Natural Enemies of Gypsy moth (Lepidoptera: Lymantriidae) in Hyrcanian Forests (Case Study: Daland Park)

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Abstract

Gypsy moth (Lepidoptera: Lymantriidae), is one of the most important forest insect pests in the world. It was accidentally introduced to North America near Boston in 1869. Gypsy moth, *Lymantria dispar* (L.), has been presented in Iran for more 70 years. "Natural enemies" refers to the predators, parasitoids and pathogens that effect pest insect's forest such as gypsy moth. Predators of gypsy moth are important in keeping gypsy moth populations low in years between outbreaks. A diverse group of birds, mammal, amphibian, and insect predators will feed on gypsy moth eggs, caterpillars and pupa. Mice are important predators of gypsy moth caterpillars and pupae. These natural enemies are important in helping to control gypsy moth outbreaks and it keeping populations low in the years between outbreaks. The study was conducted during 2007 and 2008 in Daland Park (608 ha) in Golestan to determination of natural enemies abundance and their roles of gypsy moth control. In this research were determinate many predators that activity on eggs and larvae of the gypsy moth included: Black-capped chickadee (birds) that feed on egg masses and can cause substantial egg mortality. Calosoma (Beetles) will climb to prey on gypsy moth larvae and feed of egg masses. Predators caused that substantial egg mortality up to 30%.

Keywords: Gypsy moth, *Lymantria dispar*, Outbreak, Predator, Natural enemies, Control.

Introduction

"Natural enemies" refers to the predators, parasitoids and pathogens that effect pest insect's forest such as gypsy moth. These natural enemies are important in helping to control gypsy moth outbreaks and in keeping populations low in the year between outbreaks. Some natural enemies of gypsy moth will be familiar such as insect parasitoids and pathogens may be less will known. Some of natural enemies that affect gypsy moth are native to North America. Others were deliberately introduced from Europe, Asia, India, and northern Africa, where gypsy moth is native (Mott and McCullough, 2001).

Predators

Predators of gypsy moth are important in keeping gypsy moth populations low in year between outbreaks. A diverse group of bird, mammal, amphibian and insect predators will feed on gypsy moth eggs, caterpillars and pupae. Woodlots, urban forests and other resources for predators. Restrict use of broad-spectrum insecticides to avoid harm to populations of predatory insects. The microbial insecticide known as B.t. or B.t.k (Bacillus thurgiensis var. kurstaki) is often used to protect tree foliage in residential areas during gypsy moth outbreaks (Table. 1). Unlike conventional insecticides, B.t.k. will not harm vertebrate or insect predators (McCullough, Raffia and Williamson 2001). When populations are high, aerial application of *Bt* is the most widely-used strategy for preventing defoliation. *Bt* formulations used for gypsy moth suppression affect only Lepidoptera larvae, and are harmless to other animals, including bees and other insects, birds, pets, and humans. *Bt* can be very effective at preventing defoliation when applications are timed accurately (Smiley and Davis, 1993). Applications should be made when the majority of larvae (Figure2) are second instars, as young larvae are more susceptible to *Bt*, and coverage is better when aerial applications are made before leaves fully expand and the spray can still penetrate the canopy. There is some concern that *Bt* sprays can prolong outbreaks by interfering with natural enemies. However, this does not seem to be the case. Research has shown that aerial applications of *Bt* have little overall impact on the effectiveness of gypsy moth parasites, predators, or disease organisms (Andreadis *et al.,* 1983). On the other hand, *Bt* sprays also seem to have little effect on the inherent population dynamics of gypsy moth, the populations of which tend to increase or decrease independent of whether they had been sprayed with *Bt* in previous years (Smitley and Davis, 1993). This suggests that goals and expectations of gypsy moth suppression programs should focus on protecting trees from defoliation during gypsy moth outbreaks, rather than long-term reduction of gypsy populations (Herms, 2003).

Birds

Many birds do not like to feed on large, hairy gypsy moth caterpillars, but other species seem to relish them. Yellow-billed and black-billed cuckoos, blue jays, orioles and rufous-sided towhees are among the species that feed on gypsy moth caterpillars. Some birds, such as the black-capped chickadee, will also feed on egg masses and can sometimes cause substantial egg mortality (McCullough, Raffia and Williamson 2001).

Mammals

Shrews, mice, voles and other small mammals often feed on gypsy moth caterpillars and pupae that they encounter on the ground and around the bases of trees. Mice seem to prefer the large female pupae to the smaller male pupae. This selective feeding can have a greater impact on the overall gypsy moth population than random feeding. Chipmunks, skunks and raccoons will also feed on gypsy moth larvae and pupae, and squirrels will feed on pupae.

Insect predators

Some insects are also important predators of gypsy moth. For example the calosoma bettle (calosoma sycophanta) is a "specialist" in that it feeds almost entirely on gypsy moth. It was introduced into the northeastern united stats and, more recently, into Michigan in the Great lakes region, specifically to help provide long-term control of this brightly colored bettle feed on gypsy moth caterpillars and pupae. Several native insects are also good predators and will attack gypsy moth, as well as other plant-feeding insects. Ants can also be important predators of young caterpillars. Many other insect predators and spiders are opportunistic feeders and will consume gypsy moth larvae or pupae when they are available.

Parasitoids

The term "Parasitoids" refers to certain species of wasps and flies that have a very specialized life cycle. Parasitoids lay their eggs inside, on or near the body of a host insect, such as gypsy moth caterpillar. The larval stages of most Parasitoids resemble maggots. Parasitoids larvae live by feeding on tissues in the body of the host insect, killing it in process. Once the Parasitoid has completed its development, it emerges from the host insect. Several Parasitoids are important natural enemies of gypsy moth. A few examples are described here.

Ooencyrtus kuvane

This little wasp is a specialist that parasitizes the eggs of gypsy moth. It was introduced into the United States for biological control of gypsy moth many years ago and is now well established in most of the region infested by gypsy moth. Three generations of this wasp lay,

and another generation may occur the following spring. The tiny, dark adult wasps can often be observed if you look closely at gypsy moth egg masses. You may also see the small, round holes in the egg mass where the adult wasps emerged. Because the wasp is small, it can usually attack only the eggs in the upper layer of a gypsy moth egg mss. In many years, it is able to kill 20 to 30 percent of the eggs in an egg mass. Although Ooencyrtus wasps are rarely available from commercial suppliers, you can help to protect populations that are established in your area. For example, if you intend to scrape off and destroy egg masses as part of your gypsy moth management program, it is best to wait until winter.

Cotesia melanoscelous

This is another specialized wasp that as introduced specifically for biological control of gypsy moth. The first generation of the wasp will attack very young gypsy moth caterpillars and is often successful in subduing the young host caterpillar. A section generation of the wasp can attack larger gypsy moth caterpillars, those that are about halfway through their development. This parasitoid pupates in a small, oblong yellowish cocoon. These cocoons are frequently observed near a dead gypsy moth caterpillar or attached to the bark of an infested tree. In some cases, this parasitoid can be an important source of mortality. However, the small wasps sometimes have difficulty attacking larger gypsy moth caterpillars, and the wasp has its own natural enemies that may limit its effectiveness. Avoiding applications of broad-spectrum chemical insecticides in early and midsummer will help protect this species. Application of the microbial insecticide B.t.k. may slow the development of gypsy moth caterpillars. This can benefit the *Cotesia melanoscelous* wasps and may increase the rate of parasitism.

Compsilura coccinnata

This fly attacks gypsy moth caterpillars, as well as the caterpillars of more than 100 other moth and butterfly species. It was introduced for gypsy moth control many years ago and is well established throughout much of the northeastern and north central many years ago and is well established throughout much of the northeastern and north central United States. It has tree generation a year, although only one of these generation attacks gypsy moth caterpillars. After feeding in the body of a gypsy moth aterpillar, this parasitoid pupates in a reddish brown pauperism often seem on or near the body of the dead caterpillar. This parasitoid may be important in helping to keep gypsy moth populations in check and prolonging in the period between outbreaks.

Pathogens

Gypsy moth and other insects are affected by a Varity of organisms that cause disease, including fungi, bacteria, viruses and protozoan. Two diseases are especially important in controlling gypsy moth outbreaks.

NPV- The virus disease

The gypsy moth nuclear polyhedrosis virus (commonly known as NPV) builds rapidly in dense populations, which usually causes outbreaks to collapse within two or three years. The virus can also be formulated as an insecticide that is specific to gypsy moth. However, since the virus can be produced only from live caterpillars, supplies are extremely limited, and application of the NPV spray is generally limited to environmentally sensitive habitats, such as those containing endangered butterflies and moths.

Entomophaga maimaiga

The fungal pathogen *Entomophaga maimaiga* also significantly impacts gypsy moth populations, even when populations are low. The fungus, which infects the caterpillar stage, can be disseminated to new gypsy moth infestations by dispersing resting spores. However, it spreads easily when environmental conditions are favorable, and quickly becomes established on its own. The effectiveness of *Entomophaga* is not predictable, being highly dependent on the occurrence of rainfall events at critical moments during the spring. Although *Entomophaga* can cause gypsy moth populations to decline dramatically in wet years, outbreaks still occur where *Entomophaga* is established, especially during dry springs.

Table 1 - *Microbial and chemical pesticides commonly used for gypsy moth control*

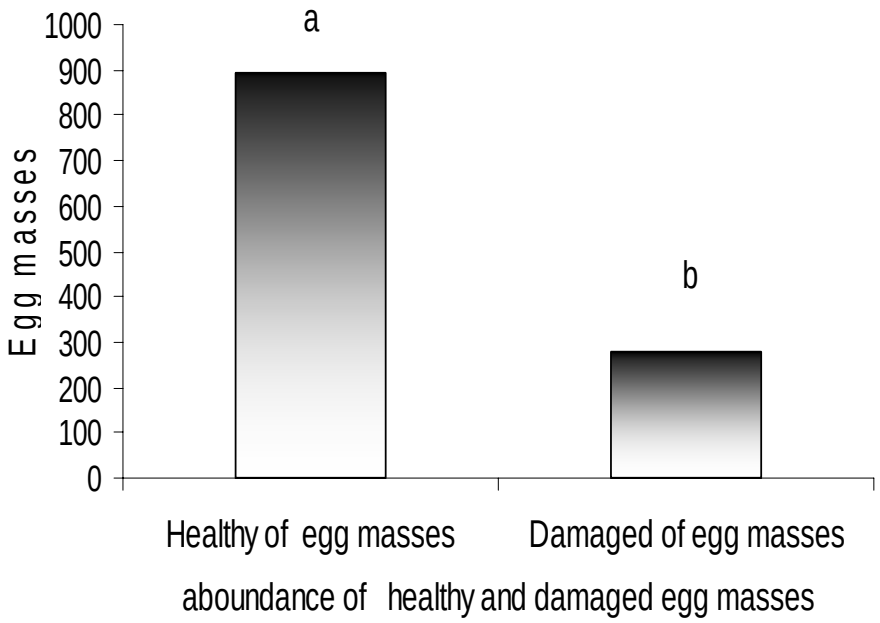
Active ingredient	Representative trade names	Remarks
Bacillus thuringiensis	Foray	Registered for aerial and ground application. Available under a variety of trade names. Toxic to other moth and butterfly larvae. Can be used safely near water.
Acephate	Orthene	Registered for aerial and ground application. Available under a variety of trade names. Toxic to bees and some gypsy moth parasites. Commonly used from the ground to treat individual trees.
Carbaryl	Sevin	Registered for aerial and ground application. Available under a variety of trade names. Toxic to bees and gypsy moth parasites. At one time, the most widely used chemical in gypsy moth control programs.
Diflubenzuron	Dimilin	A restricted-use pesticide that can be applied only by certified applicators.

Materials and Methods

Area and treatment. The experiment was conducted in Daland Park Forest, which is part of the larger Golestan forest in Hyrcanian zone, Iran (latitude 36º 2′ S - 36º 4′ S, longitude 36º 3′ E - 41º 5′ E). 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 º 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 (*parrotia persica*, *Quercus Castanifolia*, *Zelkova Carpinifolia* and *Carpinus betulus*) with a few small areas of other species (*Populus Alba, Ficus carica, Morus Alba, Cupressus S.V. horizentalis, Pinus eladerica, Thuja orientalis, Acer insigne*). The study site was newly infested with the gypsy moth. It was considered to be part of the eastern leading edge of the generally infested area. Substantial numbers of gypsy moth egg masses can be found under burlap bands placed around the boles of trees even when population densities are low and other egg masses sampling methods yield mostly zero counts (bellinger et al. 1990). In 2007-2008, Data egg masses of gypsy moth in Daland Park, Golestan province number of egg masses, healthy and infertility egg masses are recorded using complete inventory.

Results and Discussion

Results of research showed significant differences among treatment. So that the Abundance of healthy egg masses were more than damaged (Fig. 1). Gypsy moth population growth rates depend on numerous factors, including the composition of tree species in a forest stand, the density of predators, and climate. Campbell and Sloan (1978) suggested that predation by small mammals is also density- dependent in low- density gypsy moth populations. However, experiments by Elkinton et al 1989 did not support that hypothesis. In areas infested by gypsy moth for many years, there is little or nor relationship between male moth counts and subsequent defoliation at the same location (Carter et al. 1992, Liebhold et al. 1995). Egg mass counts are the most reliable cause method in medium – and high density population, and thus they are widely used for making decision concerning aerial suppression of outbreak population (Schwalbe, 1981, Ravlin et al. 1987).



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