Brazilian Journal of Biology®

ISSN 1519-6984 (Print)
ISSN 1678-4375 (Online)

Notes and Comments

The role of secondary restinga forests in the conservation of *Dichotomius schiffleri* (Coleoptera: Scarabaeinae)

A. S. Brito[a], D. M. Costa[b], I. Barros[c], M. H. G. Dompieri[d] and A. V. Teodoro[a,b,e]*

[a]Universidade Federal de Sergipe – UFS, Departamento de Agronomia, Laboratório de Entomologia, Programa de Pós-graduação em Agricultura e Biodiversidade, São Cristóvão, SE, Brasil

[b]Universidade Estadual do Maranhão – UEMA, Departamento de Ciências Agrárias, Programa de Pós-graduação em Agroecologia, Laboratório de Entomologia, São Luís, MA, Brasil

[c]Embrapa Gado de Leite, Juiz de Fora, MG, Brasil

[d]Embrapa Territorial, Campinas, SP, Brasil

[e]Embrapa Tabuleiros Costeiros, Aracaju, SE, Brasil

The dung beetle *Dichotomius schiffleri* Vaz-de-Mello, Louzada & Gavino, 2001 is restricted to the Brazilian restinga ecosystem (Vaz-De-Mello et al., 2001; Vieira et al., 2011). Evidence suggests that this beetle is threatened with extinction as it exclusively inhabits preserved restinga forests (Vieira et al., 2011). The Brazilian restinga is a biodiverse ecosystem composed with a mosaic of vegetation types such as arboreal forests and shrublands, and patches of open areas with exposed soil (Oliveira and Landim, 2014). This ecosystem has been reduced to only 7% of its original area (Brasil, 2015). Features of each vegetation type confer specific abiotic characteristics; for example, the canopy protects understorey animals by forming microhabitats that buffer effects of climate extremes (França et al., 2016). Even subtle differences in environmental variables between two adjacent areas may limit the expansion of specialist dung beetle species as they are intolerant to such variations (França et al., 2016). Here, we aimed to investigate the abundance of *D. schiffleri* among restinga vegetation types in a protected area (763.37 ha) belonging to Embrapa, located in Itaporanga D'Ajuda (11° 06' 16.19" S and 37° 11' 05.89" W, 8 m.a.s.l.), Sergipe state, Brazil. Pitfall traps were made using 500 mL disposable cups buried at ground level and containing ca. 150 mL of 20% salt water and 1.5% detergent solution. Traps were baited with pork carrion placed inside a 50 mL disposable cup held with a wire within the larger cup. Four replicates for each vegetation type were selected, totalling twelve sampling areas. At each study site, four pitfall traps were set up in a square grid 4 m apart from one another, in three vegetation types within the restinga domain, viz. secondary forests (SF) - forested habitats reaching up to 12 m in height, and the only near-original arboreal vegetation remaining; shrublands (SH) - habitats dominated by shrubs after thinning of trees; and abandoned agriculture (AA) - habitats cleared for agriculture, but abandoned for more than 20 years, currently covered by herbaceous plants, mainly the grasses and sparsely-distributed trees. Pitfall traps were inspected monthly from March 2017 to June 2018 after being left for seven days of exposure. Voucher specimens were deposited in the dung beetle collection of Universidade Federal do Mato Grosso after identification by Fernando Vaz-de-Mello. Temperature and relative humidity were recorded monthly at each study with a digital thermohygrometer (Incoterm). Cumulative rainfall one month prior to samplings were obtained from a local meteorological station. Litter weight was estimated by randomly casting a frame (0.25 m^2) in each study site four times and weighing the litter content. At each study site the number of trees and the diameter at breast height (DBH) for plants with a diameter over 10 cm was also obtained. Normalized Difference Vegetation Index (NDVI), a proxy for canopy cover, was obtained through scenes from the orbit of the European Space Agency's (ESA) SENTINEL-2 sensor, MSI sensor. A Variance Analysis (ANOVA) followed by the Tukey test was conducted to identify significant differences in the environmental variables between vegetation types. A Principal Component Analysis (PCA) was conducted to identify the relationship between the environmental variables (NDVI, tree number, temperature, relative humidity, litter layer) and *D. schiffleri* abundance within the vegetation types.

The vegetation types differed significantly for each environmental variable (Table 1). SF and SH were characterized by lower temperature and higher relative humidity in comparison with AA. SF had the highest values for tree number, litter weight, DBH and canopy cover (NDVI), while SH and AA had the intermediate and lowest values, respectively (Table 1). A total of 3,243 *D. schiffleri* individuals were collected and they were most abundant in SF, with 77.66% of individuals, followed by SH (21.65% of individuals) and AA (0.68%) ($F_{2.186} = 44.073$; $p < 0.001$). The first two axes of the PCA explained 76% of data variation (Figure 1), the first axis ($F_{2.189} = 265$, $p < 0.001$) accounted for 49.9% of the variance and was positively correlated with litter weight (cor = 70, $p < 0.001$), relative humidity

*e-mail: adenir.teodoro@embrapa.br
Received: February 22, 2021 – Accepted: June 1, 2021

Table 1. Environmental variables (means ± SD) recorded in three restinga vegetation types, viz. secondary forests (SF), shrubland (SH), and abandoned agriculture (AA) in Itaporanga d'Ajuda, Sergipe state, Brazil.

Vegetation type	Tree number (100m²)	Litter weight (g/m²)	DBH*	Relative humidity (%)	Temperature (°C)	NDVI**
SF	27.5 ± 8.3a	4888.76 ± 2423.5a	26.06 ± 3.87a	63.73 ± 9.15a	29.40 ± 2.13a	0.76 ± 0.03a
SH	12 ± 3.1 b	2597.5 ± 2944b	18.40 ± 4.06b	60.54 ± 12.10a	30.52 ± 2.85a	0.64 ± 0.77b
AA	2.5 ± 1.5c	757.5 ± 416.33c	21.5 ± 3.79c	57.60 ± 12.03b	31.35 ± 3.12b	0.44 ± 0.10c
N	168	48	168	192	192	12
p	< 0.001	< 0.001	< 0.001	< 0.005	< 0.003	< 0.001

Different letters within columns indicate significant differences among vegetation types by ANOVA followed by Tukey test. *DBH = Diameter at breast height; **NVDI (Normalized Difference Vegetation Index) as a proxy for canopy cover; *N* = Total number of observations for each measured variable; *p* = probability.

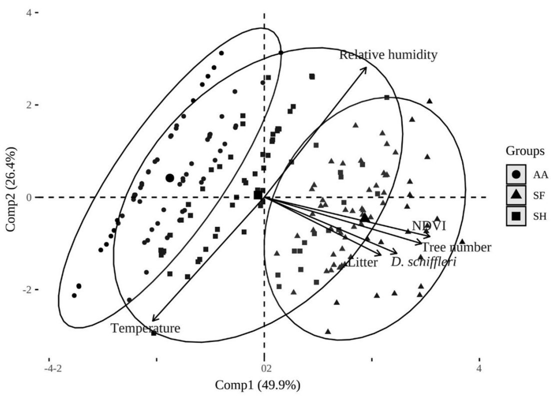

Figure 1. PCA showing the relationship between environmental variables and the abundance of *D. schiffleri* in three restinga vegetation types, viz. abandoned agriculture (AA), shrubland (SH) and secondary forests (SF) in Itaporanga d'Ajuda, Sergipe state, Brazil. NVDI = Normalized Difference Vegetation Index.

(cor = 54, $p < 0.001$), tree number (cor = 51, $p < 0.001$), NDVI (cor = 87, $p < 0.001$) and *D. schiffleri* abundance (cor = 63, $p < 0.001$), and negatively correlated with temperature (cor = - 58, $p < 0.001$). The second axis accounted for 26.4% of the variance ($F_{2.189} = 8.518$, $p < 0.001$), and was positively correlated with relative humidity (cor = 80, $p < 0.001$), and negatively correlated with litter weight (cor = -35, $p < 0.001$), temperature (cor = - 76, $p < 0.001$), tree number (cor = - 28, $p < 0.001$), NDVI (cor = - 24, $p < 0.001$) and *D. schiffleri* abundance (cor = - 30, $p < 0.001$). Therefore, environmental variables possibly acted synergistically to form a favorable microclimate in the understorey for *D. schiffleri* mainly in SF (Scheffers et al., 2014). In contrast, the lower abundances of *D. schiffleri* in SH, and the almost absence in AA, confirm that this beetle is overly sensitive to deforestation. This beetle is classed as endangered (Vaz-de-Mello et al., 2013) since it is restricted to forests within the restinga ecosystem. Overall, our results show that the surprisingly high abundance of *D. schiffleri* in restinga arboreal vegetation types emphasizes the importance of forested habitats in the conservation of this threatened dung beetle. Therefore, the protection of such forested habitats is pivotal for the conservation of this endangered dung beetle in the restinga ecosystem.

References

BRASIL. Ministério do Meio Ambiente – MMA, 2015. *Mapa de vegetação nativa na área de aplicação da lei no. 11.428/2006 - Lei da Mata Atlântica (ano base 2009).* Brasília.

FRANÇA, F., BARLOW, J., ARAÚJO, B. and LOUZADA, J., 2016. Does selective logging stress tropical forest invertebrates? Using fat stores to examine sublethal responses in dung beetles. *Ecology and Evolution*, vol. 6, no. 23, pp. 8526-8533. http://dx.doi.org/10.1002/ece3.2488. PMid:28031804.

OLIVEIRA, E.V.S. and LANDIM, M.F., 2014. Caracterização fitofisionômica das restingas da Reserva Biológica de Santa Isabel, litoral de Norte de Sergipe. *Scientia Plena*, vol. 10, pp. 1-11.

SCHEFFERS, B.R., EDWARDS, D.P., DIESMOS, A., WILLIAMS, S.E. and EVANS, T.A., 2014. Microhabitats reduce animal's exposure to climate extremes. *Global Change Biology*, vol. 20, no. 2, pp. 495-503. http://dx.doi.org/10.1111/gcb.12439. PMid:24132984.

VAZ-DE-MELLO, F., LARSEN, T., SILVA, F., FAVILA, M., SPECTOR, S. and GILL, B., 2013 [viewed 22 February 2021]. *Dichotomius schiffleri*. In: INTERNATIONAL UNION FOR CONSERVATION OF NATURE – IUCN, ed. *IUCN Red List of Threatened Species. Version 2013.2* [online]. Gland: IUCN. Available from: www.iucnredlist.org

VAZ-DE-MELLO, F., LOUZADA, J.N.C. and GAVINO, M., 2001. Nova espécie de *Dichotomius* Hope, 1838 (Coleoptera, Scrabaeinae) do Espírito Santo, Brasil. *Revista Brasileira de Entomologia*, vol. 42, pp. 99-102.

VIEIRA, L., LOUZADA, J., VAZ-DE-MELLO, F., LOPES, P. and SILVA, F., 2011. New records, threatens and conservation status for *Dichotomius schiffleri* Vaz-de-Mello, Louzada & Gavino (Coleoptera: Scarabaeidae): an endangered dung beetle species from Brazilian atlantic forest ecosystems. *Neotropical Entomology*, vol. 40, no. 2, pp. 282-284. http://dx.doi.org/10.1590/S1519-566X2011000200020. PMid:21584413.