BIODIVERSITAS
Volume 14, Number 2, October 2013
Pages: 101-105

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d140208

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

GOODARZ HAJIZADEH[1,♥], MOHAMMAD REZA KAVOSI[2], HAMID JALILVAND[1]

[1]Department 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

[2]Department 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 (Herms 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 speared 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, 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 Quercu-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. horizentalis*, *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 ($\alpha = 0.05$) 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).

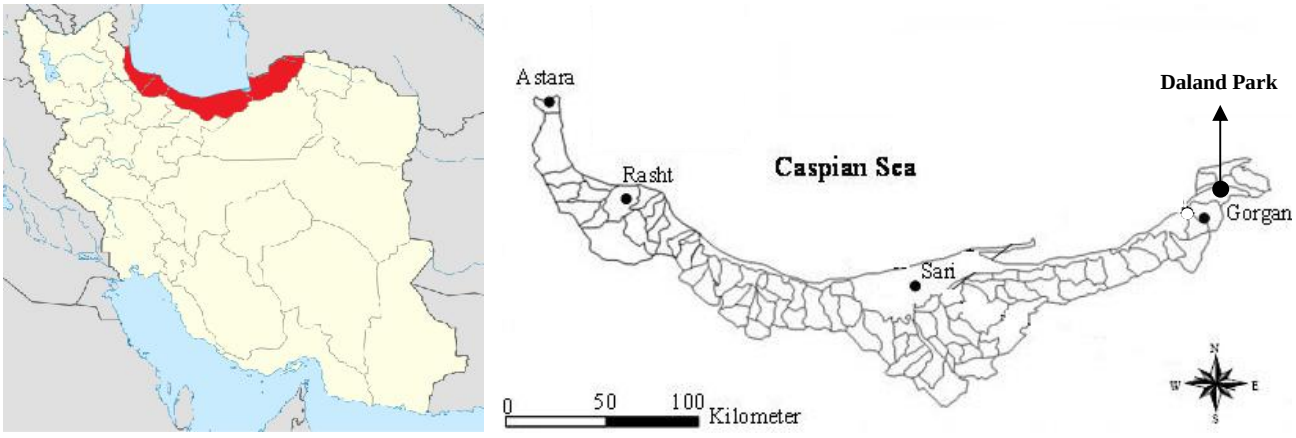

Figure 2. Location of the study site inside Daland park, the part of Hyrcanian forests, Golestan, North of Iran.

Figure 2. Defoliation and tree mortality associated with gypsy moth outbreaks in Guilan province forests of Hyrcanian Forest (Hajizadeh and Kavosi 2011).

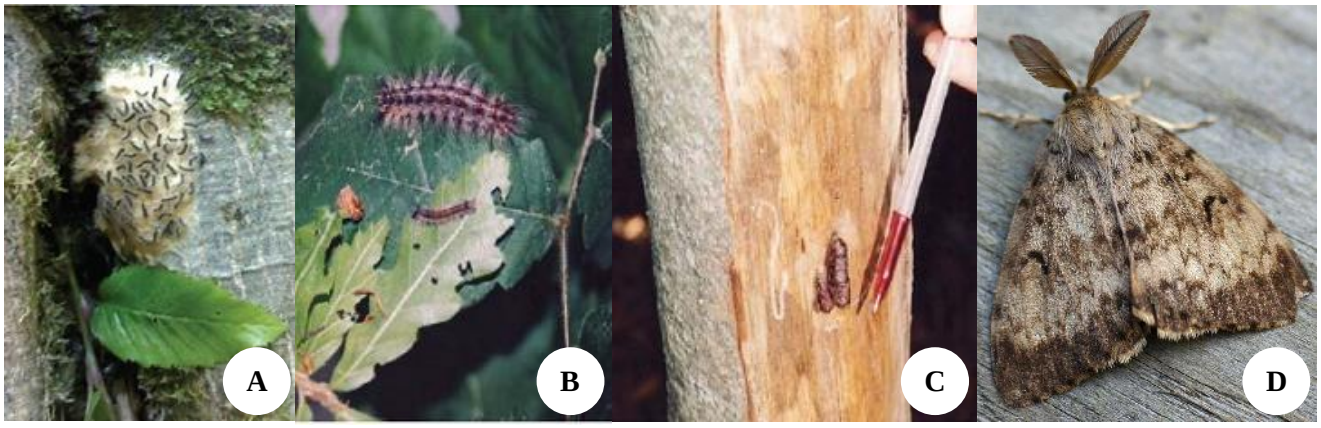

Figure 3. Life stages of gypsy moth, *Lymantria dispar;* A. egg, B. larva, C. pupa, D. imago

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

	df	**MS**	**F**	**Sig**
Between Groups	11	1.364	0.532	0.882^{ns}
Within Groups	581	2.564		
Total	592			

Note: Asterisks ($^{ns}P > 0.05$) indicate not significant differences between the treatments.

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

	df	**MS**	**F**	**Sig**
Between Groups	3	6.757	2.684	0.046*
Within Groups	589	2.517		
Total	592			

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

Table 3. Comparision of oviposite place in gypsy moth, *Lymantria dispar*

	Test Value						
Egg nests	**t**	**df**	**Sig**	**Mean difference**	**SE**	**95% confidence interval of the difference**	
	3.643	348.069	0.00	0.528	0.145	-0.814	0.243

Table 4. Analysis of variance of gypsy moth egg masses as influenced by tree species

	df	**MS**	**F**	**Sig**
Between Groups	4	8.247	3.308	0.011*
Within Groups	588	2.493		
Total	592			

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

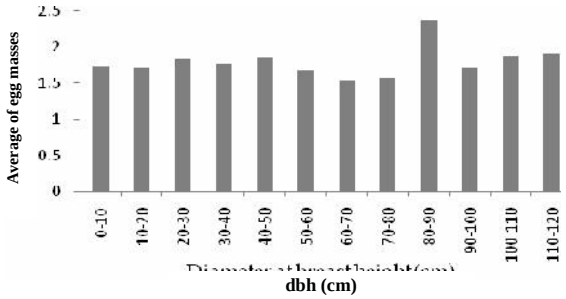

Figure 4. Average of egg masses gypsy moth in classified diameter at breast height (dbh) of host tree species in Daland Park, Golestan State region.

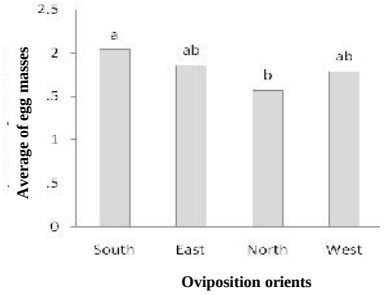

Figure 5. Average of egg masses gypsy moth in geographical direction of trunk in defoliated trees.

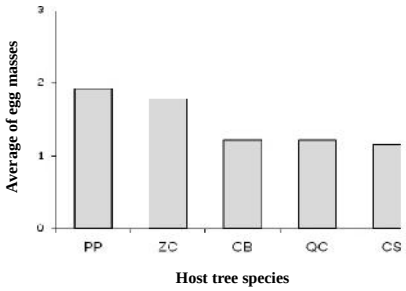

Figure 6. Mean egg masses of gypsy moth in 2009 for insects that fed on the various host tree species. PP = *Parrotia persica*; ZC = *Zelkova carpinifolia*; CB = *Carpinus betulus*; QC = *Quercus castanifolia*: and CS = *Cupressus sempervirens*. Same letters indicate mean values that are not significantly different.

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 IR-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 a appropriate way to run a program of sampling and population dynamics of the pest smoothly.

REFERENCES

Anon. 2005. Revision plan of national park Daland. Forest, Range and Watershed Management Organization Press. Gorgan.

Barbosa P, Capinera JL. 1974. The influence of food on developmental characteristics of the gypsy moth. Can J Zool 55: 1427-1429

Barbosa P. 1978. Distribution of egg masses and endemic larvae of gypsy moth population among various tree species. Can J Zool 56: 28-37.

Capinera JL, Barbosa P. 1976. Dispersal of first-instar gypsy moth larvae in relation to population quality. Oecologia 26: 53-64.

Elkinton JS, Liebhold AM. 1990. Population dynamics of gypsy moth in North America. Ann Rev Entomol 35: 571-596.

Ghent JH, Onken AH. 2004. Trip report on assistance to Mongolian Ministry for Nature and Environment for the control of forest defoliators, FAO Project TCP/MON/2902, Asheville, NC.

Gypsy Moth Digest. 2005. http://www.na.fs.fed.us/fhp/gm/.

Hajizadeh G, Kavosi MR, Afshari A, Shataee S. 2012. Effects of oviposition height and host tree species on some biological parameters of gypsy moth, *Lymantria dispar* L. J For Wood Sci 19 (1): 149-162. [Persian]

Hajizadeh G, Kavosi MR. 2011. Primary Host Tree Species of the gypsy Moth *Lymantria dispar* (Lepidoptera: Lymantriidae) in Hyrcanian Forests. J Agri Sci Tech B 1: 342-346.

Hajizadeh G. 2010. The comparison of integrated and pheromone control on the intensity and spatial distribution of *Lymantria dispar* L., [M.Sc. Thesis], Gorgan of Agricultural Sciences and Natural Resources, University Press. [Persian]

Herms DA. 2003. Assessing management options for gypsy moth. Pesticide Outlook 14: 14-18.

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.

Kurt W, Gottschalk R, Mark J. 1999. Managing forest for gypsy moth silviculture treatments in reducing foliation and mortality, 12th Central Hardwood Forest Conference of Natural Resources, Univ. Missouri, Columbia.

Lance D, Barbosa P. 1981. Host tree influences on the dispersal of first instar gypsy moths, *Lyrnantria dispar* L. J Ecol Entomol 6:411-416.

Lechowicz MJ, Jobin L. 1983. Estimating the susceptibility of tree species to attack by the gypsy moth. J Ecol Entomol 8: 171-183.

Leonard DE. 1981. Bioecology of the Gypsy Moth. In: Doane CC, McManus ML (eds.). The Gypsy Moth: Research toward Integrated Pest Management. USDA Technical Bulletin, Washington DC.

Nesslage GM, Maurer BA, Gage SH. 2007. Gypsy moth response to landscape structure differs from neutral model predictions: implications for invasion monitoring. J Biol Invas 9: 585-595.

Roden DB, Miller JR, Simmons GA. 1992. Visual stimuli influencing orientation by larval gypsy moth, *Lymantria dispar* L. J Can Entomol 122: 304-617.

Smitley DR, Rao RP, Roden DB. 1993. Role of tree trunks foliage type, and canopy size in host selection by *Lymantria dispar* (Lepidoptera: Lymantriidae). J Environ Entomol 22: 134-140.

Thorpe KW, Hickman AD, Tcheslavskaia KS, Leonard DS, Roberts A. 2007. Comparison of methods for deploying female gypsy moths to evaluate mating disruption treatments. Agric For Entomol 9: 31-37.