INFLUENCE OF ALTITUDE ON THE DISTRIBUTION OF STINGLESS BEES (HYMENOPTERA APIDAE: MELIPONINAE)*

R.A. ORTIZ-MORA, J.W. VAN VEEN**, G. CORRALES*, M.J. SOMMEIJER***

**COSTA RICA, **THE NETHERLANDS*

Introduction

The subfamily Meliponinae (stingless bees) is exclusively tropical (MICHENER, 1990), and several authors describe their spreading and distribution in the Neotropics (CAMARGO et al., 1988; MICHENER, 1979; ROUBIK, 1990, 1992). Of the stingless bees in Costa Rica a description of the nests and a key to the identification of the species is given by WILLE (1961) and WILLE and MICHENER (1973).

Little information, however, is available on ecological, geographical and climatological factors that determine different areas occupied by different (sub-) species. The mechanisms that prevent *Melipona favosa* and *M. yucatanica* from occupying the same area, although the forests are structurally similar and barely separated in Costa Rica and panama, are unkown (ROUBIK, 1990). Neither is it known why *Melipona* does not exist in the subtropical and temperate zone. ROUBIK (1990) hypothesized that the absence of suitable nesting sites and nesting materials like tree resins prevent *Melipona* from colonizing the temperate zone. As arguments he states that, for instance, *Melipona peruviana* demonstrates cold tolerance, and that *Melipona* displays ectothermy. JOHNSON and HUBBELL (1984) found that stingless bees preferred the thickest trees (95 cm dbh) for nest sites. The south-western part of the United States is likely to be favourable for bees since it counts hundreds of native species, and has an abundancy of food sources. Six species were found to occur at altitudes ranging from 200 to 1400 m in Peru, which include two biotic zones (tropical and subtropical premontane biotic zones, av. annual temp. 25-27 ^{O}C, respectively 21-23 ^{O}C), indicating that stingless bees can demostrate cold tolerance (BAUM-GARTNER and ROUBIK, 1989). In this study, cold tolerance and distribution were studied for stingless bees to gain more insight in factors influencing their distribution, on the slopes of the “Cordillera de Tilaran” mountain range, in Costa Rica. The data were correlated with specimens of the bee collection at the University of Costa Rica.

Materials and Methods

Meliponine bees were collected by hand with an aerial net on baits using a mixture of honey and pollen syrup as attractant (ROUBIK, pers. comm.) or on flowers, on a 35 km long altitudinal transect from Pozo Azul; (200 m alt.) to Monteverde (1500 m alt.), Guanacaste province, Costa Rica, at six different sites, monthly, during the rainy season, in July-December, 1991. A characterization of the vegetation of this transect is provided by HOLDRIGE (1967) and JANZEN (1983), being characterized as tropical dry forest, gradually changing to premontane tropical cloud forest. Land use is mainly for cattle grazing at the lower altitudes, but still enough forest is left to house a diverse bee population. In Pozo Azul, the average annual temperature is of 27.5 ^{O}C, with an annual precipitation of 1500 mm; in Guaria (750 m) it is about 22.5 ^{O}C, with an annual precipitation of 2500 mm, and in Monteverde – 19.0 ^{O}C, with a precipitation of 3000 mm. All collections were of equal duration (2 hr.) and from an equal quantity of baits. All specimens were identified by R.A. ORTIZ-MORA, and deposited at the Entomological Museum of the National University (Heredia) of Costa Rica. An inventory was made of the stingless bees of the entomological collection at the University of Costa Rica (San Jose), to compare the geographical data of these specimens with the ones we collected.

Results

A total number of 808 stingless bees were collected from among 20 species, mostly from the syrup baits. Table 1 presents a list of the species collected and their altitude distribution.

It is clearly shown that less species were collected at higher altitudes (6), and more at 200-500 m (14) and at 700-1000 m (14). Only three species were collected at all sites, *Trigona corvina*, *Partamona aff. cupria* and *Trigona fulviventris*, *Partamona grandipennis*, *Scaptotrigona mexicana subobscuripennis* and *M. fasciata melanopleura* were collected exclusively at the highest altitudes.

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In the collection of the Museum of Entomology of the UCR, a total of 48 species of stingless bees is present among a total number of about 2750 specimens, collected since 1959, including all species collected at the altitudinal transect. Table 2 shows the number of specimens present in the UCR collection (total No. 1472) and their altitude range.

As we may see in table 2, many of the species have been previously collected at higher altitudes (for instance *T. amalthea* and *T. angustula*) or at lower altitudes (like for instance *Scaptotrigona mexicana suboscuripennis* and *M. fasciata melanopleura*).

Table 1

Altitude distribution of stingless bees collected in Guanacaste, Costa Rica, and no. of specimens collected

Species	Altitude range (m)						No. col.
	200	500	700	1000	1200	1500	
Trigona corvina	-----	-----	-----	-----	-----	-----	106
Partamona aff. cupria	-----	-----	-----	-----	-----	-----	72
Trigona fulviventris fulviventris	-----	-----	-----	-----	-----	-----	104
Nannotrigona testaceicornis perilampoides	-----	-----	-----	-----			51
Tetragonisca angustula	-----	-----	-----	-----			77
Plebeia frontalis	-----	-----	-----	-----			24
Tetragona dorsalis ziegleri	-----	-----	-----	-----			35
Cephalotrigona capitata zexmeniae	-----	-----	-----	-----			20
Melipona beecheii	-----	-----	-----	-----			13
Scaptotrigona pectoralis pectoralis	-----	-----	-----	-----			18
Trigona amalthea silvestriana	-----	-----	-----	-----			62
Oxytrigona mellicolor	-----	-----					21
Trigona fuscipennis	-----	-----					14
Tetragona perangulata	-----	-----					1
Trigonisca buyssoni			-----	-----			4
Plebeya sp. (aff. flavoscutellata)			-----	-----			25
Geotrigona leucogastra chiriquiensis			-----	-----			8
Partamona grandipennis					-----	-----	4
Scaptotrigona mexicana subobscuripennis					-----	-----	117
Melipona fasciata melanopleura					-----	-----	32

Table 2

Altitude distribution of stingless bees collected in Costa Rica (specimens from the collection of the UCR), and no. collected

Species	Altitude (m)						No. col.
	200	500	700	1000	1200	1500	
Trigona corvina	+				+		160
Partamona aff. cupria	+				+		104
Trigona fulviventris fulviventris	+				+		123
Nannotrigona testaceicornis perilampoides	+	+					84
Tetragonisca angustula	+				+		40
Plebeia frontalis	+	+					80
Tetragona dorsalis ziegleri	+	+					83
Cephalotrigona capitata zexmeniae	+			+			87
Melipona beecheii	+	+					32
Scaptotrigona pectoralis pectoralis	+			+			145
Trigona amalthea silvestriana	+				+		102
Oxytrigona mellicolor	+			+			46
Trigona fuscipennis	+						36
Tetragona perangulata	+	+	+				58
Trigonisca buyssoni	+			+			85
Plebeya sp. (aff. flavoscutellata)	+		+				29
Geotrigona leucogastra chiriquiensis	+			+			36
Partamona grandipennis	+				+		1
Scaptotrigona mexicana subobscuripennis	+			+			81
Melipona fasciata melanopleura	+	+					60

At lower altitudes a greater diversity of stingless bee species was found. In our sample, 17 species were present at 200-1000 m altitude, and 6 at an altitude of 1200-1500 m. These data are confirmed by the specimens of the UCR collection, where 19 of the species were collected at 200 m, and 6 at altitudes of more than 1000 m. So far, only *Partamona grandipennis* has been collected exclusively in Costa Rica at high elevations. However, this observation is based on the collection of only five specimens. At low elevations only *Tetragona perangulata* was found.

If both tables are compared, it is noted that the 12 species collected for this study have a different distribution from what can be observed of the same species of the UCR collection. That means that they were collected at a higher altitude than we did (6) or at lower elevations (6). Next to the fact that the method

of collecting may have influenced it, this is also a clear indication that more factors than the mere altitude influence the distribution of species. For instance, *M. fasciata melanopleura* was found exclusivey in tropical humid forests, and, therefore is not likely to occur in the tropical dry forest of Pozo Azul (Guanacaste). This also indicates that some stingless bee species demonstrate a tolerance to cold. There were six in the altitudinal transect studies: *Trigona corvina*, *Partamona aff. cupira*, *Trigona fulviventris fulviventris*, *Partamona grandipennis*, *Scaptotrigona mexicana subobscuripennis* and *Melipona fasciata melanopleura*. *Tetragonisca angustula* and *Trigona amalthea* were collected by A. Willie in 1959 and, respectively, in 1960 at two sites, at an elevation of more than 1000 m. These 8 species demonstrate a relative tolerance to cold, since the average annual temperature at these elevations in Costa Rica is generally below 20 ^{O}C (HOLDRIDGE, 1967). Therefore, our data confirm the hypothesis formulated by ROUBIK (1989): that stingless bees demostrate a tolerance to cold, and that it is more likely that the distribution of stingless bees is exclusively tropical more because of the lack of suitable nesting sites and of plant resins than for climatological reasons.

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