

OAKS WOOD BORER BEETLE AND RELATIONSHIP WITH DRYNESS OAK TREES IN ILAM PROVINCE

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ABSTRACT

The occurrence of drought and wood borer insects several outbursts in recent years has caused a high percentage of oak forests in Ilam to become dry or damaged. To this end, during three consecutive years (2013-2015), by examining the infected trunks in the forest and breeding larvae of different species in cages and keeping infected trunks in closed containers, different wood borers were collected and identified. Also necrosis in four regions of the province including the base necrosis, necrosis cause and re-growth were evaluated. The results showed that wood borer pests include these species:

Cerambyx cerdo (Linnaeus, 1758) (Col., Cerambycidae);

Macrotoma scutellaris (Germar, 1817) (Col., Cerambycidae)

Chalcophorella bagdadensis (Laporte & Gory, 1836) (Col., Buprestidae)

Agrilus hastulifer (Ratzeburg, 1839) (Col., Buprestidae)

Chrysobothris parvipuncta (Obenberger, 1914) (Col., Buprestidae)

Lampetis mimosa (Klug, 1829) (Col., Buprestidae). 10.31 % of the bases were dried completely, and in 90% of the bases symptoms of charcoal disease and wood borer beetles were found. Good rainfall in the last year decreased the necrosis process and on average 24% of dry bases re-grew.

KEYWORDS: wood borer, pest, oak tree, Ilam province

INTRODUCTION

Ilam province with about 19045 square kilometer area is in the southwest of Iran and includes 1.2 percent of Iran's area. Forests forms about 26 percent of it, and it mostly includes forms of oak (Hosseinzadeh, 2010). As the result of climate change and drought in recent years many trees such as oak, in general, became weak and this weakness has caused certain species of wood borer pests such as Buprestidae and Cerambycidae to revolt and a high percentage of forests in the province have been damaged or dried (Jozeyan and Abaii, 2011). Wood borers and bark borers are the main reason of oak trees necrosis under stress (Salle *et al.*, 2014). So far, more than 35000 species of Cerambycidae family has been identified in the world, and a number of them are forest pests which transmit tree diseases. Their females lay their eggs on or in the bark of stems, and sticks of dying trees, fresh dried or rotting ones. Their larvae first feed off the phloem and then feed off the xylem (Allison *et al.*, 2004). *Agrilus biguttatus* beetles of Buprestidae family are the cause of oak decline in Europe in recent years. The larvae create tunnels under the bark of weak trees and kill them (Moraal and Hilszczanski, 2000). This pest attacks different species of oak that have been weakened by environmental stress or living factors (James *et al.*, 1986). Oak trees store starch in winter which makes the *Agrilus bilineatus* attack in summer. Callus tissue may limit the existence of small larvae that feed on the cambium (James *et al.*, 1990). The death of Oak trees in North America is in connection with the damage of the male adults which are able to quickly find weak trees.

Up to 160 adults per week are trapped in the sticky traps installed on the trunks of weak trees, but they have rarely been trapped in trunkless trees. This suggests that adults understand the quality of the host from distance. One of the mechanisms to find the host may be volatile compounds produced by the trees.

Appearance of host trees and the absorption rate of adults determine the success. Injured trees attract adults until the death of the cambium (James *et al.*, 1986). *Massicus raddei* Long - horned beetle from Cerambycidae family is the main pest of oak trees in North East China that damages the trunk of *Quercus liaotungensis* and *Q. mongolicus* oaks (Zhong *et al.*, 2014). *Enaphalodes rufulus*, a long-horned native insect of Missouri and Oklahoma in *Quercus ruber* had been in a state of revolt in the years 1999-2005 (Meyers *et al.*, 2013). In Serbia, 26 species of wood and bark borers, 47 species of parasitoid and 14 species of predators in the sticks of *Quercus cerris*, *Q. frainetto*, *Q. petraea*, and *Q. Robur* with 3-15 cm diameter were identified in 24 sites during the years 1992-1996; and the most important bark borer was

Scolytus intricatus and that of wood borers were *Agrilus angustulus* and *Xylotrechus antelope* (Cedomir and Aleksander, 2011). A study on the relationship between *Cerambyx* spp from Cerambycidae family and *Biscogniauxia mediterraneum* fungi (charcoal disease cause) in southwestern Spain oaks suggests that adult exit holes and fungi existence are directly related to each other (Jose *et al.*, 2005). *Biscogniauxia mediterraneum* fungi are the cause of charcoal disease in oak trees of Ilam, Lorestan, Fars and Kohgiluyeh-Boyer Ahmad, and it caused damage to the oak trees. Symptoms include discharge, separation of bark, dark and blackened tissue drain and wood (Mirabolphathi, 2013). This disease onset and extended in drought conditions (Vannini and valentine, 1994). Fungi spores develop earlier in injured parts of tree and cause pollution (Vannini, 1998).

In Iran, *Agrilus angustulus*, *A. biguttatus*, and *A. viridis* beetles from Buprestidae family in Northern provinces and *A. hastulifer* from Fars and *Anthaxia hungarica* from Kermanshah and Kurdistan and *Latipalpis persica* from Fars and beetles from Cerambycidae family such as:

Anisorus quercus, *Mesososa curculionides*, *Morimous verecundaus*, *Parandra caspica*, *Penichroa fasciata*, *Plagionotus detritus*, *Plagionotus lugubris*, *Pseudoprionus bienerti*, *Purpuricenus deyrollei*, *Purpuricenus kaehleri*, *Rhagium pygmaeum*, *Rhesus serricollis*, *Stenopterus rufus*, *Strangalia emmipoda*, *Stromatium fulvum*, *Trichoferus griseus*. *Anisorus quercus*, *Mesososa curculionides*, *Morimous verecundaus*, *Parandra caspica*, *Penichroa fasciata*, *Plagionotus detritus*, *Plagionotus lugubris*, *Pseudoprionus bienerti*, *Purpuricenus deyrollei*, *Purpuricenus kaehleri*, *Rhagium pygmaeum*, *Rhesus serricollis*, *Stenopterus rufus*, *Strangalia emmipoda*, *Stromatium fulvum*, *Trichoferus griseus* .from northern provinces, *Macrotoma scutellaris* from Kermanshah and Lorestan, *Mallosia herminae* from Kermanshah, *Mallosia mirabilis* from Lorestan, *Megopis scabricornis* from northern provinces and Fars, *Calchaenesthes divesicollis* from Lorestan, *Callimellum femoratus* and *Callimellum femoratus* from western provinces, *Osphranteria Mesoprionus* from Golestan, *Osphrantria coerulea* from various provinces, *Plocaederus luristanicus* from Lorestan, *Phytoesia kurdistanica* from Golestan, *Prionus angustatus* from Fars, *Prionus persicus* from Lorestan, *Prionus coriarius* from northern and central provinces, *Purpuricenus dalmatinus* from Lorestan and Kermanshah, *Purpuricenus thomasi* from Lorestan, *Purpuricenus wachanrui* from Fars and *Trichoferus pressi* from Fars, Bushehr, Khuzestan and northern provinces have been reported (Abaii, 2009).

Fifteen species of *Anthaxia* and seven species of *Agrilus*, which damage trees and shrubs in forests, have been reported (Bedad, 1987). In the collection and identification and analysis of the insect fauna and wood borer beetles of the Cerambycidae family, 16 species have been identified, belonging to four sub-families with economic importance (Farashiani *et al.*, 2005). In the primary analysis of these pests in Ilam, *Agrilus hastulifer* species had been identified (Jozeyan and Abaii, 2011). However, due to extreme damages of wood borer beetles and their role in necrosis of the trees in drought conditions, their analysis and identification, along with other findings related to oak trees necrosis, can help to manage the necrosis situation.

MATERIALS AND METHODS

Two of the forest areas of Ilam including Maleh Siah and Manjal were visited monthly in 2013-2015, and in each visit in order to get information on the status of various species, 3-5 meter long trunks of semiarid and dry trees were completely ripped off using power saw and ax. Notes and samples were collected on different growth stages of wood borer insects according to their appearance, density, damage location, etc. and samples were kept for breeding adults in plastic mesh containers in the laboratory of Ilam Agricultural Research Center. At each visit, many examples of dry twigs and trunks of trees have been transferred to the research center to be kept in chambers and cages. These chambers which are about 10-15 square meters, are completely closed and dark. Adult insects were collected on a daily basis, using a bowl of water beside a bright light, collected samples were identified in collaboration with research institute (Dr. Abaee). In the spring of 2014, to determine the number of dead trees, they were analyzed based on necrosis causes and the number of returnable dead trees as a result of good rainfall in 2013-2014 in four regions including Manjal, Maleh Siah, Chaghasabz, and Maleh Panjab.

- 1- Analyzing 500 trees in each area to determine the number of healthy, completely dry and semiarid trees (Table 1).
- 2- Analyzing 100 dry trees in each area based on necrosis causes and specifying the number of dead trees based on only charcoal disease, only the effects of pest damage, or both of the above (Table 2).
- 3- Analyzing 100 dry trees in each area and determining the number of returnable dead trees as the result of the good rainfall in 2013-2014 (Table 3).

RESULTS

Examples of Oak wood borers obtained from keeping and breeding larvae of various species in cages and study chambers and collected from the infected trunks include (Figure 1):

- 1) *Cerambyx cerdo* (Linnaeus, 1758) (Col., Cerambycidae)
- 2) *Macrotoma scutellaris* (Germar, 1817) (Col., Cerambycidae)
- 3) *Chalcophorella bagdadensis* (Laporte & Gory, 1836) (Col., Buprestidae)
- 4) *Agrilus hastulifer* (Ratzeburg, 1839) (Col., Buprestidae)
- 5) *Chrysobothris parvipuncta* (Obenberger, 1914) (Col., Buprestidae)
- 6) *Lampetis mimosa* (Klug, 1829) (Col., Buprestidae)

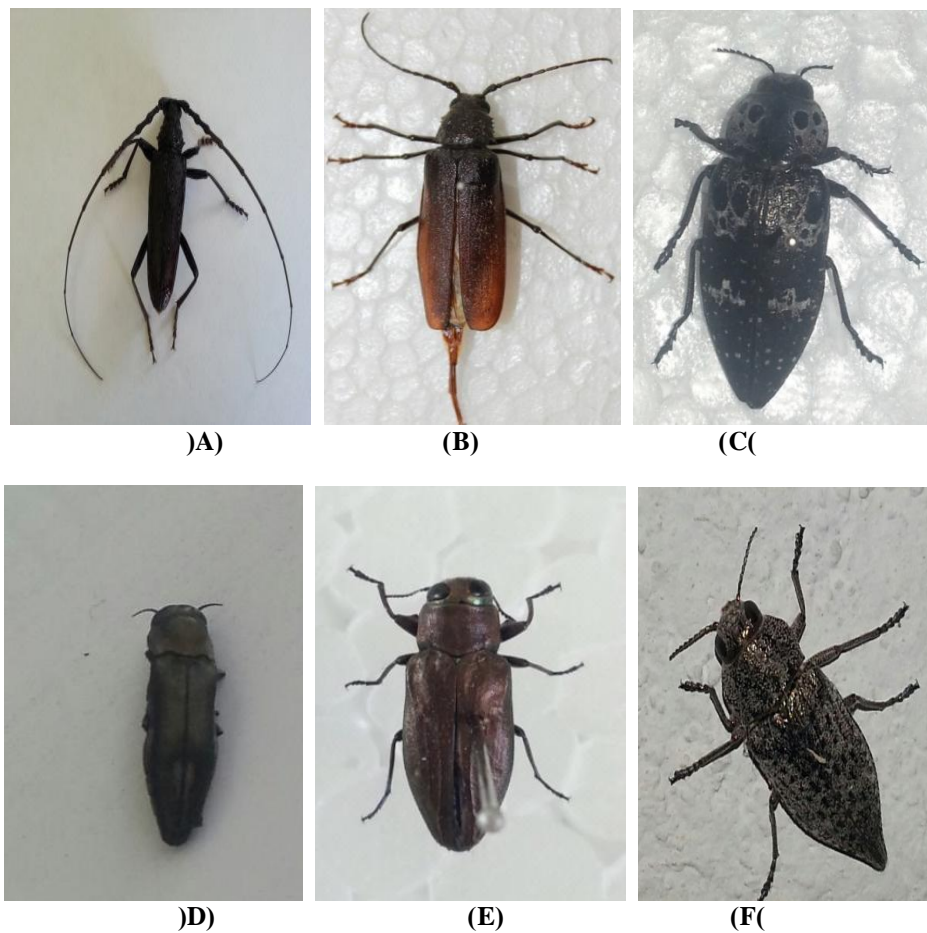


Figure 1- The wood oak borer adult beetles in Ilam

- A- *C. cerdo*
 B- *M. scutellaris*
 C- *C. bagdadensis*
 D- *A. hastulifer*
 E- *C. parvipuncta*
 F- *L. mimosa*

Among these species, *Macrotoma Scutellaris* cause damage to the trunk and thick sticks, and larvae feeds from the center parts of trunks and thick sticks (Figure 2).



(A)



(B)

Figure 2 - different growth stages of *Macrotoma Scutellaris* in the damaged oak tree trunk. A) larvae B) pupa and adult

Agrilus hastulifer species cause damage to the twigs, and larva feeds off the wood texture between the wood and bark (cambium), so that the effects of the damage is visible under the skin and on the surface of the wood (Figure 3).



Figure 3- The damages of *Agrilus hastulifer* species

Tunnels created by the Buprestidae beetle larvae under the bark parallel to the long axis of the stem or perpendicular to the long axis of the stem that causes necrosis in low density (Figure 4).



Figure 4- tunnels created by the Buprestidae beetle larvae under the bark

Analyzing Ilam rainfall weather station showed that its average long-term (30 years) rainfall was 563.8 mm per year (Anonymous, 2014), and from 2005 rainfall has been less than the long-term average for eight consecutive years (Figure 5). The long-term drought conditions, followed by wood borer insect outbreak and charcoal disease, have caused a big percentage of trees in the forests of Ilam to get dry or damaged. As Table 1 shows, the average for the full number of necrosis trees until the spring of 1393 in manjal, Maleh Siah, Chaghasabz, and Maleh Panjab was 10.8, 11.8, 9, and 9.4 percent and an average of 10.3 percent in addition to 8.7 percent semidried trees. It should be noted that in semiarid trees, due to the use of dry twigs as firewood, drying percentage was different at different times.

As Table 2 shows, with examining the symptoms of necrosis cause of dead trees in four regions including Manjal, Maleh Siah, Chaghasabz, Maleh Panjab, it is obvious that about 90 % of the dead trees have both symptoms of charcoal disease and wood borer beetles, and in all of the dry trees damages of wood borer beetles was observed.

In the agricultural year 2013-2014, due to the good rainfall, necrosis growth process had stopped. As Table 3 shows, an average 24 % of the dead trees germinated from twigs or trunks, and have been returned from necrosis state. The returnable dead trees, apart from necrosis causes, may also be damaged under these conditions: In cases where trees grow on the trunk or twigs because of an imbalance in the shoots growing on the twigs of one side of the tree (Figure 6), which may become damaged in the wind. Also some may be damaged by grazing.

Table 1. Number of dead Oak trees

| Semiarid | | Completely dry | | OK | | Number of trees | Region | Row |
|------------|--------|----------------|--------|------------|--------|-----------------|--------------|-----|
| percentage | number | percentage | number | percentage | number | | | |
| 5.8 | 29 | 10.8 | 54 | 83.4 | 417 | 500 | Manjal | 1 |
| 12.6 | 63 | 11.8 | 59 | 75.6 | 378 | 500 | Maleh Siah | 2 |
| 6.4 | 32 | 9 | 45 | 84.6 | 423 | 500 | Chaghasabz | 3 |
| 10.2 | 51 | 9.4 | 47 | 80.4 | 402 | 500 | Maleh Panjab | 4 |
| 8.7 | | 10.3 | | 81 | | | Average | |

Table 2- The number of dead trees based on the symptoms of necrosis cause

| Disease and Pests | | Only Pests Damage | | Only Charcoal Disease Symptoms | | Number of dead trees | Region | Row |
|-------------------|--------|-------------------|--------|--------------------------------|--------|----------------------|--------------|-----|
| percentage | number | percentage | number | percentage | number | | | |
| 100 | 100 | 0 | 0 | 0 | 0 | 100 | Manjal | 1 |
| 89 | 89 | 11 | 11 | 0 | 0 | 100 | Maleh Siah | 2 |
| 78 | 78 | 22 | 22 | 0 | 0 | 100 | Chaghasabz | 3 |
| 92 | 92 | 8 | 8 | 0 | 0 | 100 | Maleh Panjab | 4 |
| 89.7 | | 10.3 | | 0 | | | Average | |

Table 3. Number of returnable dead trees in the good rainfall in the agricultural year 2013-2014

| Percentage of returnable trees | Number of returnable trees | Number of non-returnable trees | Number of dead trees | Region | Row |
|--------------------------------|----------------------------|--------------------------------|----------------------|--------------|-----|
| 21 | 21 | 79 | 100 | Manjal | 1 |
| 18 | 18 | 82 | 100 | Maleh Siah | 2 |
| 32 | 32 | 68 | 100 | Chaghasabz | 3 |
| 25 | 25 | 75 | 100 | Maleh Panjab | 4 |
| 24 | | | | Average | |

In cases where returnable trees grow back on the trunk and branches, shaping is recommended, and some cases which were returned by leaping may be damaged from grazing.



Figure 5- Ilam weather station rain figure

DISCUSSION

Long-term average rainfall, according to Ilam weather station which is the nearest station to the study regions, is 563.8 mm per year (Anonymous, 2014). As it is clear from figure 5 of the agricultural year 2005-2006, 8 consecutive years' rainfall amount was less than the average annual rainfall. This long-term drought caused many trees such as oak, in general, to become weak and this weakness has caused certain species of wood borer insects of the Buprestidae and Cerambycidae family to revolt and a large percentage of the province 's forests became dry or damaged (Jozeyan and Abaii, 2011). In addition to drought and wood borers, *Biscogniauxia mediterraneanum* fungi, the cause of Oaks charcoal disease, caused damage to the oak trees in recent years in Ilam, Lorestan, Fars and Kohgiluyeh-Boyer Ahmad (Mirabolphathi, 2013). This disease onset and extended in drought conditions (Vannini and valentine, 1994). Fungus spores develop earlier on the injured surfaces of trees and cause pollution (Vannini, 1998). Wood and bark borers are the main cause of Oak necrosis under stress (Salle *et al*, 2014). So far, more than 35,000 species of Cerambycidae family has been identified in the world and a number of them are forest pests which are involved in the transmission of

tree diseases (Allison *et al.*, 2004). The output holes of adult insects of *Cerambyx* spp and Cerambycidae family and *Biscogniauxia mediterraneum* fungi (charcoal disease cause) are directly related in oak trees (Jose *et al.*, 2005). The results of this study show that six species of wood borers cause damage to the trees in Ilam, and among them the most important trunk and twigs wood borer species are *Agrilus hastulifer* and *Macrotoma scutellaris*. *M. scutellaris* larvae attack the trunk and thick sticks and *A. hastulifer* larvae damage the cambium area.

Lampetis mimosa species was found rarely and in very low density. *A. hastulifer* was previously reported in Ilam (Jozeyan and Abaii, 2011), but other species are reported in Ilam for the first time. *A. hastulifer* species have also been reported from Shiraz (Abaii, 2009). Oak wood borer beetles have been reported from the rest of the country (Abaii, 2009, Bedad, 1987, Farashiani *et al.*, 2005). In Europe, *Agrilus biguttatus* beetle from Buprestidae family has been the reason of oak decline in recent years; the larvae make tunnels under the bark of weak trees and kill them (Moraal and Hilszczanski, 2000). This pest attacks different species of oak that have been weakened by environmental stress or living factors (James *et al.*, 1986). Oak trees store starch in winter which makes the *Agrilus bilineatus* attack in summer. Callus tissue may limit the existence of small larvae that feed on the cambium (James *et al.*, 1990).

The death of Oak trees in North America is in connection with the damage of the male adults which are able to quickly find weak trees. Up to 160 adults per week are trapped in the sticky traps installed on the trunks of weak trees, but they have rarely been trapped in trunkless trees. This suggests that adults understand the quality of the host from distance. One of the mechanisms to find the host may be volatile compounds produced by the trees. Injured trees attract adult insects to the death of the cambium (James *et al.*, 1986). *Massicus raddei* long-horned beetle from Cerambycidae family is the main pest of oak trees in North East China, that damages the trunk of *Quercus liaotungensis* and *Q. mongolicus* trees (Zhong *et al.*, 2014). *Enaphalodes rufulus* long-horned beetle in Arkansas, Missouri and Oklahoma in *Quercus ruber* red oak had revolted in the years 1999-2005 (Meyers *et al.*, 2013). The most important wood borers in Serbia are *Agrilus angustulus* and *Xylotrechus antelope* (Cedomir and Aleksander, 2011). In general, long-term drought and wood borer revolt and outbreaks of epidemic charcoal Oak diseases have caused an average of 10.3 of the oak trees in the province to become dry. Wood borer damage signs in 100% of trees and symptoms of charcoal diseases and wood borers have been observed in 90% of dry trees. With the normalization of rainfall in 2013-2014 (675 mm), not only the process of oak trees necrosis have been stopped, but also an average 24 % of the dead trees germinated from the twigs or trunks and returned from necrosis state. Of course, these trees may be affected by grazing, and in cases where they germinated from twigs or trunks, because of damaged trunks and unbalanced growth of buds that are sometimes observed in one side of dry trees, may have possible injuries in the coming years as a result of environmental stress or injury.

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