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Relationship between Duration of Cattle Dung Exposure in Pastures, Its Average Crustal Thickness and Occurrences of Dipterous Insects and Their Parasitoids in South Goiás, Brazil

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Abstract. The objective of this study was to investigate the relationship between duration of cattle dung exposure in pastures, its average crustal thickness and occurrences of dipterous insects and their parasitoids in south Goiás, Brazil. Parasitoids were collected after different durations of cattle dung exposure in pastures, in an experiment conducted in south Goiás, Brazil, between January and October 2001. Cattle dung pads were exposed in pastures for periods of 24, 48, 72, 96, 120, 144, 168, 192, 216 and 240 hours were then individually taken to the laboratory for parasitoid extraction. A total of 100 dung pads were exposed in pastures and 430 parasitoid individuals were recovered from them. The most abundant species extracted were: *Paraganapis egeria* Díaz, Gallardo & Walsh (Hymenoptera: Figitidae) and *Spalangia drosophilae* Ashmead (Hymenoptera: Pteromalidae). The majority of the species were collected from cattle dung pads exposed for 144 and 240 hours. The largest number of individuals was found in feces with 240 hours of exposure.

Keywords: Hymenoptera, Diptera, Feces, Natural Enemy, Biocontrol.

1. Introduction

Diptera is one of the largest orders of insects, comprising large numbers of both species and individuals. In addition, these flies are of great medical and veterinary importance since they may produce myiasis and may be vectors of microorganisms pathogenic to humans and animals (Greenberg, 1971; Oliveira et al., 2002). Flies have been found to carry disease-causing organisms such as bacteria, protozoa and helminths (Greenberg, 1971; Oliveira et al., 2002). These associations occur because flies exploit organic material and/or waste materials that are produced by human or animal activity, especially feces and plant waste.

A diverse parasitoid fauna is found in association with these flies and is responsible for natural control over them. Among the main natural enemies of these flies are the Braconidae, Chalcididae, Pteromalidae, Encyrtidae and Figitidae (Hymenoptera) (Marchiori, 2002). Since parasitoids occupy a higher trophic level, they act as determining factors on the population densities of their hosts due to the diversity of their physiological and behavioral adaptations. In addition, since parasitoids are natural enemies of these flies that are pests, they may be used in biological control programs (Marchiori et al., 2001; Marchiori et al., 2013).

In Brazil, little is known about the insects that attack flies of economic and health importance. In order to evaluation the actions of these species in controlling fly populations, there is a need to conduct studies so as to identify species that exclusively attack these flies, for use in control programs (Silveira et al., 1989; Marchiori, 2011).

The objective of this study was to investigate the relationship between duration of cattle dung exposure in pastures, its average crustal thickness and occurrences of dipterous insects and their parasitoids in south Goiás, Brazil.

2. Material and Methods

This experiment was carried out on a farm called "Chácara Vilela", in the south of the state of Goiás, Brazil (18º25'S and 49º13'W), beside the Paranaiba river. The farm covers an area of approximately 29 hectares and supports a herd of 50 head of dairy cattle of the Girolando breed. Fresh feces were collected immediately after deposition in the barn and were mixed in four 20 L plastic buckets. Artificial pads of feces (approximately 2 L each) were produced and placed in 10 plastic containers (40 cm in diameter x 12 cm in height) containing a 5 cm layer of soil from the same site. The bottoms of the containers were perforated to allow water drainage. The containers were then randomly placed at soil level in the pasture to allow colonization by arthropods. Pads (one dung pat) were individually retrieved from the field at 24 h intervals (24, 48, 72, 96, 120, 144, 168, 192, 216 and 240 h of exposure) and were taken to the laboratory, where they were kept for 10 days. Ten repetitions were done for each duration of exposure. Each bowl was covered with a cheese cloth and was kept in the laboratory in order to collect pupae by means of flotation in water.

The pupae were individually placed in gelatin capsules (number 00) and were kept in the laboratory (temperature of 27ºC and humidity of 60%) until parasitoid hatching. The experiment was carried out from January to October 2001.

3. Results and Discussion

Regarding the appearance of the feces, they were seen to be semi-liquid and dark brown when newly produced. As they became older, a dry crust formed and this gradually thickened with increasing length of exposure (Table 1). The color of the dung pads changed from dark to light brown.

Table 2 shows that the genus *Spalangia* began to be attracted to feces from 144 hours of exposure onwards but peaked at 192 hours. *Brontaea debilis* (Thomson),

Brontaea quadristigma (Williston), *Cyrtoneurina pararescita* Couri (Diptera: Muscidae), *Oxysarcodexia thornax* (Walker), *Sarcophagula occidua* (Fabricius), (Diptera: Sarcophagidae), *Palaeosepsis* spp. (Diptera: Sepsidae) and Sphaeroceridae (Diptera: Sphaeroceridae) were the most common hosts.

Table 1. Relationship between duration of and occurrences cattle dung exposure in pastures, its average crustal thickness south Goiás, Brazil

Exposure time of feces (hours)	The average thickness of the crust (mm)	Standard deviation (mm)
24	1.67	±0.70
48	3.00	±1.00
72	3.89	±1.45
96	5.56	±2.13
120	6.00	±1.12
144	8.56	±1.24
168	10.22	±1.72
192	11.22	±1.39
216	15.11	±1.45
240	20.22	±1.09

The most abundant species of parasitoids collected were: *Paraganapis egeria* Díaz, Gallardo & Walsh (Hymenoptera: Figitidae) and *Spalangia drosophilae* Ashmead (Hymenoptera: Pteromalidae). The majority of the species were collected from cattle dung pads exposed for 240 h.

Spalangia drosophilae is cited in the literature as a parasitoid of pupae of small dipterous insects of the families Chloropidae, Drosophilidae, Muscidae, Sarcophagidae and Sepsidae (Marchiori et al., 2001; Marchiori, 2002; Marchiori et al., 2002; Marchiori et al., 2005).

Díaz et al. (1996) found *P. egeria* in pupae in Argentina. According to these authors, in Brazil this species is found in the states of São Paulo and Mato Grosso do Sul.

As cattle feces become older, as the length of exposure in the field increases, the thickness of the crust that forms also increases. Formation of this crust seems to block the odor that attracts arthropods (Laurence, 1955). The rate of change of the feces also depends on the degree of insolation and weather conditions such as temperature and humidity (Laurence, 1955).

Flechtmann and Rodrigues (1992) found that newly deposited feces provided more suitable conditions for the development of dipterous insects. They noted that the odor and staining of fecal masses changed after the fourth day of exposure.

Moreover, they observed that feces over 10 days of age would not attract parasitoids of the genus *Spalangia*, and that most of the species that inhabited the dung pads featured rapid development.

According to Morgan et al. (1989), newly formed pupae are more susceptible to parasitism by *Spalangia*. These authors showed that *Spalangia endius* (Walker) (Hymenoptera: Pteromalidae) showed a parasitism rate of up to 72.0% in newly formed pupae.

Table 2. Relationship between duration of cattle dung exposure in pastures, its average crustal thickness and occurrences of dipterous insects and their parasitoids in south Goiás, Brazil

Exposure time of feces (hours)	Parasitoids	Frequency	Total
24	*Paraganaspis egeria*	12	
			12
48	*Paraganaspis egeria*	06	
			06
72	----------	00	
			00
96	----------	00	
			00
120	----------	00	
			00
144	*Paraganaspis egeria*	02	
	Spalangia drosophilae	08	
	Spalangia cameroni	01	
	Trichopria sp.	01	
			15
168	*Paraganaspis egeria*	03	
192	*Paraganaspis egeria*	15	
	Spalangia drosophilae	06	
	Trichopria sp.	06	
			27
216	*Paraganaspis egeria*	12	
	Trichopria sp.	03	
	Spalangia drosophilae	03	
			18
240	*Paraganaspis egeria*	18	
	Muscidifurax sp.	01	
	Spalangia cameroni	06	
	Spalangia drosophilae	03	
	Spalangia endius	03	
			31

A study on succession and colonization in cattle feces of various ages that was conducted at Fazenda Santo André in the municipality of Campinas, SP, found that Hymenoptera were present at all sampling times, with varying population sizes. The relative density of Hymenoptera went on increasing, and reached its peak at 144 hours. This differed from our results, in which the largest number of individuals was achieved in feces with 240 hours of exposure (Amaral, 1996).

4. Conclusion

1-The most abundant species collected were: *P. egeria* and *S drosophilae.*

2-The majority of the species were collected from cattle dung pads exposed for 144 and 240 hours.

3-The largest number of individuals was found in feces with 240 hours of exposure.

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