

Daily Rhythm of Pollen Production by *Apis mellifera* L(Hymenoptera: Apidae) in Sorriso, Mato Grosso State, Brazil

by

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ABSTRACT

Insect pollinators are important in reproduction of several plants species increasing the agricultural productivity and the quality of the food. *Apis mellifera* (Hymenoptera: Apidae) is an important plant pollinator besides its fundamental role in the pollen based products often used in food and pharmaceutical industry. In the field of beekeeping, the palynology is important in botanical biodiversity studies, because pollen provides information about environmental quality. The understanding of the time frequency of pollen collection by *A. mellifera* can give additional information about the foraging behavior of this bee species in studies about daily and seasonal availability of pollen for plants, mainly during the periods of lower activity of the bee colony. The aim of this research was to study the time frequency of pollen production by *A. mellifera* in Sorriso, Mato Grosso State, Brazil and to observe the effect of the temperature, relative humidity and sunlight on this activity of this bee. The period with higher pollen production was between 10:00 AM until 01:00 PM and this period can be characterized by higher sunlight and temperature with lower relative humidity periods.

Keywords: Pollination, foraging activity, climatic effects.

INTRODUCTION

The bee pollen is composed by the accumulation of several pollen grains

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daily collected by bees. They promote agglutination through the addition of salivary secretions and small amount of nectar (Brasil 2001).

The productivity of pollen varies according to some factor, such as geographical localization and the type of collector (Barreto *et al.* 2005). The intermediate internal collector showed good results in the States Rio Grande do Sul, (900 - 2200g/colony/month), Santa Catarina (930 - 4000/colony/month), São Paulo (2.000 - 3.500g/colony/month) and Minas Gerais (2.000 - 3.000g/colony/month) (Barreto *et al.* 2005).

It is estimated that the pollen production in Brazil is around 200 ton/yea, mainly in the States of Bahia, Paraná and Santa Catarina. However Mato Grosso, Mato Grosso do Sul and Ceará have high potential for pollen production (Barreto *et al.* 2005)

There are different compounds in the bee collected pollen, such as some



Fig. 1 (A) and (B). Colonies of *Apis mellifera* (Hymenoptera: Apidae) placed in an Amazonian Rain Forest fragment (E 11°49'34" e SW e 55°48'46"), countryside of Sorriso, Mato Grosso – Brazil.

antioxidants that are important in the inhibition of free radicals (Kroyer & Hegedus 2001, Nagai *et al.* 2002, Campos *et al.* 2003). Additionally they can be used as a food supplement because of they contain amino acids, carbohydrates, lipids, mineral substances, proteins and vitamins that are indicated to prevent pathologies (Escribano *et al.* 1999, Kroyer & Hegedus 2001).

Studies about palynology have contributed on the environmental quality by providing the identification of harmful compounds that makes this technique important in bio monitor programs (Conti & Botre 2001).

The pollination is one of the most important mechanisms for biodiversity maintenance and promotion because most of the plants depend on pollinators for the sexual reproduction. Additionally, the flower resources are the main food sources for different group of animals (Proctor *et al.* 1996, Alvesdos-Santos 2003, Endress 1998). So, the plants developed some mechanisms to attract pollinators, such as aroma, color and shape of the structures to be pollinated (Dafni 1992) and the bees are fundamental for this process (Galai *et al.* 2009). The bees also are important pollinators in agricultural crops, most of the times increasing the productivity (Silva 2007)

In Brazil, the African bee has a great acceptability by the beekeepers because of its productivity, tolerance to diseases and adaptability in different environments (Kerr 1967, Gonçalves 1994).

Apis mellifera (Hymenoptera: Apidae) is very important in honey, wax, real jelly and propolis production, can contribute for the pollination (Witter & Blochetein 2003, Vandermeer & Perfecto 2006) and bigger fruit production and in higher quantity (Kristjansson & Rasmussen 1991, Carvalho & Marchini 1999, Boti *et al.* 2005, Vieira *et al.* 2008, Richards 2001, Lemasson 1987).

The fly characteristics of the bees can allows the foraging up to 30 meters high but they are commonly found up to 5 meters high and 2000 meters far from the colony (Moreti & Marchini 1998, Wiese 1985).

The foraging activity can vary during the day and this variation is caused by changes in temperature, relative humidity, season of the year and day lightness (Antonini *et al.* 2005, Hilário *et al.* 2007, Hilário *et al.* 2000, Kajobe & Echazarreta 2005, Silva *et al.* 2011). It can also vary among insects but there is a pattern where bigger bee species (Apidae and Andrenidae) and ants forage during all day long. Species of Vespidae and Lepidoptera prefer foraging

under higher temperature and lightness, especially between 8 AM – 3 PM o'clock, with maximum activity around 12 PM o'clock (Antonini *et al.* 2005, Souza & Teresinha 2011).

The aim of this study was to evaluate the time frequency of the bee pollen by *A. mellifera* in Sorriso, Mato Grosso State, considering that this information can improve the maintenance and manipulation techniques of bee colonies in the North of Mato Grosso State, Brazil.

MATERIAL AND METHODS

This research was carried out in the “Fazenda Luana” Apiary (E 11°49'34” e SW e 55°48'46”), in the countryside of Sorriso, Mato Grosso State, Brazil. The region is covered by small areas of Ombrophylous Tropical Rain Forest. The pollen grains were collected in samples between 13-15th of December 2011. This period is characterized by the higher productivity of bee products and production of larvae, increasing the foraging activities of the bees and consequently increasing the pollen production (Dreller & Page 1999). The dates were defined through weather forecast website (www.climatempo.com.br), observing and choosing the sunny days and with absence of any rain that are favourable conditions for foraging activities of Hymenoptera insects (Santos *et. al.* 2009).

In this experiment 29 *A. mellifera* colonies were placed on a stand (70 cm high) and 2 meters far from each other (Figure 1). For collecting the pollen



.Fig. 2 (A). Internal or top pollen collectors. (B) Collector tray of pollen. (C) Detail of the amount of pollen grains collected per hour. (D). Collection procedure of the pollen grains. (E) Pollen grains collected and counted.

grains we used the one internal collector (top type) (Figures 2A, B, C, D, E), (15 cm high, 48 cm length and 40 width) in each colony. This type of collector has a lateral tray where the pollen grains can be removed and is composed by four grids, where they can remove the pollen from the bees and prevent other insects to access the collected pollen.

Collector pollen were assembled in field 24 hours before the evaluation for the bees to adapt to the collectors. At 6 AM o'clock the collectors were cleaned and removed all the pollen grains. One hour later was started sampling, collecting all the pollen grains every hour. At 6PM o'clock we collected the last sample and then finished the experiment.

Weather data (temperature, relative humidity and sunlight) were collected from a weather station of the Institute of Agricultural and Environmental Sciences of the Federal University of Mato Grosso.

The data were analysed using the System for Statistical Analysis (SAEG 9.1). It was tested the effect of the time during the day, temperature, relative humidity and sunlight on the amount of pollen grains collected using analysis of variance (ANOVA). All the significant effects were then tested by analysis of regression ($p = 0.05$). Those parameters without significance were presented by descriptive analysis.

RESULTS

The time ($F = 18,81$; $p = 0,0006$), relative humidity ($F = 7,08$; $p = 0,0120$) and sunlight factors ($F = 24,21$; $p = 0,0006$) had significant effects on the amount of pollen grains collected by *Apis mellifera* during the period of the experiment. In other hand, only temperature did not significantly affected the amount of pollen grains collected ($F = 2,96$; $p = 0,1900$).

Between 7 AM - 10 AM o'clock the amount of pollen grains collected increased exponentially and around 10 AM o'clock we collected the higher amount after 11 AM o'clock the amount reduced until 2 PM o'clock. After this period the amount of grain pollen was regular until 6 PM o'clock but around zero (Figure 3 A).

The sunlight range between 300 - 600 W/m², the relative humidity between 80 - 95% were the ranges with higher amount of pollen grains collected. Sunlight lower than 100 W/m² and relative humidity lower than 80% and

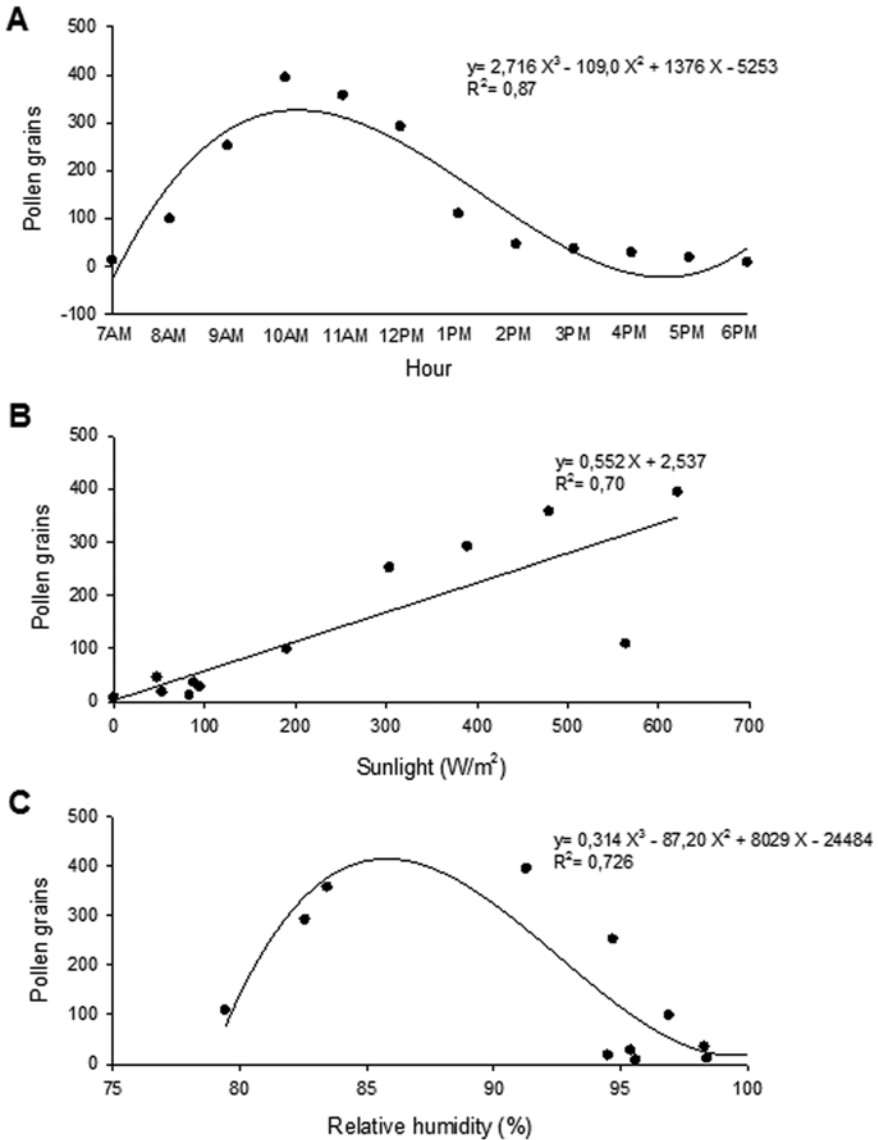


Fig.3. Pollen grains collected per hour (A), in function of the sunlight (B) and the relative humidity (C) in an Amazonian Rain Forest fragment in Sorriso, Mato Grosso – Brazil.

higher than 95% showed lower productivity of pollen grains by *A. mellifera* (Figure 3 B and C).

Because of the fact that temperature did not affected the amount of pollen grains collected, we presented this data through descriptive analysis that allows this factor to contribute in the knowledge of the foraging dynamics and pollen collection by *A. mellifera* in Sorriso. Temperatures up to 26 °C and higher than 30 °C showed lower amount of pollen grains collected by *A. mellifera*. In other hand, temperatures between 27 – 29 °C showed higher activity of pollen collection (Fig. 4).

The sunlight, temperature and relative humidity dynamics showed that between 10AM-01PM o'clock there were higher sunlight and temperature and lower relative humidity (Figure 5).

DISCUSSION

One fact that could be associated to the dynamics of collecting the pollen grains is the foraging activity. Some Hymenoptera (e.g. Andrenidae, Apidae, Formicidae and Vespidae) forage almost during all day long, mainly between 8 AM - 3 PM o'clock. This period seems to be favourable for this taxon and

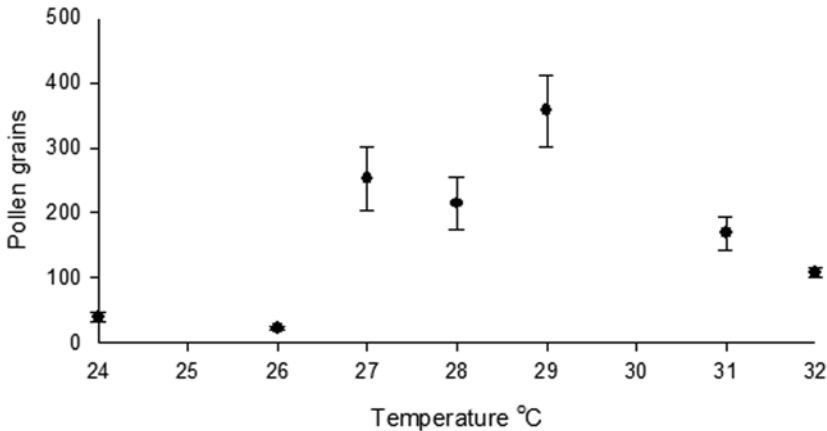


Fig. 4. Pollen grains collected in function of temperature in an Amazonian Rain Forest fragment in Sorriso, Mato – Brazil.

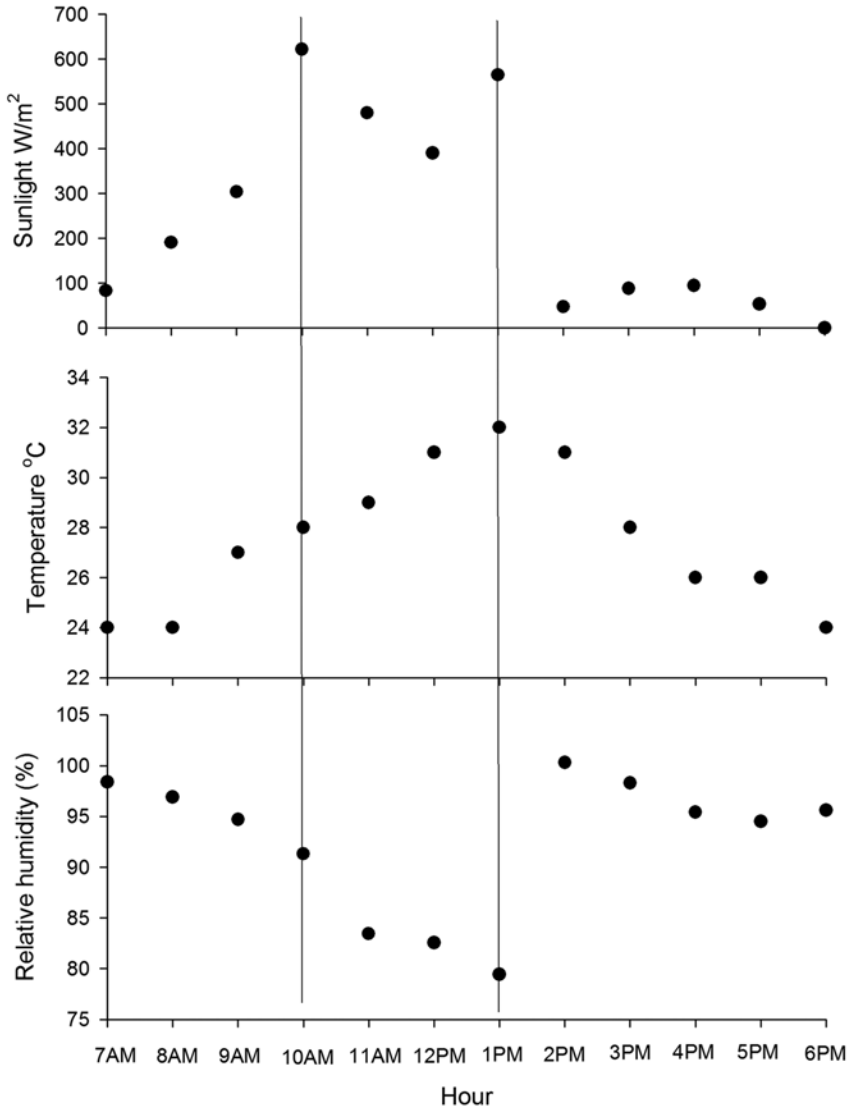


Fig. 5. Weather dynamics (sunlight, temperature and relative humidity) in an Amazonian Rain Forest fragment in Sorriso, Mato Grosso – Brazil.

periods around 12 PM o'clock is the one with higher activity (Antonini *et al.* 2005, Souza & Teresinha 2011).

The temperature did not affect the amount of pollen grains collected. This may happen by the fact the temperature in Sorriso region is almost constantly high, without significant variations. It is common temperatures higher than 24 °C after 7 AM o'clock. The higher amount of pollen grains collected occurred under 29 °C of temperature and this result agrees with others researches carried out with *A. mellifera* (Roubik 1989). So, temperatures around 29 °C maybe ideal for the pollen collection by *A. mellifera* also in Sorriso (Figure 2).

The sunlight range observed showed that the higher amount of pollen grains collected is around the same range found in the literature on *A. mellifera* where the range between 200 - 799 W/m² showed higher activity on the pollen collection (Roubik 1989).

The relative humidity range that showed higher amount of pollen grains collected was different from the ones in the current literature about the intensity of pollen collection by *A. mellifera* around 40 - 79% of relative humidity (Roubik 1989). This means that this fact can be related to the geographical position of the experimental site inside a Amazonian Rain Forest fragment. The fragment is characterized by high relative humidity level during all day long mainly because of the plant respiration.

The period between 10 AM – 1 PM o'clock showed great conditions for the foraging activity and consequently the pollen grain collection. This range period can be considered as the period with higher activity of *A. mellifera*.

Besides the weather conditions on the pollen collection by *A. mellifera*, another important factor is the availability of the pollen by the plant that occurs with higher intensity during the morning and lower intensity during the afternoon (Marchini & Moreti 2003, Heard 1994, Vithanage & Ironside 1986).

According to our results about the daily period of higher activity or pollen grain production, we could conclude that the period between 10 AM – 1 PM o'clock is the best period for the pollen collection by *A. mellifera* in Sorriso, Mato Grosso. This period is also the one for higher activity of the bee colony.

According to our results, the best period of managing the colonies is during the early mornings (7 AM - 9 AM o'clock), with lower bee activities.

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