Ecography

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Supplementary material

Appendix 1. Measurements of the quantitative specialization network metrics.

To investigate the effects of chronic anthropogenic disturbance and rainfall on specialization of ant-plant mutualism, we used the following metrics:

A) **Interaction evenness**: it quantifies the equitability of the interaction frequency between ant species and EFN-plant species, as:

$$E_S = \frac{-\sum_i \sum_j p_{ij} ln p_{ij}}{lnL}$$

Where p_{ij} is the proportion of interactions in a cell between ant species j and EFN-plant species i ($p_{ij} = a_{ij}/\mathrm{m}$) and L is the number of realized links in a network.

B) **Weighted generality**: we first calculated the Shannon diversity of interactions for ant species j and EFN-plant species i, respectively, as:

$$H_j = -\sum_{i=1}^{I} \left(\frac{a_{ij}}{A_j} . ln \frac{a_{ij}}{A_j} \right)$$

where a_{ij} is the number of interactions of ant species j visiting EFN-plant species i,and A_j is the sum of interaction of ant species j (Bersier *et al*. 2002, Blütghen *et al.* 2008). Weighted generality reflects the mean of the effective number of EFN-plants visited per ant species weighted by the interaction frequency of ant species, as:

$$G_{qw} = \sum_{j=1}^{J} \frac{A_j}{m} 2^{H_j}$$

where Aj is the sum of interactions of ant species j and m is the total number of interactions in the network.

C) **Weighted vulnerability** is analogous to the generality index, reflecting the mean of the effective number of ants per EFN-plant species weighted by the interaction of EFN-plant species. For quantifying this index, we just need to replace *j* for *i* and *J* by *I* in the Generality equation.

D) **Index *H_2'***: it measures specialization based on the difference between realized and expected associations generated by null frequency distribution of the marginal totals (Blütghen *et al.* 2006). First, we calculated the Shannon diversity of the entire network:

$$H_2 = -\sum_{i=1}^{J}\sum_{j=1}^{I}(p_{ij} . \ln p_{ij})$$

Where p_{ij} is the proportion of interactions in a cell between ant species *j* and EFN-plant species *i* as showed above. Then, we calculated the standardized network specialization index:

$$H_2' = \frac{H_{2\,max} - H_2}{H_{2\,max} - H_{2\,min}}$$

Appendix 2. List of extrafloral nectaries (EFNs)-bearing plant species interacting with their associated attendant ant species during the years 2014 and 2016 in sixteen plots distributed along chronic anthropogenic disturbance and rainfall gradients in Caatinga dry forest, Brazil. Ant species attending each EFN-bearing plant species are indicated by numbers in 2014 and letters in 2016 (see Appendix 3).

2014		**2016**	
EFN-bearing plant species	Associated ant species	EFN-bearing plant species	Associated ant species
Chloroleucon foliolosum	2, 5, 6, 8, 9, 13, 14, 16, 17, 21, 23	*Anacardium occidentale*	j, y
Croton heliotropiifolius	3, 5, 9, 16, 20	*Chloroleucon foliolosum*	d, j, n, r, z
Croton nepetifolius	2, 5, 12, 19, 20, 21, 23	*Cnidoscolus bahianus*	a, d, j
Croton tricolor	5	*Croton heliotropiifolius*	d, i, n, o
Cynophalla flexuosa	9	*Croton nepetifolius*	a, d, j, k, x, z
Pilosocereus tuberculatus	9, 13	*Croton tricolor*	d, j, m, t
Piptadenia stipulacea	2, 5, 12, 14, 16, 21	*Cynophalla flexuosa*	j
Pityrocarpa moniliformis	5, 8, 9, 12, 16, 21, 23	*Piptadenia stipulacea*	a, d, e, h, i, j, m, q, r, x

Poincianella microphylla	1, 5, 7, 8, 9, 12, 16	*Pityrocarpa moniliformis*	a, b, c, d, i, j, l, m, n, o, r, s, u, w, x, y, z
Poincianella pyramidalis	9	*Poincianella microphylla*	d, h, j, l, p, r, x
Senegalia bahiensis	9, 16, 21, 23	*Poincianella pyramidalis*	d, r
Senegalia sp.	5, 23, 25	*Sapium glandulosum*	a, d, j, r, x
Senna rizzinii	1, 5, 9, 11, 12, 16, 19, 21, 23, 24	*Senegalia bahiensis*	a, r, z
Senna splendida	5, 16, 17, 23	*Senegalia* cf *polyphylla*	i
Senna velutina	4, 5, 9, 12, 22	*Senegalia piauhiensis*	d, i, j, o, x
Tacinga palmadora	2, 3, 4, 5, 9, 10, 13, 14, 15, 16, 18, 23, 25	*Senna rizzinii*	a, d, j, o, x
Varronia curassavica	4, 5, 6, 9, 21, 22, 23	*Senna splendida*	i
		Tacinga palmadora	d, f, j, x
		Turnera cearensis	j, r

Appendix 3. List of associated ant species attending plants bearing extrafloral nectaries during the years 2014 and 2016 in sixteen plots distributed along chronic anthropogenic disturbance and rainfall gradients in Caatinga dry forest, Brazil.

2014	**2016**
1- *Azteca* sp. A	a- *Azteca* sp. A
2- *Brachymyrmex* sp. A	b- *Brachymyrmex* sp. B
3- *Brachymyrmex* sp. B	*c- Camponotus blandus*
4- *Brachymyrmex* sp. C	*d- Camponotus crassus*
5- Camponotus crassus	*e- Camponotus fastigatus*
6- Camponotus fastigatus	f- *Camponotus* sp. C
7- Cephalotes clypeatus	g- *Camponotus* sp. G
8- *Cephalotes* pr. *cordatus*	*h- Cephalotes persimillis*
9- Cephalotes pusillus	i- *Cephalotes* pr. *cordatus*
10- Crematogaster abstinens	*j- Cephalotes pusillus*
11- Crematogaster crinosa	*k- Crematogaster abstinens*
12- *Crematogaster* pr. *evallans*	*l- Crematogaster crinosa*
13- *Crematogaster* pr. *obscurata*	m- *Crematogaster* pr. *evallans*
14- Dolichoderus quadridenticulatus	n- *Crematogaster* pr. *obscurata*
15- Dorymyrmex goeldii	o- *Crematogaster* sp. D
16- Dorymyrmex thoracicus	p- *Crematogaster* sp. E
17- Ectatomma muticum	*q- Dorymyrmex goeldii*
18- Linephitema neotropicum	*r- Dorymyrmex thoracicus*
19- Pheidole radoskowiskii	*s- Ectatomma muticum*
20- *Pheidole* sp. E	*t- Gnamptogenys sulcata*
21- Pseudomyrmex acanthobius	*u- Pheidole radoskowiskii*

22- Pseudomyrmex elongatus	v- *Pheidole* sp. D
23- Pseudomyrmex gracilis	w- *Pheidole* sp. E
24- Pseudomyrmex laevifrons	*x-* *Pseudomyrmex acanthobius*
25- Solenopsis virulens	*y-* *Pseudomyrmex elongatus*
	z- *Pseudomyrmex gracilis*

Appendix 4. Summary of the general linear models accounting for the effects of chronic anthropogenic disturbance (CAD), annual mean rainfall and their interaction on temporal stability in the observed interaction evenness, generality, vulnerability, index H_2' and the 'abundance- and richness-controlled' temporal stability of interaction evenness, generality, vulnerability and index H_2' among the years 2014 and 2016 in Caatinga dry forest, Brazil. Statistical models were performed with 16 and 11 plots to show that the results are consistent as regards the number of plots. The statistical outputs conducted with 16 plots are similar to those in Table 2, but only results from completed models are here shown. Significant values are in bold.

Source of Variation	**Statistical models (n = 16 plots)**		**Statistical models (n = 11 plots)**	
	t	***P***	**t**	***P***
Observed interaction evenness				
CAD	0.887	0.3939	0.163	0.147
Rainfall	1.561	0.1469	0.959	0.369
CAD*Rainfall	-0.987	0.3448	-1.975	0.089
Observed generality				
CAD	3.305	**0.006**	2.400	**0.047**
Rainfall	2.205	**0.048**	1.291	0.238
CAD*Rainfall	-3.717	**0.003**	-2.824	**0.026**
Observed vulnerability				
CAD	-1.733	0.109	-1.271	0.244
Rainfall	0.400	0.696	-0.080	0.939
CAD*Rainfall	1.259	0.232	0.906	0.395
Observed index H_2'				

CAD			1.299	0.235
Rainfall			0.735	0.486
CAD*Rainfall			-1.707	0.132
Controlled interaction evenness				
CAD	0.458	0.656	0.388	0.710
Rainfall	0.349	0.733	0.169	0.870
CAD*Rainfall	-0.656	0.526	-0.595	0.571
Controlled generality				
CAD	1.241	0.238	0.348	0.738
Rainfall	0.847	0.414	0.459	0.660
CAD*Rainfall	-1.421	0.181	-0.579	0.581
Controlled vulnerability				
CAD	-0.833	0.421	-1.271	0.244
Rainfall	0.118	0.908	-0.080	0.939
CAD*Rainfall	0.375	0.714	0.906	0.395
Controlled index H_2'				
CAD			0.701	0.506
Rainfall			0.256	0.805
CAD*Rainfall			-1.101	0.307