. inconsequens and T. tabaci were the most dominant species. Several studies have shown that T. tabaci is the most dominant among the species of Thysanoptera. In the studies by Pobożniak (2005) and Mirab-balou et al. (2017), T. tabaci was classified as eudominant species. In the case of T. inconsequens, there are fewer studies showing this species as eudominant (Teulon et al., 1998). T. inconsequens is widely distributed in most countries (Mirab-balou et al., 2015). Adults of this species have been recorded from over 200 plant species including species of Acer (Sapindaceae), Fagus and Quercus (Fagaceae), Fraxinus (Oleaceae), Prunus and Pyrus (Rosaceae). This species seriously damages young leaves and causes premature leaf fall of sugar maple in north east of USA (Teulon et al., 1994).

T. inconsequens has been identified for the first time on Montpellier maple trees of Iran through this study. The larvae and adults of this species can cause significant damage by feeding on the flowers and leaves. During the months of April till the first week of July, this kind of damage is seen in the nature. Severe foliage damage could result in early spring defoliation followed by refoliation in May or June. According to Teulon et al. (1998), this species has only one generation per year and populations do not increase over the summer.

Among the predators, A. intermedius was the most dominant species. A. intermedius specimens have been found in Europe on 30 different host plants, always in mixed populations with phytophagous insects including 18 thrips species (Trdan et al., 2005). Adults and larvae of A. intermedius, were found as predator of 44 species of thrips (Riudavets, 1995). The main pest genera for which A. intermedius has been reported as predator are: Haplothrips (Dyadechko et al., 1971) and Thrips (Franco et al., 1999).

**Conclusion**

In the present study, it was found that T. inconsequens and T. tabaci are respectively eudominant and dominant thrips species on A. monspessulanum. At both collection sites, A. intermedius was the dominant predator thrips species on Montpellier maple trees. There is a need for more investigations on the role of A. intermedius as a biological control agent of phytophagous thrips.
Acknowledgments

We are grateful to Hamid Veisi, who helped us in field sampling. This work was supported by Ilam University, grant number 32/724.

References


فون و تنوع گونه‌ای تربیس‌ها در جنگل‌های استان ایلام، ایران

مجید میراب‌بی‌لاو، مجید محمودی و بهزاد میری

چکیده: درخت افرا (Insecta: Thysanoptera) روی درختان افرا (Acer monspessulanum) مزیزان چندین گونه تربیس با اهمیت اقتصادی می‌باشد. هدف از این مطالعه بررسی فون و تنوع گونه‌ای تربیس‌ها روی درختان افرا بود که در استان ایلام طی سال‌های 1394 و 1395 انجام شد.

نمونه‌برداری از تربیس‌ها در پر سازی در جنگل‌های کوهستانی و مانند مکان‌های انبوه و اماکن طبیعی انجام شد. نجاتی از آنها در این پژوهش غیر از نتایج اولاً فواید و نتایج مثبتی داشت. همچنین گونه تربیس جنس ترنی سفید (Taeniothrips inconsequens Uzel) به عنوان گونه غلاب است. در منطقه مانند 4 گونه و در منطقه گچ‌جاز 5 گونه در این پژوهش یافت شدند.

وژگران کلیدی: تربیس، تنوع، جمعیت