

OCCURRENCE AND BIOGEOGRAPHIC ASPECTS OF
Melipona quinquefasciata IN NE BRAZIL
(HYMENOPTERA, APIDAE)

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ABSTRACT

The stingless bee *Melipona quinquefasciata* is not included among the nine bee species of *Melipona* described in literature of NE Brazil. However, reports of some farmers raised suspicion on the occurrence of *M. quinquefasciata* in the state of Ceará, in NE Brazil. Investigations were carried out from July 1997 to September 2000, by means of trips to the areas of probable occurrence of this bee species. Results confirmed the presence of *M. quinquefasciata* in Ceará and determined its habitat along the chapada do Araripe (Araripe plateau) and all extension of planalto da Ibiapaba (Ibiapaba plateau), in altitudes between 600 and 900 m. *Melipona quinquefasciata* lives in the phytocoenosis of cerrado (Brazilian savanna), cerradão (savanna forest) and carrasco (montane deciduous shrub vegetation) on the top of Araripe plateau, and only carrasco in the Ibiapaba plateau. Due to pressures caused by reduction of the area covered with native vegetation, large use of agrochemicals in anthropic areas and generalised predatory hunting of honey and beeswax, *M. quinquefasciata* is in risk of disappearing from the ecosystems of Araripe and Ibiapaba plateaus within a few years.

Key words: biogeography of bees, ground-nesting bee, stingless bee, *Melipona quinquefasciata*, urucu-do-chão.

RESUMO

Ocorrência e aspectos biogeográficos de *Melipona quinquefasciata* no Nordeste do Brasil (Hymenoptera, Apidae)

A abelha sem ferrão *Melipona quinquefasciata* não consta entre as nove espécies de *Melipona* relatadas na literatura para o Nordeste do Brasil. Porém, relatos de agricultores levaram à suspeita de sua ocorrência no Ceará. Investigações foram conduzidas de julho de 1997 a setembro de 2000, por meio de viagens sistemáticas às áreas de provável ocorrência. Os resultados confirmaram a presença de *M. quinquefasciata* no Ceará e determinaram seu habitat ao longo da chapada do Araripe e toda a extensão do planalto da Ibiapaba/Serra Grande, em altitudes variando entre 600 e 900 m. *Melipona quinquefasciata* ocupa as fitocenoses de cerrado, cerradão e carrasco sobre a chapada do Araripe, e apenas o carrasco no planalto da Ibiapaba/Serra Grande. Devido a pressões causadas à espécie pela redução da área coberta com vegetação nativa, ao uso indiscriminado de agrotóxicos nas áreas antropizadas e ao extrativismo de mel e cera feito de forma predatória e em larga escala, *M. quinquefasciata* corre o risco de desaparecer dos ecossistemas da chapada do Araripe e planalto da Ibiapaba/Serra Grande em alguns anos.

Palavras-chave: abelha de ninho subterrâneo, abelha sem ferrão, biogeografia de abelhas, *Melipona quinquefasciata*, urucu-do-chão.

INTRODUCTION

According to Moure (1951), *Melipona* Illiger, 1806, originated from post-gondwanian lineages which evolved subsequent to palaeological changes that occurred in the new environment which definitively split from the African continent in the Upper Eocene. This generic taxon comprises presently four subgenera proposed by Kerr *et al.* (1967), *Melipona* and *Micheneria*; and Moure (1992), *Melikerria* and *Eomelipona*.

Melipona is exclusive of the neotropics, where more than 40 species are found in the equatorial, tropical and subtropical regions of the American continent (Schwarz, 1932; Michener & Sakagami, 1990; Camargo & Pedro, 1992). The Northeast of Brazil (Fig. 1) is situated between 1°02' -18°20' S and 34°47' -48°45' W, covering an area of 1,644,039 km², from the state of Maranhão to the state of Bahia, which correspond to 9.3% of the Brazilian territory (Andrade, 1977; Funceme, 1993), and counts approximately with 23% of the known *Melipona* species – *M. asilvai*, *M. compressipes fasciculata*, *M. mandaçãia*, *M. marginata*, *M. quadrifasciata anthidioides*, *M. rufiventris*, *M. scutellaris*, *M. seminigra pernigra* and *M. subnitida* (Schwarz, 1932; Moure & Kerr, 1950; Moure, 1971; Gonçalves, 1973; Moure, 1992). Only the geographic distribution of these species is known in NE Brazil, but there is uncertainty about their actual distribution in terms of the phytocoenosis (*sensu stricto*) they occupy.

Melipona quinquefasciata, is a species belonging to the subgenera *Melikerria* and described by Lepeletier in 1836 (Moure, 1975), which is not included among the species reported to occur in NE Brazil. Records known so far about the geographic distribution of *M. quinquefasciata* show its occurrence only in Southern states of Brazil, from the South of Espírito Santo to Rio Grande do Sul, including areas of Minas Gerais, Goiás, Mato Grosso, Mato Grosso do Sul; Bolivia, in its Southern part; Paraguay and North-Northeast of Argentina (Mariano-Filho, 1911; Schwarz, 1932; Kerr, 1948; Moure, 1948, 1975; Viana & Melo, 1987). However, farmer's reports of a Meliponin species different of all other known species to the state of Ceará, but with similar characteristics of *M. quinquefasciata*, suggested its occurrence in the chapada do Araripe (Araripe plateau), Southern

border of Ceará, and in the planalto da Ibiapaba/Serra Grande (Ibiapaba plateau), Western border of Ceará. If such suspicion is confirmed, *M. quinquefasciata* will become a new occurrence of *Melipona* to the NE Brazil.

CHARACTERIZING THE STUDY AREA

Araripe plateau

The Araripe plateau is situated in the South of Ceará being a natural border with the neighboring state of Pernambuco. It is also the state line between Pernambuco and part of Piauí. The geographic localization of the Araripe plateau is given by the coordinates 39°00' -40°50' W and 7°15' -7°50' S (Fig. 1).

This plateau has a Mesozoic origin (Lower Cretaceous – Albian), around 2,580 km², and is 180 km long (East-West) and about 70 km wide (North-South). The relief exhibits tabular aspect, altitude between 850-900 m, on a sandstone stratification (Exu Formation) where, according to the Brazilian classification of soils, predominate Dystrophic Red-Yellow Latosol soils (Lima, 1978; Sousa *et al.*, 1979; Sousa, 1988, 1997; Leite & Marques, 1997). Although others soil nomenclature such as FAO/Unesco and Soil Taxonomy classifications could be used in this work, we decided upon the Brazilian classification of soils because, according to Whitemore & Prance (1987), it corresponds best with ecological reality in the neotropics.

The weather in Araripe plateau shows pluvial means over 1,000 mm per year (summer/fall) and annual thermal variation means estimated in 24°C, following into the bioclimate 4bTh and 4cTh of Gaussen (Nimer, 1972; Sudene, 1973; Andrade, 1977).

Vegetation of this plateau is made up of a seasonal semideciduous forest below 700 m, and a tropical rainforest (montane semiperennial rainforest) at an altitude between 750-850 m, both on the hillside, while at the top there is a savanna forest (cerradão), an isolated tree savanna (campo cerrado) and a montane deciduous shrubby vegetation (carrasco) (Figueiredo, 1986; Fernandes, 1990, 1998; Fernandes & Bezerra, 1990; Veloso *et al.*, 1991; Rizzini, 1997; Araújo *et al.*, 1998a, b, 1999).

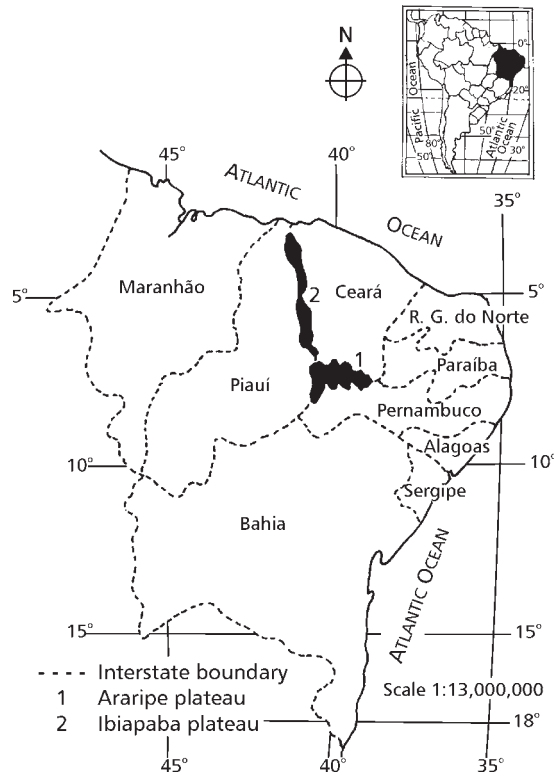


Fig. 1 — Location of Araripe and Ibiapaba plateaus in NE Brazil. Source: IBGE (1966).

Ibiapaba plateau

The Ibiapaba plateau runs in the North-South direction for almost 500 km composing the Western border of Ceará with Piauí. Its geographic position is given by the coordinates 40°15'-41°30' W e 3°15'-7°00'S (Fig. 1).

This plateau has a Paleozoic origin (Devonian), and comprises the Eastern limit of the sedimentary drainage basin of Maranhão-Piauí. It covers an area of approximately 8,000 km², and is divided in two sectors (Southern Ibiapaba and Northern Ibiapaba) by the canyon of river Poti, which begins in Ceará but flows to Piauí cutting the plateau. The relief (650-900 m) declines gradually to the West, towards Piauí, giving the "cuesta" appearance that characterizes this plateau (Sousa *et al.*, 1979; Sousa, 1988, 1997). Predominant soils are associations of Eutrophic Red-Yellow Podzolic, Dystrophic Red-Yellow Latosol, and associations of Quartz Sands (Leite & Marques, 1997).

Local weather shows annual pluvial and temperature means ranging from 750 to 1,250 mm (summer/fall), and 24° to 26°C, respectively, according to the North/South sectors of the plateau. This figures place the Ibiapaba plateau into the 4bTh and 4cTh climate classification of Gaussen (Nimer, 1972; Sudene, 1973; Andrade, 1977).

Vegetation is mainly represented by carrasco (montane deciduous shrubby vegetation), but on the Northern side of the plateau, in its higher portion, there is a montane semiperennial rainforest, and a seasonal semideciduous forest is also found on its Western hillside (Figueiredo, 1986; Fernandes, 1990, 1998; Fernandes & Bezerra, 1990; Veloso *et al.*, 1991; Rizzini, 1997; Araújo *et al.*, 1998a, b, 1999).

MATERIAL AND METHODS

In order to investigate the occurrence of *M. quadrifasciata* in NE Brazil, we made a series of

trips to the Araripe and Ibiapaba plateaus between July 1997 and September 2000 where we collected worker bees from colonies of the species under investigation, determined the limits of its geographic space, identified its nesting niches, and correlated this information with environmental aspects related to landscape shape, climate, soil and vegetation. Coordinates and altitude of each nest site were registered using a GPS (Global Position System) and a precision altimeter.

Most bees were collected using entomological nets to catch them in flight when they approached the nest entrance returning from field trips. However, many colonies stopped their external activities when approached by people. To collect bees from these colonies, we introduced through the nest entrance a dried or fresh leaf of any grass species found in the vicinity. This leaf was about 30-40 cm long and by push-and-pull movements inside the nest entrance tube, we irritated workers enough to make them grab the leaf with their mandibles before withdraw it from the nest and capture the bees. In two cases, workers were caught when they were trying to lick sweat from exposed areas of the authors' bodies, namely hands, arms, face and neck.

Each bee was killed immediately after its capture using a lethal flask, according to Borror & De Long (1969) and Almeida *et al.* (1998), but with sulphuric ether as the active chemical. Then, each specimen was placed in a plastic vial with 70% alcohol or, provisionally, in freezer at -5°C . Finally, bees were dried at 45°C in an oven of the Animal Physiology Laboratory in the Departamento de Zootecnia (Animal Department) of Universidade Federal do Ceará (UFC), then mounted in entomological pins and labeled accordingly. Later, part of the specimens were sent to be identified in the Departamento de Zoologia of Universidade Federal do Paraná, while the remaining specimens were deposited in the collection of the Departamento de Zootecnia/UFC.

RESULTS

Results showed that the investigated species of Meliponin was, in fact, *M. quinquefasciata*. Four inhabited nests were found in the Araripe plateau, occupying the phytocoenosis of cerrado (Brazilian savanna), cerradão (isolated tree savanna), car-

rasco (montane deciduous shrub vegetation) and the montane semiperennial rainforest (Table 1); and in the Ibiapaba plateau other three nests were recorded in the area of carrasco vegetation (Table 1), characterizing the habitat of *M. quinquefasciata* in the state of Ceará (Figs. 2 and 3).

In the Araripe plateau, only one of the nests was not situated at the top within any of the three phytocoenosis mentioned above. This nest was found immediately below the plateau's front, in an degraded area of the montane semiperennial rainforest, between 700 and 750 m in height, where predominate associations of Dystrophic and Eutrophic Lithosol soils + Eutrophic Equivalent Red-Yellow Podzolic soils + Dystrophic and Eutrophic Red-Yellow Latosol soils, according to Leite & Marques (1997) (Fig. 2, Table 1).

Four non-inhabited nests, where bee colonies had been removed by local inhabitants to extract honey and wax, were also found in the Araripe plateau. These nests were between 1.5 and 3.0 m deep into the ground. An inhabited nest found in the county of Ubajara, Ibiapaba plateau, had been dug, also for honey and wax extraction, up to 2.0 m deep, but in this occasion honey hunters did not succeed in having access to the colony (Fig. 3).

More details of nest location and the examined material of *M. quinquefasciata* are given in Table 1.

DISCUSSION

Although *M. quinquefasciata* have been known by local inhabitants of the Araripe and Ibiapaba plateaus since the Brazilian colonial period, the present work recorded for the first time the occurrence of this bee species in NE Brazil, expanding the knowledge on the natural habitats of this Meliponin. Despite the fact that all observed nests have been found in the state of Ceará, the geomorphologic uniformity of the areas and existence of the same vegetation formations in Piauí and Pernambuco portions of the plateaus suggest that the bee species also occurs in those states.

The presence of *M. quinquefasciata* in NE Brazil, apart from the other known populations of this species, can be explained by its isolation in remains of former vegetation communities found secluded in the phytocoenosis of caatinga (tropical thorn scrub vegetation).

TABLE 1
Details on the location of nests and examined material of *Melipona quinquefasciata* Lepeletier, 1836 in the state of Ceará, Brazil.

Place of occurrence	Method of collection	Coordinates	Altitude (m)	Type of vegetation	Date	Collector	Number of specimens/sex
Sítio Fábrica, Santa Fé, Crato, Ceará, Brazil (AP)	DN	07°09'30.6''S 39°32'40.1''W	760	DF	29.VII.1997	L. W. Lima-Verde B. M. Freitas	11/f
Fazenda Nova, Flamengo, Serra do Ermo, Aiuaba, Ceará, Brazil (IP)	EPB	06°43'25.5''S 40°22'54.8''W	630	CAR	12.IX.1997	L. W. Lima-Verde B. M. Freitas	01/f
Júlio Gomes, Campo Alegre, Crato, Ceará, Brazil (AP)	DN	7°17'34.2''S 39°35'6.3''W	870	CAR	15.XII.1999	L. W. Lima-Verde B. M. Freitas	08/f
Rodovia 060 ramal para Cacimbas, Jardim, Ceará, Brazil (AP)	DN	7°29'44.0''S 39°21'13.5''W	815	CAR	02.III.2000	L. W. Lima-Verde B. M. Freitas	17/f
Rodovia 060 ramal para Porteiros, Estrada do Fio, Barbalha, Ceará, Brazil (AP, FLONA)	EPB	7°23'00.0''S 39°17'00.0''W	900	CER	30.III.2000	L. W. Lima-Verde B. M. Freitas	02/f
Sítio Melancias, Estrada São Luís (Reserva Ecológica de Serra das Almas), Tucuns, Crateús, Ceará, Brazil (IP)	DN	5°7'59.0''S 40°54'43.0''W	600	DF	09.II.2000	L. W. Lima-Verde B. M. Freitas	08/f
Sítio Poço de Areia, Nova Várzea, Ubajara, Ceará, Brazil (IP)	DN	3°50'32.0''S 41°04'48.8''W	680	CAR	16.IX.2000	L. W. Lima-Verde B. M. Freitas	01/f

AP = Araripe plateau; CAR = carrasco; CER = cerradão; DF = dry forest; DN = direct from nest; EPB = exposed parts of the body; f = female; FLONA = National Araripe Forest; IP = Ibiapaba plateau.

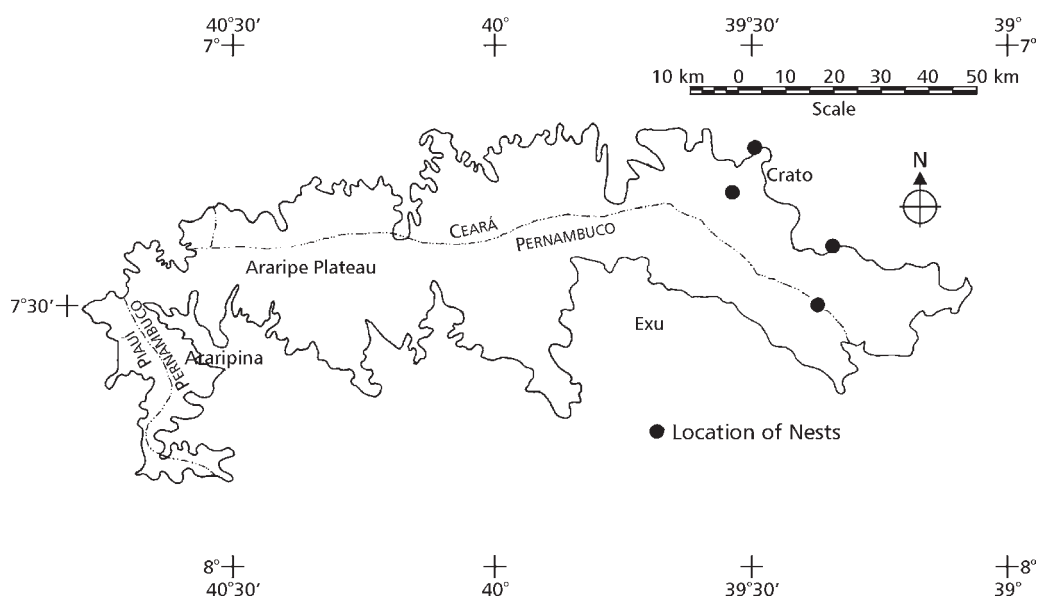


Fig. 2 — The Araripe plateau and location of *M. quinquefasciata* nests. Source: Brasil (1981a).

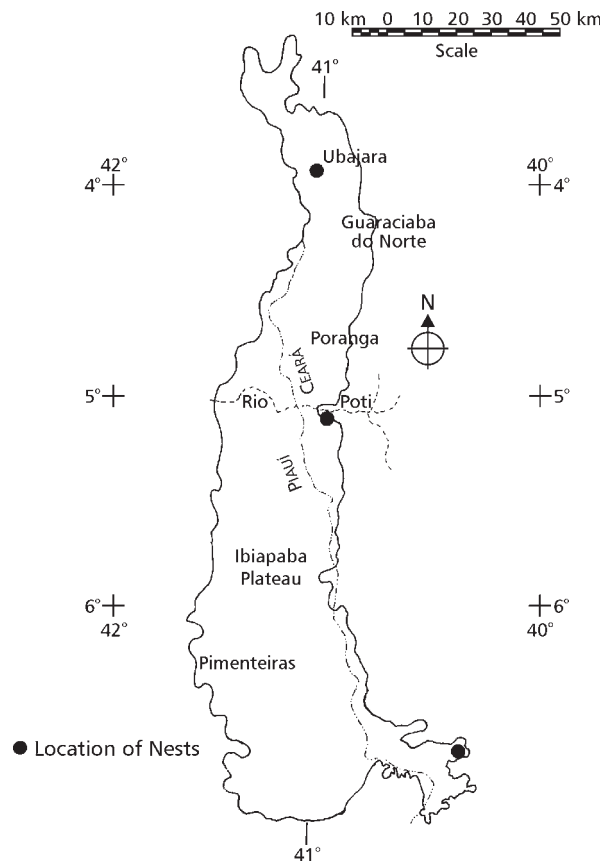


Fig. 3 — The Ibiapaba plateau and location of *M. quinquefasciata* nests. Source: Brasil (1981b).

According to Sousa *et al.* (1979) and Pinto (1986), climatic differentiation in NE Brazil began more intensively with the palaeological events that occurred in the Pliocene (Tertiary) and strengthened during the Pleistocene (Quaternary). The pluvial regimes of these periods were characterized by intense rains and glaciations that accelerated erosive processes and lead to the dismount of the great Brazilian central plateau (Pinto, 1986). Submitted to those elevated pluvial gradients there was, predominantly, a savanna vegetation similar to that of present-day cerrado (Brazilian savanna), associated to open vegetation represented by campestrian formations (Mabesoone & Rolim, 1973/1974; Bigarella *et al.*, 1984). Placing the sedimentary elevations of the Araripe and Ibiapaba plateaus in this context, it is feasible to accept that the vegetation found nowadays in those enclaves is a remnant portion of the

predominant vegetation existing in the great Brazilian central plateau prior to its dismount. *Melipona quinquefasciata* would have survived in those refugia as a discontinuous species until present days.

According to Vanzolini (1970) and Bigarella *et al.* (1975), disjunction of a favorable environment implies in the appearing of areas where life becomes impossible, characterizing a “dispersion barrier”. In the case of *M. quinquefasciata*, this barrier is represented by extensive intermontane lowered areas, which appeared as a consequence of the dismounting of the great Brazilian central plateau, nowadays covered by caatinga (tropical thorn scrub vegetation) in response to the prevailing semi-arid climate.

Present environmental conditions of Araripe and Ibiapaba plateaus are similar to that of the Brazilian central plateau, specially in relation to

the altitude, soil and, in part, vegetation and flora, leading local populations of *M. quinquefasciata* to show little variation in feeding and nesting behavior in relation to other *M. quinquefasciata* populations, since these resources are basically the same as those found in central areas of Brazil (Freitas & Lima-Verde, in preparation). Other geological formations with similar characteristics to the areas studied in this work are found in NE Brazil and can also hide unknown populations of *M. quinquefasciata*, although so far there is no evidence of their existence.

Considering particularly the Northeastern population of *M. quinquefasciata*, its occurrence in two distinct geological formations may suggest that bee communities of Araripe and Ibiapaba plateaus are genetically isolated. However, the nest found immediately below the Araripe plateau's front suggests a possible means used by the species to migrate between the plateaus. Such migration may occur because separating the plateaus there is a gap of differentiated geomorphology showing lowered areas of 500-600 m of altitude, and the distance in a straight line between the plateaus is approximately 30 km, with a narrow band of Dystrophic Red-Yellow Latosol soil (Leite & Marques, 1997). These conditions are apparently favorable for the survival of the species in its journey from one plateau to another.

The Ibiapaba plateau itself is divided in two sectors (Southern Ibiapaba and Northern Ibiapaba) by the river Poti forming a canyon 2.5-3.0 km wide and 250-300 m above sea level, but with deep soils in association with Equivalent Eutrophic Red-Yellow Podzolic soils (Leite & Marques, 1997). In this case, the short distance that separates the two sectors of the Ibiapaba plateau may not be an obstacle even to the passage of new colonies from one side to another by the characteristic swarming process of the Meliponins (Nogueira-Neto, 1954).

There is a need for studies to investigate evolutionary aspects of *M. quinquefasciata* within the Northeastern population, and between this population and others occurring elsewhere in Brazil and neighboring countries, with the aim to evaluate possible genetic divergence towards sub-speciation, since isolation of such populations due to recent palaeoevents (Pleistocene) did not allow yet any differentiation in terms of species.

Paradoxically, confirming the occurrence of *M. quinquefasciata* in NE Brazil comes at a time when this species is already threatened to disappear from the ecosystems of Araripe and Ibiapaba plateaus. Pressures caused to this species by the great reduction of area still covered by native vegetation, indiscriminate use of pesticides and other agrochemicals in anthropic areas and generalised predatory hunting of honey and beeswax are making it each time more difficult in finding new colonies.

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