LABOR DIVISION AMONG WORKERS OF *MELIPONA COMPRESSIPES FASCICULATA* WITH COMMENTS ON TASK SPECIALIZATION (HYMENOPTERA, APIDAE, MELIPONINAE)

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ABSTRACT

Division of labor in *Melipona compressipes fasciculata* Smith, 1854 was carried out approaching the main duties developed by workers through individually marked bees. The results found were represented graphically and it was suggested that the guard task can be specialized.

KEYWORDS. Hymenoptera, Meliponinae, *Melipona,* labor division, task specialization.

INTRODUCTION

Caste and labor division are the most important organization traits in the colonies of social insects. Rösch (1925) **apud** Free(1965) emphasized the age variation in which different duties were carried out by *Apis mellifera* Linnaeus, 1758 bees in the colony, i.e., there was a sequence of tasks performed by bees according to their ages. Ribbands (1952) pointed out to the fact that the duties of any individual is a result of the colony requirements as well as of the age of individuals. Lindauer (1952) referred that labor division was not so rigid and it varies according to the colony conditions. Studying *A. mellifera*, Kerr & Hebling (1964) observed that labor division among workers is related to the age and weight of the bees, and to a certain extent, to the needs of the hive. When observing the oviposition process behavior in *Melipona compressipes fasciculata* Smith, 1854, Giannini & Bego (1998) characterized the colony conditions considering some important aspects which were determinant points for evaluation of the colony level (interval between two consecutive processes, number of oviposited cells per oviposition process, duration of the provisioning phase, number and duration of worker food discharges). It is important to emphasize that such data were employed in this paper due to the fact that this labor division was realized in the same colony.

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Environmental variables alter the performance of some hive duties. FREE (1961) studied the access of workers to dietary pollen. These variables also include: nectar and pollen availability in the field (KOLMES, 1985a,b); amounts of brood present in the colony (WINSTON & FERGUSSON, 1985,1986); amount of wax present in the colony (KOLMES, 1985b; FERGUSSON & WINSTON, 1988; KOLMES & SOMMEIJER, 1992a,b); colony population levels (WINSTON & PUNNETT, 1982; KOLMES & WINSTON, 1988).

The aim is to analyze some tasks carried out by workers of *Melipona compressipes fasciculata* Smith, 1854 in order to verify their performance in 12 duties studied during almost 3 months of observations.

MATERIAL AND METHODS

The study was carried out in Ribeirão Preto, São Paulo, Brazil, from September to December 1991. Two colonies of stingless bees of *M. compressipes fasciculata* were used. The colonies were not manipulated except for the introduction of 104 marked workers which were obtained by removing combs from another hive; the callow bees were placed to emerge overnight in an incubator at 28°C. The newly emerged workers were introduced into the observation hive in the morning within 1-2h after marking. Such emerged workers were individually marked on the mesonotum with numbered plates ("Opalithpättchen") when they were less than 24h old.

Observation was carried out in both extra and oviposition periods, i.e., 8h of daily observation. The marked workers were recorded as performing one or more tasks through individual observations. The following tasks were recorded: (1) Cerumen: removal of cerumen from old brood cells, construction of support pillars, food pots and involucrum; (2) Nectar dehydration: a bee extends her proboscis and exposes a small drop of nectar that is in the process ripening; (3) Colony cleaning: a bee carries or removes the corpses of dead bees or pieces of cocoon and waste and dumps them outside the nest; (4) Comb building: a bee uses her mandibles to add and/or to shape wax in the process of constructing a brood cell on the margin of a comb; (5) Foraging: collection of food and material for nest construction; (6) Worker post-discharge: a bee stays around the provisioned cell, and inserts her head into a brood cell in the course of the provisioning and oviposition process (POP); (7) Ventilation: a bee stands in the hive and produces an air current by rapidly fanning her wings; (8) Enclosure gap: a bee closes any kind of colony gap with cerumen, batumen and/or mud, mainly to avoid the entrance of intruders; (9) Operculation of brood cell: a bee seals a cell containing a larva ready to pupate by manipulating the capping material with her mandibles; (10) Food discharge into brood cell: a bee discharges food into a brood cell in the course of POP; (11) Worker oviposition: after a brief inspection at the cell containing larval food, the worker places her abdomen into the fed cell and lays an egg in the center of the larval food; (12) Guarding: a bee stands on her meso and metathoracic legs, with prolegs held lifted and forward.

The colony conditions (tab. I) were evaluated in the beginning and end of the observations based on the number of brood combs and available food (pollen and honey pots).

Table I. General conditions of the colony of *Melipona compressipes fasciculata*.

Colony conditions	Sept, 27 1991	Dec, 20 1991
Number of pollen pots	open 5	open 6
	closed 3	closed 12
Number of honey pots	open 5	open 6
	closed 14	closed 31
Number of fresh combs	3	2
Number of older combs	4	2

RESULTS

Cerumen work and nectar dehydration were respectively carried out by 104 and 95 marked members in the colony. Colony cleaning, comb building, foraging, post-discharge and ventilation duties were respectively performed by 90, 86, 72, 70 and 63 bees, while enclosure gap, operculation, food discharge, worker oviposition and guarding were done by 41, 35, 35, 12 and 3 individuals, respectively (fig. 1). For more details on the worker's age sequence of *M. compressipes fasciculata* see GIANNINI (1997).

The number of bees and the duration in days (fig. 2) by and during, which the whole set of tasks was performed, showed that most bees realized the colony duties mainly during one day and the number of individuals decreased gradually. The guard task represented an exception due to the fact that three workers carried out this task during one day. Worker oviposition also represented a different pattern, i.e., ten individuals laid eggs during one day and two bees oviposited during two days (fig. 2).

DISCUSSION

Studying labor distribution among workers of *Melipona favosa* Fabricius, 1789, SOMMEIJER (1984) observed three activities which were carried out in higher percentage: building of brood cells, larval food depositing and operculation. The guarding duty was performed for a long time (29 days), during which the bees engaged in such work were not so small when compared to those related to brood combs.

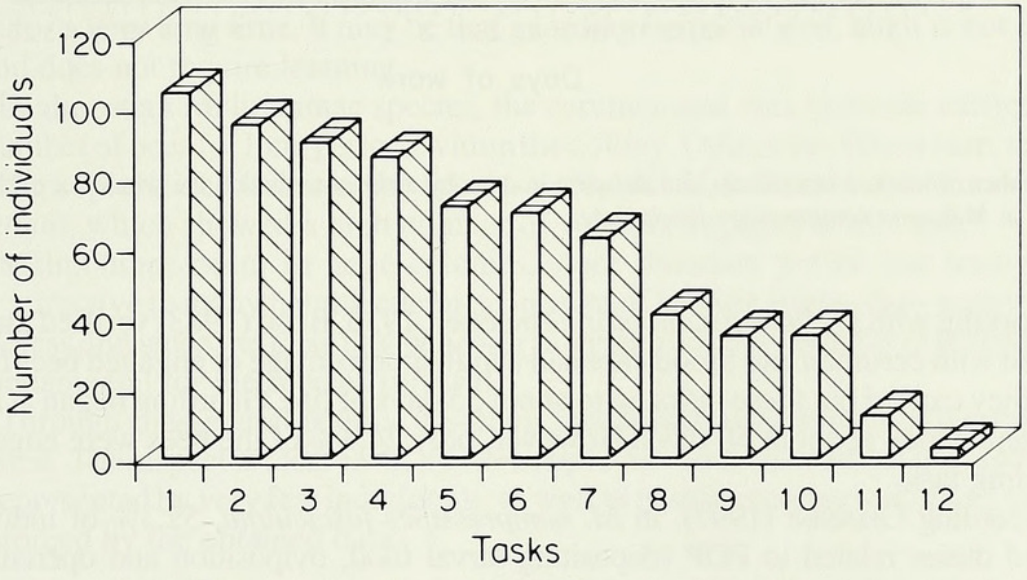

Fig. 1. Number of marked individuals performing each task in *Melipona compressipes fasciculata*: 1, Cerumen work; 2, Nectar dehydration; 3, Colony cleaning; 4, Comb building; 5, Foraging; 6, Worker post-discharge; 7, Ventilation; 8, Enclosure gap; 9, Operculation of brood cell; 10, Food discharge into brood cell; 11, Worker oviposition; 12, Guarding.

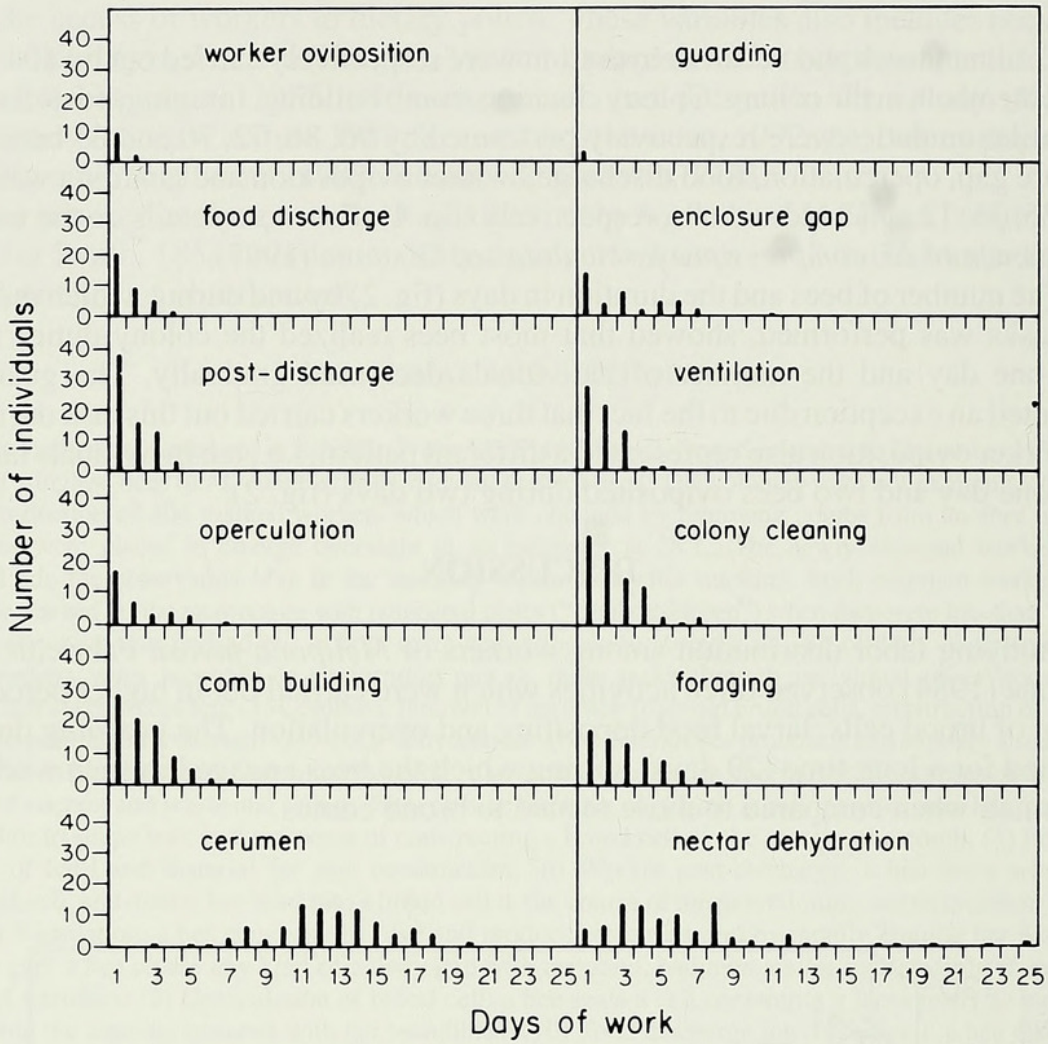

Fig. 2. Number of marked individuals and duration in days by and during which the whole set of tasks was performed in *Melipona compressipes fasciculata*.

Working with *Melipona b. bicolor* Lepeletier, 1936, BEGO (1983) verified that tasks performed with cerumen and brood care had a higher percentage of engaged bees (100%) and that they carried out these tasks up to about 35 days of life. Guarding began at around 18 days and ended at about 50 days. However, only 24.3% of the bees were engaged in the guarding task.

According GIANNINI (1997), in *M. compressipes fasciculata*, 52.3% of individuals performed duties related to POP (depositing larval food, oviposition and operculation), 76.6% worked in cell construction, and 99.1% of bees were seen working with cerumen. The respective periods for the development of these tasks were respectively, 20, 25 and 55 days.

In *Nannotrigona* (*Scaptotrigona*) *postica* (Latreille, 1807), SIMÕES & BEGO, (1991) dealt with three typical colonies and demonstrated that the duty involving wax and cerumen was carried out by about 85%, 100% and 70% of the bees, and the guarding task by about 10%, 12% and 5%. The former lasted around 30, 35 and 30 days, and the latter

about 5, 5, and 3 days. Duties related to brood care were performed by approximately 30%, 10% and 38% of bees and lasted around 15, 3 and 11 days.

Workers of *Plebeia remota* Holmberg, 1903 started the first task a few days after emerging, that is, the general construction task which involved the use of cerumen; the percentage of bees visualized performing this work was 94%. The participation in cell building, and in the provisioning and oviposition process were restricted to bees at a small age interval, and only a small proportion of the marked workers were seen participating (12%) (Benthem **et al.**, 1995). In *Trigona* (*Scaptotrigona*) *xanthotricha* Moure, 1950, the bees are engaged with cerumen work during almost all their life span, and the guarding duty was realized by only four individuals among a total of 60 marked bees (Hebling **et al.**, 1964).

The task performed with cerumen is generally the one in which workers engage most frequently. As to brood care, which involves cell building, food discharges, oviposition and operculation, most of the results showed that these tasks were not performed by a great number of bees, except in *M. b. bicolor*, and comb building and post-discharge in *M. compressipes fasciculata,* whose percentage of engaged bees was relatively high.

As to guarding in *N.* (*Scaptotrigona*) *postica,* Simões & Bego (1991) and *M. compressipes fasciculata,* few individuals worked in this task for few days. However, Bego (1983) observed few individuals of *M. b. bicolor* worked for a longer time.

Studying *A. mellifera*, Lindauer (1953) demonstrated the occurrence of few bees specialized in guarding and water carrying. According to Visscher (1983), in *A. mellifera*, very few bees in a colony appear to specialize in corpses removal. Moore **et al.** (1987) reported that guarding in *A. mellifera* is a specialized task which few bees realize. However, such duty does not appear to require experience since so few bees remain as guards for a very long time. It may be that guarding is specialized, but it is not a complex task and does not require learning.

In almost all Meliponinae species, the cerumen and wax tasks are carried out by a high number of bees for long periods within the colony. Otherwise, brood care, seemingly, should be a specialized task in many species except for *M. b. bicolor* and *M. compressipes fasciculata*, which showed a high number of workers engaged in this task.

Meliponinae occur in large colonies, store abundant pollen and honey, and are highly attractive to many natural enemies. In spite of lacking stings, they are by no means defenseless and since the guarding behavior is a means of nest defense (Michener, 1974), it is fundamental for the species survival.

Through the general results, a certain specialization in the guarding duty can be suggested. This aspect is clear in *M. compressipes fasciculata* in which the guarding bees were represented by very few individuals, as well as in other species formerly cited, which is reinforced by the obtained data.

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