Oecologia Australis
14(1): 232-237, Março 2010
doi:10.4257/oeco.2010.1401.13

RESIDUAL POLLEN IN NESTS OF *Centris analis* (HYMENOPERA, APIDAE, CENTRIDINI) IN AN AREA OF CAATINGA VEGETATION FROM BRAZIL

Marcos da Costa Dórea [1], Cândida M. L. Aguiar [2,], Luís E.R. Figueroa [3], Luciene C. Lima e Lima [3] & Francisco de Assis R. dos Santos [1,2]*

[1] Programa de Pós-Graduação em Botânica, Universidade Estadual de Feira de Santana. Av. Transnordestina, s/n, Novo Horizonte. Feira de Santana, BA, Brazil. CEP: 44036-900.

[2] Departamento de Ciências Biológicas, Universidade Estadual de Feira de Santana. Av. Transnordestina, s/n, Novo Horizonte. Feira de Santana, BA, Brazil. CEP: 44036-900.

[3] Departamento de Ciências Exatas e da Terra, Universidade do Estado da Bahia, Campus II. Caixa-postal: 59. Alagoinhas, BA, Brazil. CEP: 48040-210.

E-mails: mcdorea@gmail.com, candida.aguiar@gmail.com (*), lerfyn@yahoo.com.br, llima@gd.com.br, fasantos@uefs.br

ABSTRACT

Information is presented concerning pollen stored in nests of *Centris analis*, a native Brazilian bee species important as a potential pollinator of tropical fruit trees. Sampling was performed in an area of hyperxerophytic caatinga shrub vegetation in the "Estação Biológica de Canudos" (Canudos Biological Station - EBC), Bahia State, Brazil. The pollen spectrum present in the nests of *C. analis* was determined by examining the pollen residues found on the walls of the larval cells and in feces incorporated into the construction of the nests. The pollen spectrum in the studied nests (n=5) of *C. analis* was composed of a total of six pollen types, of which *Byrsonima vacciniifolia* (45.98%) and *Chamaecrista ramosa* (44.73%) demonstrated the highest occurrence frequencies. The pollen types *C. ramosa*, *Banisteriopsis muricata* and *Byrsonima vacciniifolia* also appear to be important resources for C. analis in the caatinga vegetation at the EBC. The presence of the pollen type Rhaphiodon echinus probably indicates a nectar source used by C. analis during specific periods. C. analis utilized only a fraction of the resources available in the EBC, and the plants reported here are new registers of food sources for *C. analis* in the Brazilian semiarid region.

Keywords: Entomopalynology; pollen; solitary bees; pollinator.

RESUMO

POLEN RESIDUAL EM NINHOS DE *Centris analis* (HYMENOPERA, APIDAE, CENTRIDINI) EM UMA ÁREA DE VEGETAÇÃO DE CAATINGA NO BRASIL. Neste trabalho são apresentados dados sobre o pólen estocado em ninhos de *Centris analis*, uma espécie de abelha nativa candidata ao manejo com vistas à polinização de fruteiras. Este tipo de informação é fundamental para o desenvolvimento de sistemas de manejo de polinizadores. A amostragem foi conduzida em vegetação de caatinga hiperxerófila arbustiva, na Estação Biológica de Canudos (EBC), ecorregião do Raso da Catarina, Bahia, Brasil. O espectro polínico presente nos ninhos de *C. analis* foi estudado a partir da análise do resíduo do pólen presente nas paredes das células de cria e nas fezes incorporadas aos casulos. O espectro polínico total nos ninhos (n=5) de *C. analis* foi composto por seis tipos polínicos, dos quais *Byrsonima vacciniifolia* (45,98%) e *Chamaecrista ramosa* (44,73%) tiveram maiores médias de freqüência de ocorrência. Os tipos *C. ramosa*, *B. vacciniifolia* e *Banisteriopsis muricata* podem ser apontados como fontes de pólen importantes para *C. analis* na caatinga da EBC. O tipo polínico *Rhaphiodon echinus* provavelmente indica uma fonte de néctar regularmente utilizada por *C. analis* naquele período. *C. analis* utilizou apenas uma fração dos recursos disponíveis. As fontes de recursos florais registradas neste estudo na Estação Biológica de Canudos são novos registros de plantas alimento de *C. analis* para a região do semiárido brasileiro.

Palavras-chave: Entomopalinologia; pólen; abelhas solitárias; polinizadores.

RESUMEN

POLEN RESIDUAL EN NIDOS DE *Centris analis* (HYMENOPERA, APIDAE, CENTRIDINI) EN UN ÁREA DE VEGETACION DE CAATINGA EN BRASIL. En este trabajo se presenta información acerca del polen almacenado en nidos de *Centris analis*, una especie de abeja nativa, considerada de importancia por su carácter de potencial polinizador de árboles frutales tropicales. El muestreo fue realizado en la vegetación de caatinga hiperxerófila arbustiva en la "Estação Biológica de Canudos" (EBC), ecorregión de Raso da Catarina, Bahía, Brasil. Se estudió el espectro polínico presente en los nidos de *C. analis* a partir del análisis de residuos de polen presentes en las paredes de las células larvales y en las fecas incorporadas en la construcción de los nidos. El espectro polínico total de los nidos de *C. analis* (n=5) estuvo compuesto por seis tipos polínicos, de los cuales *Byrsonima vacciniifolia* (45.98%) y *Chamaecrista ramosa* (44.73%) presentaron las frecuencias de ocurrencias más altas. Los tipos de polen *C. ramosa, Banisteriopsis muricata* y *Byrsonima vacciniifolia* también pueden ser considerados como importantes fuentes de polen de *C. analis* en la vegetación de caatinga en el EBC. La presencia del tipo de polen *Rhaphiodon echinus* probablemente indica una fuente de néctar utilizada por *C. analis* durante períodos específicos. *C. analis* utilizó sólo una fracción de los recursos disponibles. Cabe destacar que las especies de plantas reportadas en este trabajo (en el EBC), constituyen nuevos registros de fuentes de alimento para *C. analis* en la región semiárida de Brasil.
Palabras clave: Entomopalinología; polen; abejas solitarias; polinizadores.

INTRODUCTION

The analysis of larval provisions provides a good deal of quantitative and qualitative information about the use of local floral resources by bees. The methodologies described here have not yet been widely employed in studying the floral resources utilized by solitary Brazilian bees, and only a few Brazilian species of *Centris* have been examined, including *C. flavifrons* (Rêgo *et al*. 2006), *C. maranhensis* (Ramos *et al*. 2007), *C. tarsata* (Mendes & Rêgo 2007, Dórea *et al*. 2009), and *C. analis* (Oliveira & Schlindwein 2009).

The recent development of a precise method for analyzing pollen residues contained in the substrates composing the brood cells and in the bee's feces (Dórea *et al*. 2009) has aided palynological studies of cavity-nesting bees. Information is presented here concerning the pollen spectrum found in nests of *Centris analis*, a native Brazilian bee species potentially manageable for commercial fruit tree pollination, especially acerola (*Malpighia emarginata* DC.) plantations (Oliveira & Schlindwein 2009). Very little information is currently available concerning the floral resources utilized by *C. analis* (see Quiroz-Garcia *et al.* 2001, Gaglianone 2003 and Oliveira & Schlindwein 2009), mainly in the semiarid region of northeastern Brazil (Aguiar *et al*. 2003). This type of knowledge is fundamental for developing pollinator management systems because it is essential to identifying food resources that can maintain bee populations with alternative pollen, nectar and/or oil resources when necessary.

MATERIALS AND METHODS

The field study was carried out at the Canudos Biological Station (CBS) (09º56'40.9" S x 39º00'55.7" W), situated in the municipality of Canudos, in the Raso da Catarina eco-region, Bahia State, Brazil. The CBS is characterized by a predominantly shrub hyperxerophytic *caatinga* vegetation. The regional climate is tropical semiarid, with an average annual temperature of 24 ºC and an average total yearly rainfall of 454 mm (SEI 1998).

The pollen spectrum present in the nests of *C. analis* was examined by analyzing pollen residues on the walls of the brood cells and in the feces incorporated into the cocoon. Nests were obtained by offering trap-nests (cardboards straws, 0.8 x 10.5cm) inserted into holes drilled through wooden boards; short lengths (1.5 x 17cm) of bamboo internodes were also used, as described by Aguiar *et al.* (2005). A total of 224 trap-nests were made available to the bees in two sampling sites in the CBS, and subsequently monitored on a monthly basis for 36 months (January/2004 to December/2006). Any nests built by the bees were removed to the laboratory

(LAMIV/UEFS) and emerging adults were sacrificed and deposited in the Johann Becker Entomological Collection of the Museu de Zoologia da Universidade Estadual de Feira de Santana (MZUEFS).

After emergence of the adults, the nests were submitted to chemical treatments to remove the pollen residues, as described by Dórea *et al*. (2009). The treated residues from each nest were mounted in glycerinated gelatin on seven slides (five of which had glycerinated gelatin containing safranin stain).

Pollen type identifications and quantitative analyses were performed on at least 1,000 pollen grains per sample, following Vergeron (1964). The occurrence frequency of each pollen types in each nest analyzed was calculated, as well as the averages of the frequencies of each pollen type among the samples, following Villanueva-Gutiérrez & Roubik (2004).

RESULTS

During research period, *Centris analis* females built their nests in five of the cardboard straws displayed. No nests were built inside the bamboo internodes. All five nests were obtained in July 2004. The total pollen spectra found in these nests comprised six pollen types from four plant families (Table 1). All of the pollen types had their botanical affinity identified.

The average occurrence frequencies of the different pollen types in the five nests of *C. analis* (Table 1) indicated that *Byrsonima vacciniifolia* and *Chamaecrista ramosa* were most frequent the pollen types (representing 45.98% and 44.73% of all of the pollen grains counted, respectively).

While an over-all total of six different pollen types were encountered in the five nests analyzed (Figure 1), the number of pollen types per nest varied from three in nest III to five in nest V. Two nests (I and II) contained almost exclusively a single pollen source, with the pollen type *C. ramosa* being responsible for more than 90% of their frequencies. In the other three nests, the main pollen type (*B. vacciniifolia*) had frequencies varying from 64 to 83%, but it was complemented by one or two accessory pollen types. The pollen type *Banisteriopsis muricata* (family Malpighiaceae) presented frequencies between 8 and 15% in three of the five nests analyzed, suggesting it represents an important species as complementary pollen source for *C. analis*.

DISCUSSION

The analyses of the occurrence frequencies of the different pollen types in the nest samples indicated that the types *Chamaecrista ramosa, Banisteriopsis muricata* and *Byrsonima vacciniifolia* are important pollen sources for *C. analis* in the *caatinga* vegetation at the CBS. The latter two types are from species of the family Malpighiaceae, which also provides floral oils (as does *Peixotoa hispidula* A. Juss.). *C. analis* has been reported to collect floral oils or pollen from numerous genera of Malpighiaceae, including *Byrsonima*, *Malpighia*, *Bunchosia*, *Hiraea* and *Stigmaphyllon* (Teixeira & Machado 2000, Quiroz-

Table 1. Frequency of occurrence (%, FO) of the pollen types in *Centris analis* nests in the Canudos Biological Station, Bahia State, Brazil.

Pollen types	Nests					Average
	I	II	III	IV	V	FO
Asteraceae						
Conocliniopsis prasiifolia	0.09					0.02
Lamiaceae						
Rhaphiodon echinus	3.17	2.17		0.96	0.34	1.33
Leg.-Caesalpiniaceae						
Chamaecrista ramosa	93.93	95.95		25.26	8.49	44.73
Malpighiaceae						
Banisteriopsis muricata	2.71	1.79	14.59	9.00	8.16	7.25
Byrsonima vacciniifolia	0.09	0.09	82.56	64.11	83.01	45.98
Peixotoa hispidula			2.85	0.67		0.70

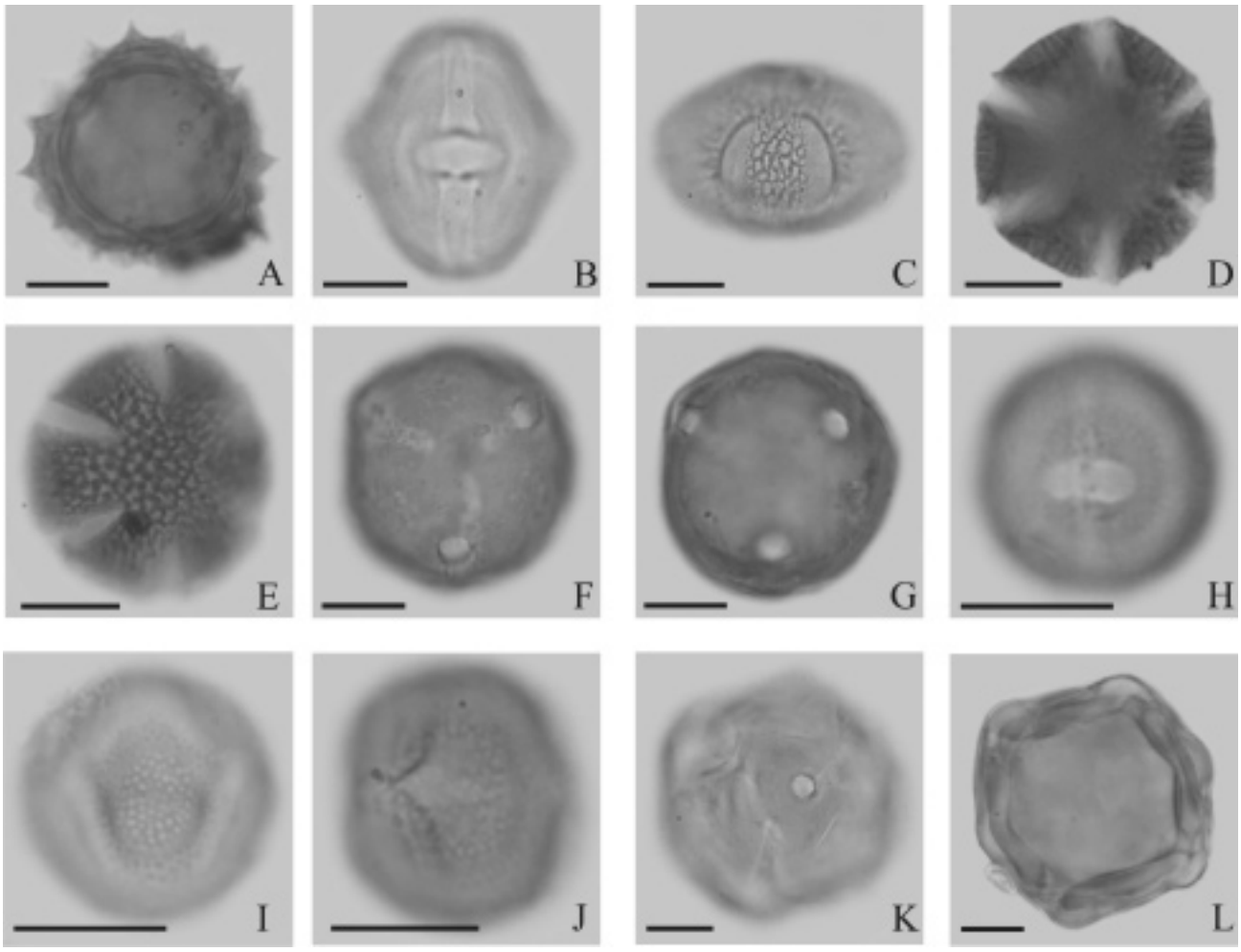

Figure 1. Pollen types found in the nests of the solitary bee *Centris analis*. A. *Conocliniopsis prasiifolia* (Asteraceae). B. *Chamaecrista ramosa* (Leguminosae). C-E. *Raphiodon echinus* (Lamiaceae). F-G. *Banisteriopsis muricata* (Malpighiaceae). H-J. *Byrsonima vacciniifolia* (Malpighiaceae). K-L. *Peixotoa hispidula* (Malpighiaceae). (Bar scale = 10 μm)

Garcia *et al.* 2001, Gaglianone 2003, Oliveira & Schlindwein 2009). Oils represent an important resource for the reproductive activities of *C. analis* as the females use this oily material to line the internal surfaces of the brood cells (Jesus & Garófalo 2000).

Chamaecrista ramosa is an important pollen-producing plant of the Leguminosae family that has flowers with poricidal anthers that are very attractive to species of *Centris* bees (Aguiar *et al*. 2003). In examining nests of *Centris tarsata*, Dórea *et al.* (2010) found the pollen type *C. ramosa* as well as the types *C. nictitans* and *C. swainsonii*, are all which are from the same plant group. The Leguminosae is considered one of the most important plant families of the *caatinga* (Costa *et al*. 2002), and representatives of the family offer considerable quantities of resources for the bees in the *caatinga*, often during periods when the resources of other plant families are very scarce. Within Leguminosae, many species of subfamily Caesalpinioideae have poricidal anthers, such as *Chamaecrista ramosa* (Vogel) H.S.Irwin & Barneby, from which *Centris* individuals extract pollen grains by buzzing (a necessary ability for legitimate pollen collection from these anthers).

The pollen type *Rhaphiodon echinus*, while present in only low frequencies, was recorded in various nests and is probably a regular source of nectar (Santos *et al.* 2006) for *C. analis*. Nectar is an important food resource for *C. analis* larvae and it is collected during up to eight foraging trips after concluding brood cells provisioning with pollen (according to Jesus & Garófalo 2000). This same pollen type was encountered among the majority of the pollen samples stored by *Apis mellifera* L. examined by Novais *et al.* (2009) in the CBS.

In spite of the sampling effort made in the present study, the number of pollen types recorded for *C. analis* nests was relatively small. This may be due, in part, to the concentration of their nesting activities in only a single month (July) and to the small number of

nests obtained. As in our study, *C. analis* made few or no nests in trap-nests in other areas of the Brazilian semiarid (Aguiar *et al*. 2005a, Schlindwein *et al.* 2006). *C. analis* was also absent in samples collected in flowers from different localities in the semiarid region (Aguiar & Martins, 1997, Aguiar & Zanella 2005, Aguiar *et al*. 2005b). The information available suggests that this species is not very abundant in this region.

Although only a few nests could be analyzed, it was evident that *C. analis* utilized only a fraction (six pollen types) of the available pollen resources. The flora of the CBS is rich in plant species that are known to produce floral resources (Silva 2007), and a total of 15 pollen types were encountered in the nests of *Centris* species in this area in July 2004 (Dórea 2007; Dórea *et al.* 2010). The pollen types *Anemopaegma laeve*, *Mimosa filipes*, *Spermacoce* sp., *Arrabidaea parviflora*, *Capparis yco*, *Krameria tomentosa*, *Caesalpinia microphylla*, *Senna rizzini* and *Psittacanthus bicalyculatus* were found in nests of *C. tarsata* (Dórea *et al.* 2010) or *C. trigonoides* (Dórea 2007), but not in nests of *C. analis* in July 2004.

Oliveira & Schlindwein (2009) analyzed the pollen spectrum of 18 brood cells of *C. analis* and found, in addition to the pollen of *Malpighia emarginata*, only two pollen types (*Solanum* spp) in one site, and five pollen types in other site. They pointed out the notable fidelity of *C. analis* to collecting pollen from *M. emarginata* when these bees were nesting in acerola orchards (or in agro-forest environments with acerola plants), even though there were many other plant species in the same orchard (or very near by) offering pollen resources. Quiroz-Garcia *et al*. (2001)) found 17 pollen types in four nests of *C. analis* and other six different pollen types were obtained from the scopal contents of six females, in a tropical deciduous forest (Jalisco, México). These authors concluded that *C. analis* should be classified as polylectic, without a strong preference for any single plant family.

The present study in the CBS identified new important plant species to the diet of *C. analis* in the semiarid region of northeastern Brazil. In spite of recent efforts (Schlindwein *et al*. 2006, Oliveira & Schlindwein 2009, and the present study), however, our knowledge of the food resources needed to maintain *C. analis* populations is still very limited, and it will be needed to widen the sampling area in future investigations to generate data on a regional scale that can aid in the management of these bees as pollinators of fruit trees in northeastern Brazil on a commercial scale.

ACKNOWLEDGEMENTS: The authors would like to thank Dr. Favízia O. Freitas for identifying the bee species; the Fundação Biodiversitas for the permission to undertake this research in the CBS; the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for the grant awarded to FAR Santos (Proc. 304545/2007-4) and for financing this project (Proc. 555102/2008-4); as well as the Fundação de Amparo à Pesquisa do Estado da Bahia (FAPESB) for financial support for this project (Proc. AP0116/2007).

REFERENCES

AGUIAR, C.M.L & MARTINS. C.F. 1997. Abundância relativa, diversidade e fenologia de abelhas (Hymenoptera, Apoidea) na caatinga, São João do Cariri, Paraíba, Brasil. *Iheringia*, Ser. Zool. 83:151-163.

AGUIAR, C.M.L.; ZANELLA, F.C.V.; MARTINS, C.F. & CARVALHO, C.A.L. 2003. Plantas visitadas por *Centris* spp (Hymenoptera, Apidae, Centridini) para obtenção de recursos florais na caatinga. *Neotropical Entomology*, 32(2): 247-259.

AGUIAR, C.M.L. & ZANELLA, F. 2005. Estrutura da comunidade de abelhas (Hymenoptera: Apoidea: Apiformis) de uma área na margem do domínio da caatinga (Itatim, BA). *Neotropical Entomology*, 34:15-24.

AGUIAR, C.M.L.; GARÓFALO, C.A. & ALMEIDA, G.F. 2005a. Trap-nesting bees (Hymenoptera, Apoidea) in areas of dry semideciduous forest and caatinga, Bahia, Brazil. *Revista Brasileira de Zoologia*, 22(4): 1030-1038.

AGUIAR, C.M.L.; GIMENES, M. & REBOUÇAS, P.L. de O. 2005b. Abelhas (Hymenoptera, Apoidea). Pp 259-281. *In*: F.A. Juncá, L. Funch & W. Rocha (orgs.). Biodiversidade e Conservação da Chapada Diamantina. Ministério do Meio Ambiente, Brasília, 435p.

COSTA, J.A.S.; NUNES, T.S. & FERREIRA, A.P.L.; STRADMANN, M.T.S.; QUEIROZ, L.P. 2002. *Leguminosas forrageiras da caatinga: espécies importantes para comunidades rurais do sertão da Bahia*. Feira de Santana, Universidade Estadual de Feira de Santana (UEFS) e Serviço de Assessoria a Organização Populares Rurais (SASOP), 112p.

DÓREA, M. da C. 2007. *O pólen armazenado por abelhas solitárias (Apidae, Centridini): estudo em uma área de caatinga na Bahia*. Dissertação de Mestrado. UEFS, Feira de Santana, Bahia, Brasil, 76p.

DÓREA, M. da C.; SANTOS, F.A.R.; LIMA, L.C.L. & FIGUEROA, L. 2009. Análise Polínica do Resíduo Pós-emergência de Ninhos de *Centris tarsata* Smith (Hymenoptera: Apidae, Centridini). *Neotropical Entomology*, 38(2): 197-202

DÓREA, M. da C.; AGUIAR, C.M.L.; FIGUEROA, L.E.R., LIMA e LIMA, L.C. & SANTOS, F.de A.R. dos. 2010. Pollen residues in nests of *Centris tarsata* Smith (Hymenoptera, Apidae, Centridini) in a tropical semiarid area in NE Brazil. *Apidologie* (in press)

GAGLIANONE, M.C. 2003. Abelhas da tribo Centridini na Estação Ecológica de Jataí (Luís Antonio, SP): Composição de espécies e interações com flores de Malpighiaceae. Pp. 279-284. *In*: G.A.R. Melo & I.A. Santos (eds.). Apoidea Neotropica: Homenagem aos 90 anos de Jesus Santiago Moure. Criciúma, UNESC, 320p.

JESUS, B.M.V. & GARÓFALO, C.A. 2000. Nesting behaviour of *Centris (Heterocentris) analis* (Fabricius) in southeastern Brazil (Hymenoptera, Apidae, Centridini). *Apidologie*, 31: 503-515

MENDES, F.N. & RÊGO, M.M.C. 2007. Nidificação de *Centris (Hemisiella) tarsata* Smith (Hymenoptera, Apidae, Centridini) em ninhos-armadilha no Nordeste do Maranhão, Brasil. *Revista Brasileira de Entomologia* 51: 382-388.

NOVAIS, J. S.; LIMA, L.C.L. & SANTOS, F.A.R. 2009. Botanical affinity of pollen harvested by *Apis mellifera* L. in a semi-arid area from Bahia, Brazil. *Grana*, 48:224-234.

OLIVEIRA, R. & SCHLINDWEIN, C. 2009. Searching for a manageable pollinator for acerola orchards: the solitary oil-collecting bee *Centris analis* (Hymenoptera: Apidae: Centridini). *Journal of Economic Entomology*, 102:265-273.

QUIROZ-GARCIA, D.L.; MARTINEZ-HERNANDES, E.; PALACIOS-CHAVEZ, R. & GALINDO-MIRANDA, N.E. 2001. Nest provisions and pollen foraging in three species of solitary bees (Hymenoptera: Apidae) from Jalisco, Mexico. *Journal of the Kansas Entomological Society*, 74(2):61-69.

RAMOS, M.; MENDES, F.; ALBUQUERQUE, P. & RÊGO, M. 2007. Nidificação e forrageamento de *Centris* (*Ptilotopus*) *maranhensis* Ducke (Hymenoptera, Apidae, Centridini). *Revista Brasileira de Zoologia*, 24(4): 1006-1010.

REGO, M.M.C.; ALBUQUERQUE, P.M.C.; RAMOS, M.C. & CARREIRA, L. M. 2006. Aspectos da Biologia de Nidificação de *Centris flavifrons* (Friese) (Hymenoptera: Apidae, Centridini), um dos Principais polinizadores do Murici (*Byrsonima crassifolia* L. Kunth, Malpighiaceae), no Maranhão. *Neotropical Entomology*, 35(5): 579-587.

SANTOS, F.A.R.; OLIVEIRA, J.M.; OLIVEIRA, P.P.; LEITE, K.R.B.; CARNEIRO, C.E. 2006. Plantas do semi-árido importantes para as abelhas. Pp. 61-86. *In*: SANTOS, F.A.R. (ed.). Apium Plantae. Recife, Ministério da Ciência e Tecnologia, Série IMSEAR, vol. 3, 130p.

SCHLINDWEIN, C.; MARTINS, C.F.; ZANELLA, F.C.V.; ALVES, M.V.; CARVALHO, A.T.; DARRAULT, R.O.; DUARTE JR., J.A.; OLIVEIRA, M.D.; FERREIRA, A.G., GUEDES, R.S.; FERREIRA, R.P.; PINTO, C.E.; SILVEIRA, M.S. & VITAL, M.T.A.B. 2006. Diagnóstico e manejo dos polinizadores de mangabeira e aceroleira. *In*: Anais do VII Encontro sobre abelhas, USP, Ribeirão Preto, SP, Simpósio 16, em CD-ROM, 850p.

SEI (SUPERINTENDÊNCIA DE ESTUDOS ECONÔMICOS E SOCIAIS DA BAHIA), 1998. *Atributos climáticos do estado da Bahia*. Salvador, Secretaria de Planejamento do Estado da Bahia. Série Estudos e Pesquisas, v. 38, 85p.

SILVA, F.H.M. 2007. *Contribuição à palinologia das caatingas*. Tese de Doutorado, UEFS, Feira de Santana, Bahia, Brasil. 178p.

TEIXEIRA, L.A.G. & MACHADO, I.C. 2000. Sistema de Polinização e Reprodução de *Byrsonima sericea* DC (Malpighiaceae). *Acta Botanica Brasílica*, 14(3): 347-357.

VERGERON, P. 1964. Interprétation statistique des résultats en matière d'analyse pollinique des miels. *Annales de l´Abeille* 7(4): 349-364.

VILLANUEVA-GUTIÉRREZ R. & ROUBIK, D.W. 2004. Pollen sources of long-tongued solitary bees (Megachilidae) in the Biosphere Reserve of Quitana Rôo, México. Pp. 185-190. *In*: B.M. Freitas & J.O.P. Pereira (eds.). *Solitary bees: conservation, rearing and management for pollination.* Imprensa Universitária, UFC, Fortaleza, Brasil, 285p.

Submetido em 29/06/2009

Aceito em 28/01/2010