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Full Length Research Paper

Population dynamics of *Chrysoperla externa* (Hagen) (Neuroptera: Chrysopidae) in a silvopastoral system

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In this study we investigated lacewings (Neuroptera: Chrysopidae) in a silvopastoral system. The study was conducted between July, 2006 and June, 2008 in a pasture with *Brachiaria decumbens* and trees. Adult specimens were caught twice a month by using a malaise trap, while the larvae were caught in the shoots of fodder and by visual observation. Flowering panicles were also observed for the presence of immature specimens. All adult lacewings (1186) belonging to one species *Chrysoperla externa* (Hagen, 1861). The adult population peaked between April and June, but this occurrence was significantly affected by temperature and rainfall. We only captured 8 adult lacewings by using the malaise traps. There was a significant correlation between the number of immature specimens and relative humidity and the number of captured adults. A higher population density of larval and adult lacewings was associated with the flowering of signalgrass, leading to the inference that pollen was used as a source of protein. This strategy ensures that these predators remain on crops during periods of prey scarcity.

Key words: Lacewing, pasture, predator, seasonality, survey.

INTRODUCTION

Insects represent the most abundant animals in almost all ecosystems and can be used to evaluate the impact of environmental changes (Rocha et al., 2010). It is important to study insects to understand their close relationship with the environment. It is of great importance to know the population dynamics of predators such as green lacewings (Neuroptera: Chrysopidae) among insects. Green lacewings are found in many natural environments or environments modified by humans (Costa et al., 2003; Miliczky and Horton, 2005; Silva et al., 2006), where they feed on various pest insects. We know very little about the population dynamics of Neuroptera in most of these environments, including silvopastoral systems. These systems can accommodate a great diversity of arthropods because, as an exploitation model, they closely resemble a natural forest and have trees, grasses, and cattle in the same area, showing several ecological interactions. Among the different species of grasses, those in the genus *Brachiaria (*Poaceae), such as *Brachiaria decumbens* Stapf have shown good acceptance (Boddey et al., 2004).

Lacewing may be present in almost all agroecosystems (McEwen et al., 2001). It is necessary to explore the relationship of these predators with different food sources present in these environments. The ecological study of green lacewings in the fields is very important for conservative biological control. Thus, the maintenance of such habitats, which provide sites for development and permanence of these predators in crops, is of prime importance for the success of these insects as biological control agents. Knowledge of the population dynamics of a species is of paramount importance for their effective management. The presence of an insect in a given ecosystem may represent only a casual introduction, making it necessary to confirm its interaction with the crop by observing its developmental stages or

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seasonality. For most Chrysopidae, there is more or less of an established regional fluctuation in population every year (Souza and Carvalho, 2002). However, factors such as climate change and decreased food supply may alter the synchrony of a population (Szentkirályi, 2001).

According to Rao et al. (2000), research on understanding the influence of ecological factors that promote the population dynamics of natural enemies in agroforestry systems is necessary for sustainable pest management. Therefore, knowledge of the population dynamics of lacewings and interactions with their habitat is important for their use as biocontrol agents. Thus, the aim of our study was to evaluate the population dynamics of green lacewings in a silvopastoral system.

MATERIALS AND METHODS

Tests were conducted on a silvopastoral system in Coronel Pacheco MG, Brazil (21º 33′ 22″ S and 43º 06′ 15″ W; altitude, 410 m) between July, 2006 and June, 2008. The climatic of the region is cwa (mesothermal), according to Koppen's classification, with a dry season from May to October and a rainy season from November to April. The temperature ranges from 16°C in winter to ≥ 23°C in summer (Antunes, 1986). The 4 ha sampling area consisted of *B. decumbens* maintained in a 30 m-wide band alternating with 10 m bands comprising *Eucalyptus grandis* W. Hill ex Maiden (Myrtaceae), *Acacia mangium* Wild (Fabaceae), *Acacia angustissima* Wild (Fabaceae), and *Mimosa artemisiana*, Heringer and Paula (Fabaceae).

Adult green lacewings were sampled biweekly for a period of 2 years for 2 consecutive hours in the morning. The sampling was performed in the entire area in a zigzag-type pattern, and the green lacewings were captured using a hand net. A malaise trap (Townes model) remained installed throughout all sampling periods, permitting uninterrupted collection of the insects. The specimens were preserved in a vial containing 70% ethyl alcohol and formaldehyde drops and removed every 15 days. The lacewings were identified by Dr. Renildo Ismael Félix Costa of the Federal Institute of Northern Minas. Larvae were sampled every fortnight by using a sweep net to reach the grass shoots and through observations of plants in 1 m^2 areas that were randomly selected between April, 2007 and March, 2008. During the flowering periods, approximately 500 inflorescences were collected and inspected for immature lacewings in the laboratory.

Data on temperature, rainfall, and relative humidity were obtained from the meteorological station of Embrapa Dairy Cattle located 100 m from the sampling area. The results were analyzed for correlation between climatic factors and the occurrence of insects by using the Spearman test (Saeg, 2007).

RESULTS AND DISCUSSION

Over 24 months of active collection, peaks in the populations of adult chrysopids were observed in April, May, and June 2007, when 421, 447, and 310 insects, respectively, were collected (Figure 1A). *Chrysoperla externa* (Hagen, 1861), a very common and well-studied species in the neotropical region (Souza and Carvalho, 2002) were the only species collected in our study. The high population density in the months mentioned earlier suggests a possible migration of adults from surrounding areas, since in the preceding months, the insect was either absent or in insufficient numbers to cause these population peaks (Figure 1A). It is interesting to note that, *B. decumbens* was in the flowering period in the months of the highest abundance of *C. externa*; this may be one of the factors that stimulated the migration of the insects. The population of *Chrysoperla sinica* that migrates via long-distance flights was observed by Liu et al., (2011).

Abiotic factors influenced the population dynamics of *C. externa*, but the number of *C. externa* adult specimens was not influenced by relative humidity (r = 0.006, z = 0.293, P = 0.384). There was a significant correlation between the number of adults and temperature (r = - 0.552, z = - 2.648, P = 0.004) and rainfall (r = - 0.508, z = - 2.438, P = 0.007). The highest number of insects was observed during the months in which temperature and rainfall showed the lowest indices (Figure 1B). Similar findings were obtained by Gitirana et al. (2001) and Souza and Carvalho (2002), who recorded the highest populations of *Ceraeochrysa* spp. and *C. externa*, respectively, in citrus orchards during the months with low temperature and rainfall. Silva et al. (2006), who studied population fluctuations in *C. externa* in coffee crops in Brazil, recorded a reduction in the number of insects with increase in rainfall and temperature. Thus, these climatic factors limit the occurrence as well as the survival of these species under natural conditions. Souza and Carvalho (2002) reported that rainfall, for example, can influence many aspects of the population behavior of these insects, through direct mechanical action or indirect effect on their habitats.

In contrast with the present study, Cardoso et al. (2003) and Costa (2006) verified positive correlations between temperature and abundance of green lacewings in the forest and observed a higher number of insects in hot periods. Accordingly, the absence of significant correlations between rainfall and lacewing populations in that environment could be attributable to the collection of samples near a creek, where water is available throughout the year. Although, Penny (2002) used the malaise trap to catch Neuropterans, this collecting method was not effective in our study. During the 2 sampling years, we captured only 8 *C. externa* adults. We caught 1 adult in December 2006, 1 in May 2007, 3 in June, 2007 and 3 in October, 2007. This record is in agreement with the findings of Carvalho and Souza (2000), who reported that hand nets were more effective than any other method for collection of lacewings. Ábrahám et al. (2003) investigated the Neuroptera community by using different capture methods and observed that suction traps were more efficient than malaise traps.

We collected 31 larvae over the year (Figure 1A) in the flowers of *Brachiaria*. The number of larvae did not correlate with temperature (r = - 0.054, z = - 0.179, P =0.428) or rainfall (r = 0.054, z = 0.179, P = 0.428). However, there was a significant correlation between the number of immature specimens and relative humidity(r =+0.545, z = 1.807, P = 0.035) and the number of

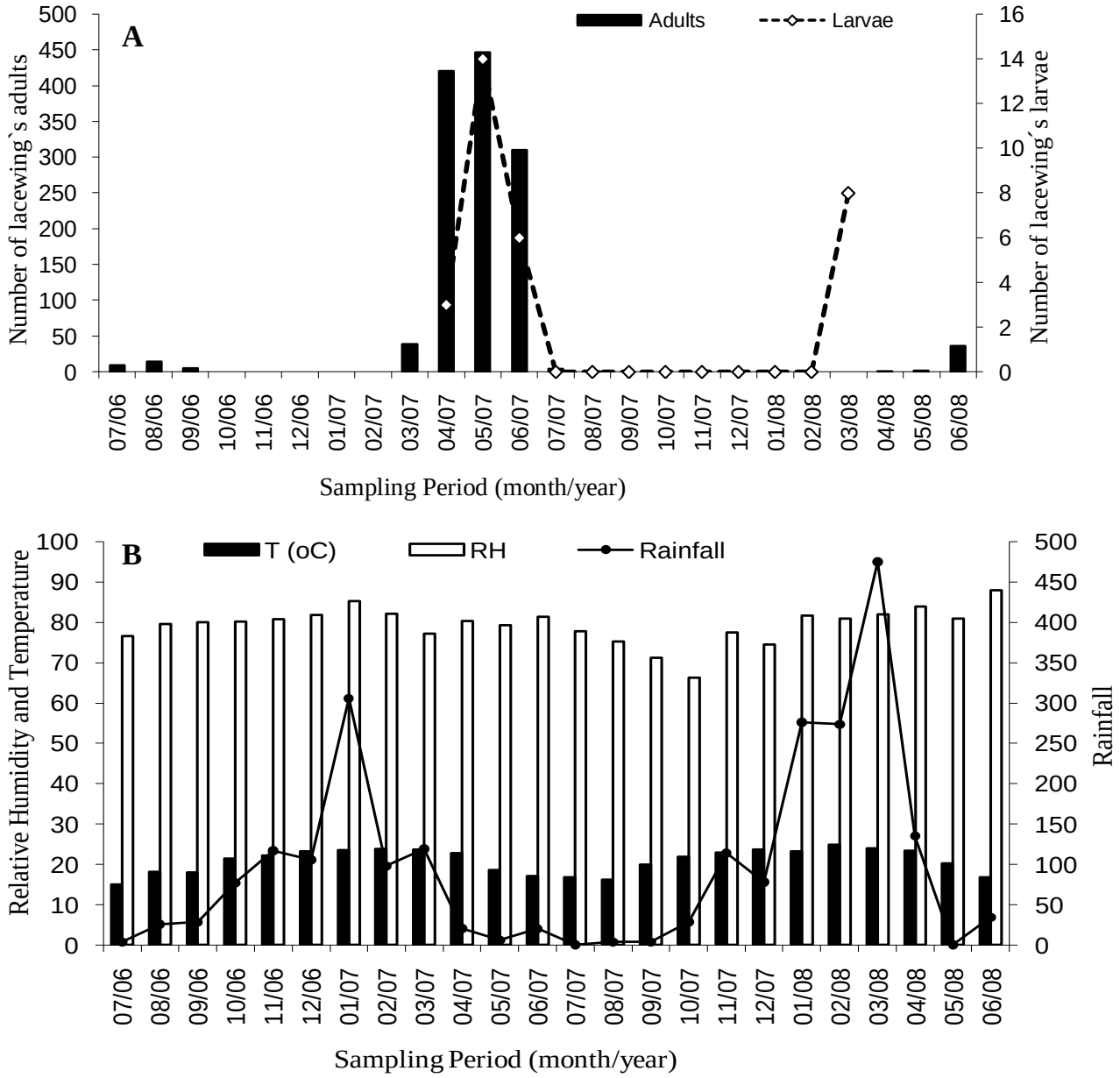

Figure 1. A - Seasonal distribution of adults and lacewings larvae collected in the silvopastoral environment, Coronel Pacheco, MG. B - Average monthly temperature (TºC), relative humidity (RH%) and rainfall (mm) during the sampling period in silvopastoral environment, Coronel Pacheco, MG. July 2006 to June 2008.

captured adults (r = 0.598, z = 1.984, P = 0.023). We considered the *C. externa* population as a function of plant phenology and observed that the population peak observed in May coincided with the time of flowering of *Brachiaria*, which usually occurs from May to July, according to Lascano et al. (2002). Silva et al. (2006) observed that the presence of grasses in an agroforest increased the occurrence of insects who consumed the pollen as food.

Thus, we believe that the population density of *C. externa* in silvopastoral systems is probably related to the availability of pollen, which serves as the prime food source for the adults. Such findings were reinforced by the absence of any other arthropod species that could serve as a diet for this predator. Thus, pollen, which is known as a food source for adult Chrysopidae alone, may also allow larval development being used as an important protein source at the times when preys are insufficient.

These results were in accordance with those obtained by Oliveira et al. (2009) who studied the biological response of *C. externa* larvae fed on grass pollen diets and observed that wet pollen can be an alternative

protein source for chrysopids. This justifies the positive correlation between relative humidity and the number of larvae sampled in this study. These observations may imply an interesting and important strategy used by larvae that guarantees the permanence of these predators on crops in times of prey shortage. Moreover, the presence of higher plant diversity in the silvopastoral system provides appropriate conditions for ensuring the permanence of these predators on the crops.

According to McEwen et al. (2001), green lacewing may be present in almost all agroecosystems. It is necessary to explore the relationship of these predators with the different food sources (pests) present in these environments. The ecological study of green lacewings in the fields is of fundamental importance for conservative biological control. Thus, the maintenance of such habitats that provide sites for development and permanence of these predators in crops is of prime importance for the success of these insects as biological control agents.

Conclusions

1. *C. externa* was the only species of lacewing captured in a silvopastoral system, with maximum populations recorded during the months with low rainfall and temperature.
2. *C*. *externa* larvae were associated with *B. decumbens* inflorescences during periods of prey scarcity and they fed on pollen, the best source of protein.

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