



SHORT NOTE

Foraging Activity of *Xylocopa cearensis* (Ducke) in Sand Dune Landscape

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Abstract

Bees foraging strategy is affected by the distribution and abundance of flower resources, mainly nectar and pollen. Homing time of female *Xylocopa cearensis* (Ducke) bees to their nests was assessed through a simple translocation method. The hypothesis addressed was that resource distribution in the landscape level influences bee homing time. The study area comprises about 300ha in a sand dune field with patchy shrubs in Salvador, Bahia, Brazil. The mean homing time after translocation was 60min (sd = 4.36min; n = 03), except for one bee that did not returned. The translocation technique was successfully applied to large solitary bees, since they do return to their own nest and can be easily recognized when arriving. Also, a bee returned carrying pollen, what suggests foraging activity after translocations. Results evidence landscape functional connectivity since bees were able to move through local habitats. Further studies should address movement cost tradeoffs and its consequences on bee diversity conservation.

Bees foraging strategy is affected by the local distribution and abundance of flower resources, mainly nectar and pollen. The solitary bee *Xylocopa cearensis* (Ducke) is large (>10 mm) and long-flying (Pasquet et al., 2008) and thus is more likely to move between patchy sand dunes of Restinga vegetation (Pinto et al., 1984), which is naturally fragmented and associated to the Atlantic forest domain. This ecosystem combines patchy bushy vegetation and harsh environmental conditions (high speed winds, intense solar radiation and salinity) that can be influential to the foraging range of *X. cearensis* which is locally abundant and the main pollinator of many plants (Viana et al., 2002; Viana et al., 2006). Bee's essential resources (food, mates and nesting material) must be achieved within foraging range from their nests, causing a tradeoff between trophic resource profit and energy cost to bridge some temporal and spatial distance.

This study addresses the hypothesis that both clumped food resources and nesting sites distribution may influence interpatch movement of *X. cearensis* within a landscape. We used translocation experiments to assess the flight range and the homing-time of female bees of *X. cearensis* to their nests. The study area comprises 300ha in a sand dune field in Salvador, Bahia (12°55'07.19"S and 38°19'03.78"O), Brazil (Fig 1). According to Köppen classification, the local climate is tropical hot, humid, with annual average temperature of 25.8 °C, mean relative humidity of 81%, and monthly rainfall of 175.03 mm. Nests were located following a previous study (Silva & Viana, 2002) and new records. From seven nesting sites, active nests were selected by chance and the spontaneous flight of individual female bees were recorded. During observations mean temperature was 31.95 °C (sd = 2.35), UR was 62.63% (sd = 2.70) and cloudiness ranged from sunny



to > 70%, during three days, from January 11th to 13th, 2009, between 05:25 am and 01:30 pm. Based on microclimate and flight activity data, the translocation experiments were performed on April 20th and July 2nd, 12th and 20th, 2009, between 05:30 am and 09:30 am, during the period of highest bee foraging activity. Translocations were performed from nests located at 12 nesting sites (Table 1), with mean distance of 490.16 m (sd = 362.50; range = 7.07 to 942.23 m). Bees were collected at nest entrance using a piece of a transparent plastic tube (aprox 10 -15 cm long x 2 cm wide), wide enough for the individual bee to walk inside of it, and closed with plastic lids. The nest entrance and thorax of female bees were marked with white nail polish before translocation, becoming distinguishable at returning. Bees were translocated to three distances (200 m, 400 m and 600 m) in randomly chosen directions, comprising the most common spectrum of flight range, but yet below the maximum spontaneous displacement to allow nest returning (Pasquet et al., 2008). Also, distances allowed bees to forage only in resting area, preventing them to be translocated into anthropogenous surrounding habitats. A return event was recorded when it came back to the nest, but if no return was detected after 24 hours of release, it was recorded as no return. To be sure that only active females were translocated we first inducted females to fly out of the nest by slightly attacking against the nested branch with a wooden stick. We recorded the time of bee capture, the time of release after translocation, and the time the bee returned to the original nest (detected through continuous focal observation).

For each distance four female bees were translocated, each taken from a different nest entrance and mostly from different nest sites (Table 1). Data were analyzed using the observed homing times after release, which were compared using a one-tailed *t*-test and a Cox proportional hazards survival analysis (Cox, 1972) using Survival Package (R version 3.1.2 software). The explanatory variable was the translocation distance and the dependent variable was the homing time and return success rate (proportion of returned individuals) per unit time for each translocation distance. Bees that did not return were considered as right censored (incomplete) data (Cox, 1972). Spontaneous female flights from natural nests started from 5:41 to 9:23 min and finished from 12:05 - 13:20 pm, with higher intensity from dusk to 10:30 am. Foraging trips ranged from 1 min to 58 min, with an average homing time of 19.62 min (sd = 15.74, n = 41 foraging trips). Similarly, Camillo et al., (1986) found that flight duration of *X. suspecta* females varied from 5 to 37 minutes (18.3 ± 9.2 min), although daily flights occurred throughout the day, with a higher frequency between 4 and 5 pm. The mean homing time after translocation, in all distances was greater than spontaneous flight and one female did not return after 400 m translocation, indicating that bees may have faced harsher conditions or longer homing distances with the translocation than expected for natural flights. Just one bee translocated at 400 m returned carrying pollen, suggesting that foraging activity is possible after translocations, since none carried any pollen before release. These large solitary bees were

Table 1. Main results from translocation experiments from natural nests of *Xylocopa cearensis*, in sand dunes, Salvador, Bahia.

Distance (m)	Nest site	Nest Location (UTM 24S)	Number of nests	Number of bees	% of returning	Mean time (sd)	Time range (Min. and Max.)
50	N5(2)**	573893 and 8571829	4	4	100	31.5 (39.37)	7-89
	N9	574099 and 8572535					
	N15	573919 and 8572542					
200	N7	573857 and 8571759	4	4	100	28 (21.57)	5-57
	N6	573862 and 8571754					
	N8	573849 and 8571768					
	N16	573963 and 8572612					
400	N2	573820 and 8571850	4	4	75	49.3 (44.02)	6-94
	N7*	573857 and 8571759					
	N11	574039 and 8572528					
	N17	573940 and 8572693					
600	N2	573820 and 8571850	4	4	100	62 (25.73)	35-93
	N3	573823 and 8571824					
	N10	574095 and 8572581					
	N15	573919 and 8572542					

* female did not return

** two bees were taken from two different nests

successfully translocated, since they returned to their nest and could be easily recognized when arriving. Although tests show no clear relation between translocation distance and homing time, the preliminary results provide experimental evidence of the functional connectivity within restinga landscape, since bees were able to overcome local interpatch distances (Fig 1), although with lower efficiency than spontaneous flights. The decrease in probability and higher return time is expected when foragers are released in distant areas they are not familiar with. There was a tendency of bees to return earlier when released from 50 and 200 m distances than when released further away from their nests, although all tested distances comprise their common range (Fig 2). Also, it is evidence that bees may forage across local habitats. Previous studies on foraging paths of *X. cearensis* in shrub patches, found that bees stay longer and visit more flowers in a single patch because resources are clumped (Costa et al.,

2002; Pigozzo et al., 2007; Ramalho & Rosa, 2010; Freire & Pigozzo, 2014), because of high individual or flower density than other species (Viana et al., 2002; Viana & Kleinert, 2006). In the case which at least part of the individuals of the bee population has small foraging range, then local habitat structure and their interpatch distances are very meaningful for conservation purposes. Therefore, maintaining the diversity of habitat patches in sand dunes within a landscape level is essential to retain bee diversity and pollination services. Further studies should include more individuals and greater distances such as 1000 m to provide evidence that the harsh environment and clumped floral resources, may favor short foraging distances as found for other bees (Gathmann & Tschantke, 2002; Zurbuchen et al., 2010). Studies addressing such tradeoff and its consequences on movement patterns and service delivery for *Xylocopa* bees in restinga environment are still needed.

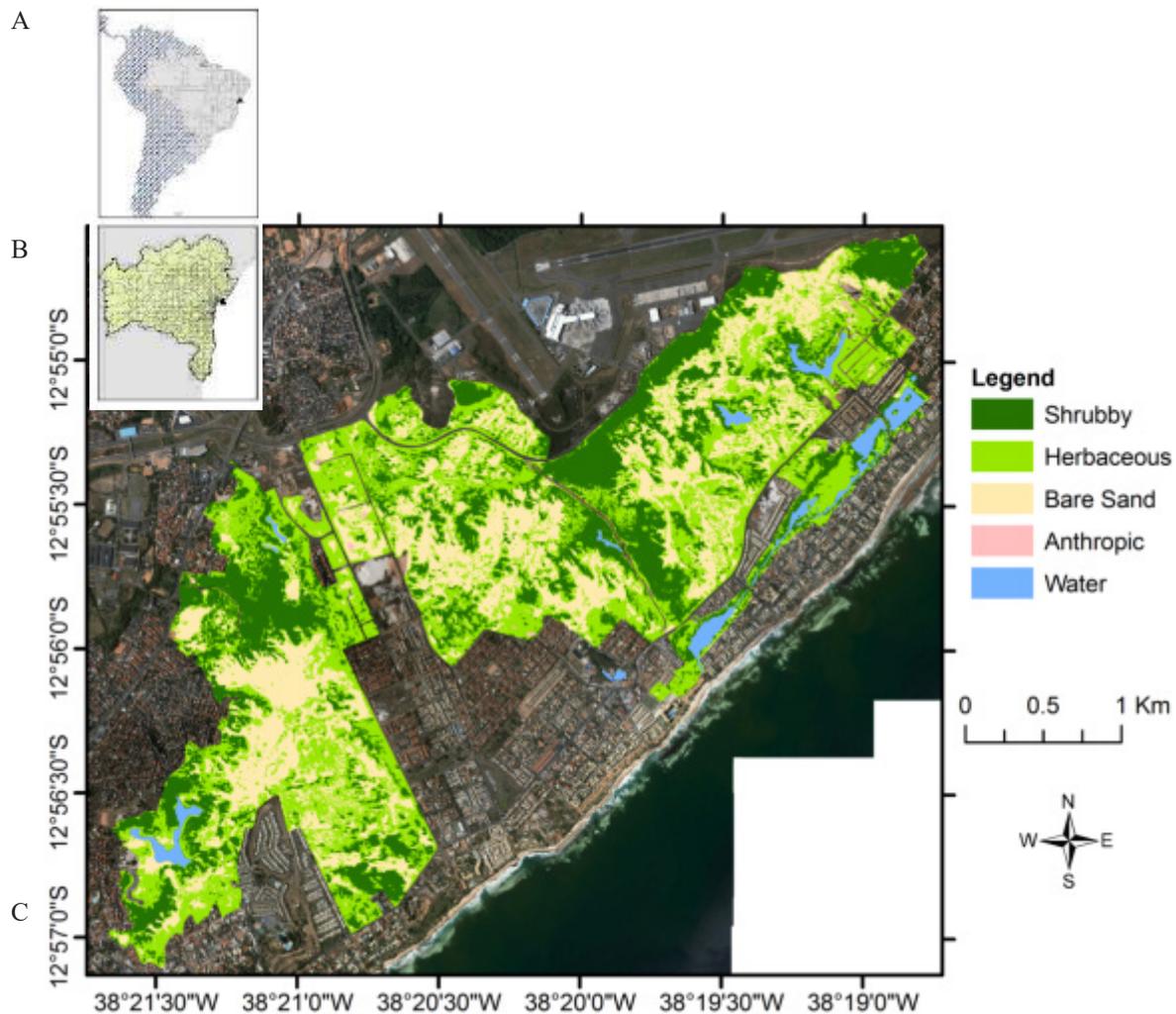


Fig 1. Location of the study site: A – in relation to Brazil, B – Bahia State and C – and geographical range of the Environmental Protection Area of Abaeté sand dunes (1.800 ha) showing the types of natural habitats of the landscape. Translocation experiments were performed in nests located in the northern part (upper area), comprising 300 ha (Map: Eduardo F. Moreira)

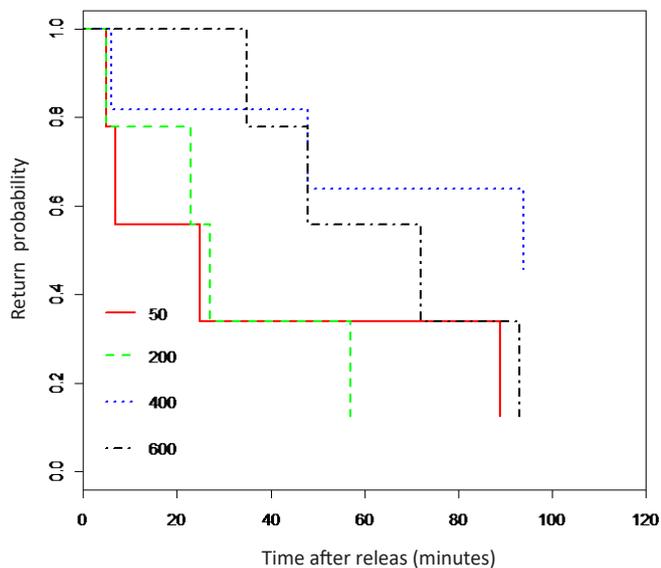


Fig 2. Homing times of individual females of *X. cearensis* after translocation according to translocation distance, estimated from the Cox Proportional Hazards Model. Time limit used was 120 m for better graph visualization, as no bee took more than this time to return and exploratory tests performed using 240 and 280 m did not change the results. (N = 17 female bees, including one that did not return at 400 m release). Data are not statistically significant because of low sample size, but two groups with different mean return time can be seen, one with the two shorter distances and shorter times and the other with the longer distances and times.

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