Evolution of oviposition behavior in gypsy moth (Lymantria dispar) in Hyrcanian forests, North of Iran

GOODARZ HAJIZADEH1,*, MOHAMMAD REZA KAVOSI2, HAMID JALILVAND1
1Department of Forestry, Faculty of Natural Resources, Sari Agricultural Sciences & Natural Resources University, P.O.Box:#578, Sari, Mazandaran Province, IR-Iran. Tel./Fax. +98 151 3822715, *email: goodarzhajizadeh@gmail.com
2Department of Forest Ecology, Faculty of Forest Sciences, Gorgan University of Agricultural Sciences & Natural Resources, Gorgan, Golestan Province, IR-Iran.

Manuscript received: 26 June 2013. Revision accepted: 24 July 2013.

ABSTRACT

Hajizadeh G, Kavosi MR, Jalilvand H. 2013. Evolution of oviposition behavior in gypsy moth (Lymantria dispar) in Hyrcanian forests, North of Iran. Biodiversitas 14: 101-105. Oviposition behavior has been introduced at the center of many of the major debates on the ecology and evolution of interactions between insects and plants. The objective of this research was to determine the number of egg masses gypsy moth in relation to diameter at breast height (dbh), egg placement, orientation and host tree species. Sampling was carried out in Daland national park, Gorgan province. By global position system (GPS) device using polygons with width of 20 m and determined azimuth, defoliated trees were recorded. Data and means were compared using Duncan’s multiple range tests. Results showed that the diameter at breast height was not significantly affected by the number of egg masses. The effect of oviposition place on number of egg masses gypsy moth were significant (P<0.01). The highest number of egg masses (2.148 egg masses/tree) was observed at trunk of defoliated trees; also, minimum (1.65 egg masses/tree) occurred in branches of defoliated trees. The effects of oviposition orient were significant (P<0.05). The means comparison showed that the maximum rates of egg masses was occurred in the south geographical position (2.04 egg masses/tree), the least of defoliation was related to the north direction (1.57 egg masses/tree). The primary host tree species was Persian iron wood (Parrotia persica). In finally, the selectivity of oviposition females may often provide the initial basis for divergence of insect populations on to different plant species, and it may drive the evolution of some plant defenses.

Key words: behavior, egg masses, gypsy moth, Lymantria dispar, oviposition

INTRODUCTION

The gypsy moth Lymantria dispar L. (Lepidoptera: Lymantriidae) is a major pest of forests and shade trees in the north-eastern United States (Thorpe et al. 2007). Subsequent to its introduction from Europe in approximately 1868, it has defoliated more than 34 million ha and more than five million ha have been treated with insecticides to suppress populations (Gypsy Moth Digest 2005). Defoliation stresses and kills trees; and indirect effects of defoliation can reverberate throughout forested ecosystems. Social impacts are also substantial. Recreational use of parks grounds is sharply curtailed during outbreaks; and the substantial nuisance created by large number of wandering larvae and frass raining from trees exacerbates its pest status in urban areas (Hermes 2003).

The female moth does not fly, even though she has large wings. Egg masses or clumps are usually found near empty pupal cases of females. Eggs are placed in dark sheltered areas, bark crevices, under loose bark, and the undersides of limbs, rocks, stumps, leaf litter, vehicles, and outdoor household equipment (Leonard 1981).

The gypsy moth is a highly polyphagous folivore which will feed on over 300 species of woody plants (Leonard 1981). Among its favored foods are oaks and aspens. Newly hatched gypsy moth larvae are carried to hosts by wind dispersal in the spring, landing on plants and then either remaining to feed or redispersing (Capinera and Barbosa 1976; Lance and Barbosa 1981).

Gypsy moth is one of the most important pests in Hyrcanian forests, north of Iran. It was observed for the first time in 1937 in Guilan region, Hyrcanian forest zone. The largest outbreaks of gypsy moth occurred in Talesh forest in Guilan forests in 1975 (Kavosi 2008). It is spread in Hyrcanian, Arasbaran and Zagros forests (oak forests) during this time. It was recognized that gypsy moth is distributing in thorough Hyrcanian forests and the most importantly, its focus are, Daland park (Golestan province), Zare and Noor parks (Mazandaran province) and Rezvanshahr and Masal forests (Guilan province) (Hajizadeh 2010). The activity of this pest in central parts and the south western forests of IR-Iran has been admitted outside these regions. The defoliated rate in Hyrcanian zone is further more than the other zones and thousands of hectares of forests in this zone are getting extinct (rate of defoliated in Guilan region has reached to the fields and houses) (Hajizadeh and Kavosi 2011).

Hajizadeh et al. (2012) studied the effects of oviposition height and host tree species on some L. dispar’s biological parameters of gypsy moth in Hyrcanian forests. Samples were taken on five oviposition heights (0.5, 1, 1.5,
2.5 m) on trunk of four common host tree species including, *Zelkova carpinifolia*, *P. persica*, *Quercus castaneifolia* and *Carpinus carpinifolia*. Results showed that the oviposition heights significantly affected pest biological parameters (egg clutch size, egg hatching percent, larval body length and mortality percent of first instars), but the effects of host tree species and interacting effects were not significant. The highest survival percent, egg clutch size and body length was observed at oviposition height of 0.5 m on the *P. persica* species, and the most egg mortality of first instars was recorded at oviposition height of 2.5 m on the *Q. castaneifolia* species.

Lechowicz and Jobin (1983) studied the effects of estimating the susceptibility of tree species to attack by the gypsy moth. Numbers of gypsy moth larvae feeding on each of 922 randomly sampled trees in a Quercus-Acer-Fraxinetum forest in the southwestern Quebec, Canada were counted in 1979 and in 1980 to quantify the larval feeding preferences as observed in the field for eighteen deciduous and one coniferous tree species at the northern range limit of the gypsy moth. Both the diameter height (dbh) and the estimated foliage biomass of the sampled trees were used to calculate the relative proportions of foliage represented by each of the nineteen tree species in the forest canopy.

The objective of this research was to determine the effects of diameter at breast height (dbh), egg placement, orientation and host tree species on number of egg masses gypsy moth, *Lymantria dispar* (L.) in Hyrcanian forests at the north of Iran.

**MATERIALS AND METHODS**

The experiment was conducted in Daland park, which is part of the larger Golestan forest in Hyrcanian zone, IR-Iran (latitude 36°2′S-36°4′S, longitude 36°3′E-41°5′E) (Figure 1). This area is approximately, 3750 m long and 2900 m wide and has a total area of 608 ha. The study region has an average temperature of 16.5°C, a total annual rainfall of 660 mm and an altitudinal range of 75-119 m above sea level. The park consists almost entirely of *P. persica*, *Q. castaneifolia*, *Z. carpinifolia* and *C. betulus* with a few small areas of other species (*Populus alba*, *Ficus carica*, *Morus alba*, *Cupressus S.V. horizontalis*, *Pinus eladerica*, *Thuja orientalis* and *Acer insigne*). The study site was recently infested by the gypsy moth. It was considered to be part of the eastern leading edge of the generally infested area (Anon 2005). To coordinate the egg masses gypsy moth, to zigzag between the trees were moving. By global position system (GPS) device with a width of 20 m and azimuth polygon specific coordination of defoliated trees was recorded (Figures 2 and 3). Data and means were compared using Duncan’s multiple range tests.

**RESULTS AND DISCUSSION**

Results showed that the diameter at breast height (dbh) of host tree species has no significant effect on the number of egg masses gypsy moth (Table 1). Maximum of egg masses were observed at 80-90 cm dbh (2.37 egg masses/tree) (Figure 4). In geographical direction of the trunk of host tree species, there was no significant difference (P<0.01) (Table 2). The compare of means showed that the maximum rates of egg masses in defoliated trees occurred in the south position (2.04 egg masses/tree), the least of defoliation was related to the north (1.57 egg masses/tree) (Figure 5). The effects of oviposition place were significant (P<0.01). The highest number of egg masses (2.148 egg masses/tree) was observed at the trunk of defoliated trees (Table 3). As expected, tree species had significant effect (ɤ = 0.05) on egg masses of gypsy moth (Table 4). The maximum of egg masses of defoliated trees was observed on Persian iron wood, *Parrotia persica* (average 1.92 egg masses per defoliated tree). Minimum (average 1.15 egg masses per defoliated tree) occurred in the trunk of *Cupressus Sempervirences var horizontalis* (Figure 6).

![Figure 2](image-url)  
**Figure 2.** Location of the study site inside Daland park, the part of Hyrcanian forests, Golestan, North of Iran.
Figure 2. Defoliation and tree mortality associated with gypsy moth outbreaks in Guilan province forests of Hyrcanian Forest (Hajizadeh and Kavosi 2011).

Figure 3. Life stages of gypsy moth, *Lymantria dispar*; A. egg, B. larva, C. pupa, D. imago

Table 1. Analysis of variance of gypsy moth egg masses in diameter at breast height of defoliated trees.

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>11</td>
<td>1.364</td>
<td>0.532</td>
<td>0.882*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>581</td>
<td>2.564</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>592</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Asterisks (*P > 0.05) indicate not significant differences between the treatments.

Table 2. Analysis of variance of gypsy moth egg masses, as influenced by oviposition orients.

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>3</td>
<td>6.757</td>
<td>2.684</td>
<td>0.046*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>589</td>
<td>2.517</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>592</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Asterisks (*P < 0.05) indicate significant differences between the treatments.

Table 3. Comparision of oviposite place in gypsy moth, *Lymantria dispar*
Table 4. Analysis of variance of gypsy moth egg masses as influenced by tree species

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>4</td>
<td>8.247</td>
<td>3.308</td>
<td>0.011*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>588</td>
<td>2.493</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>592</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Asterisks (*P < 0.05) indicate significant differences between the treatments.

Discussion

The gypsy moth, *Lymantria dispar* L., is one of the most important pests of forest trees throughout the world, including Hyrcanian forests of the northern of Iran. Larval herbivory can result in leaf area reductions, leaves abscission, and eventually, yield quality and quantity losses. The average of egg masses gypsy moth, as an index, which indicates the status invasion. Recognition of oviposition place and diameter at breast height (dbh) of host trees is a way to study the population dynamic and sampling programs to monitoring gypsy moth. Criteria such as the defoliation, reducing the diameter of the trunk and killing the host tree species to determine the economic damage of gypsy moth, are used (Barbosa 1978).

The relationship between infestation and diameter at breast height of host tree species varies depending on the forest types. However, the infestation rate in the mixed forest types of trees with a low canopy is less (Smitley et al. 1993). In this study, the highest infestation rate was observed in the diameter of 80-90 cm, this result was in consistent with other researchers (Roden et al. 1992; Smitley et al. 1993; Nesslage et al. 2007).

Kurt et al. (1999) studied the effect of silviculture treatments in the management of gypsy moth, they concluded destruction and persistency of forest trees areas of activity provide the pest. Construction of facilities in fringes of forest areas and degraded forests into agricultural lands and orchards in the areas of the forest canopy is open.

Opening the forest canopy, high temperatures, low humidity and light on the forest environment are followed. The better conditions for growth and development of gypsy moth in forest areas make available (Ghent and Onken 2004). The highest infestation rate in south direction of the trunk defoliated trees was observed, which was consistent with findings of other researchers. Gypsy moth, in Hyrcanian forests, north of Iran, the second half of June to August according to altitude and weather conditions, at night on leaves, the skin split tree trunks, rocks and even man-made forest in the oval-shaped mass oviposition on them with a bunch of hair and fluff coats. So after leaving the pupal skin, usually in the same location will start oviposition. Then, all part of the summer and autumn and winter as eggs in diapauses State spends the life cycle gypsy moth, eggs categories that are easy to biopsy.

High population densities in the gypsy moth, the eggs on the trunks of host trees are found in most categories. However, at low population densities, a large percentage of egg categories, under the rocks and trees along streams are observed. Categories of eggs of this pest, the outbreak had a small organ, each are containing 75 to 100 eggs. But the growing population and a static number of eggs in very few categories of rebellion, but their larger size, each containing 700 to 1000 eggs. In this study, the highest rate of egg masses gypsy moth on the trunks of host trees was the lowest of the branches of trees, which is consistent with findings of other researchers (Barbosa and Capinera 1974; Elkinton and Liebhold 1990).
CONCLUSION

The gypsy moth, Lymantria dispar L., is one of the most important pests of forest trees throughout the world. Larval herbivory can result in leaf area reductions, leaves abscission, and eventually, yield quality and quantity losses. In fact, in this study, we found significant differences in defoliation levels among tree species. We found that the primary host tree species of gypsy moth in Iran was Persian ironweed, Parrotia persica. In finally, identification of suitable host trees and high spawning of gypsy moth appropriate way to run a program of sampling and population dynamics of the pest smoothly.

REFERENCES

Kavosi MR. 2008. Study of distribution gypsy moth, Lymantria dispar L. in the North forests. The First Symposium of Climate Change and Dendrochronology, Sari University, Mazandaran.