Universidade de São Paulo

Instituto de Biociências

Dispersão de sementes por insetos

Gudryan J Baronio
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25/04/23

1

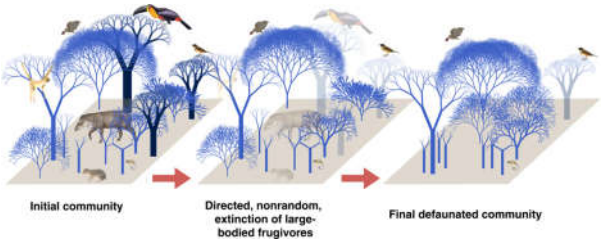
Porque estudar dispersão?

Cultivos e plantações

Conservação dos ecossistemas

2

Porque estudar dispersão?



10.1126/sciadv.1501105

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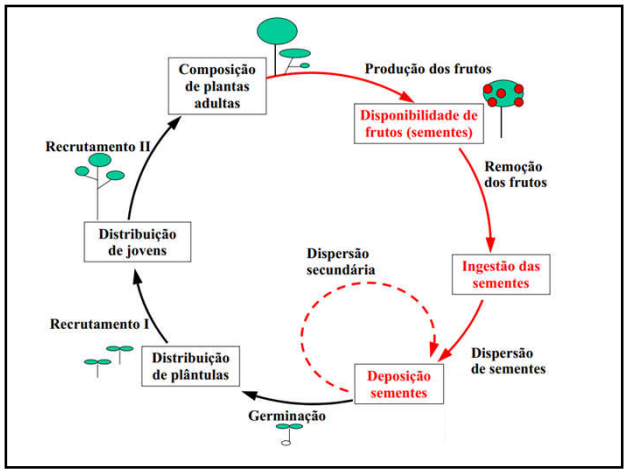

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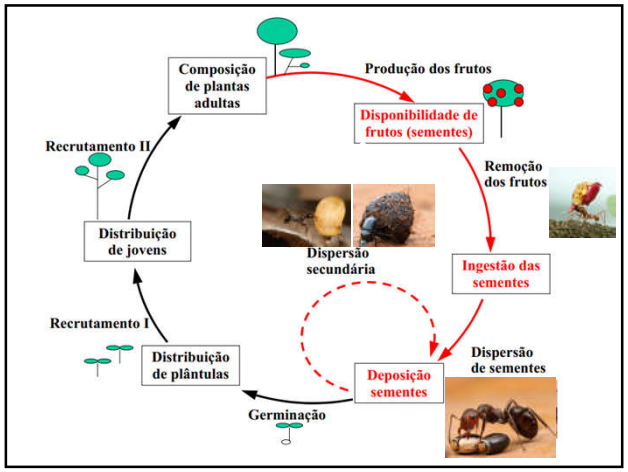
E os insetos?

5



6

Hipóteses ecológicas/evolutivas da dispersão de sementes

1- Escape

Predadores
e
patógenos

evitar a mortalidade próximo à planta-mãe

7

Hipóteses ecológicas/evolutivas da dispersão de sementes

2- Colonização

Novos locais

desenvolvimento em ambiente
com menor competição

8

Hipóteses ecológicas/evolutivas da dispersão de sementes

3- Dispersão direcionada

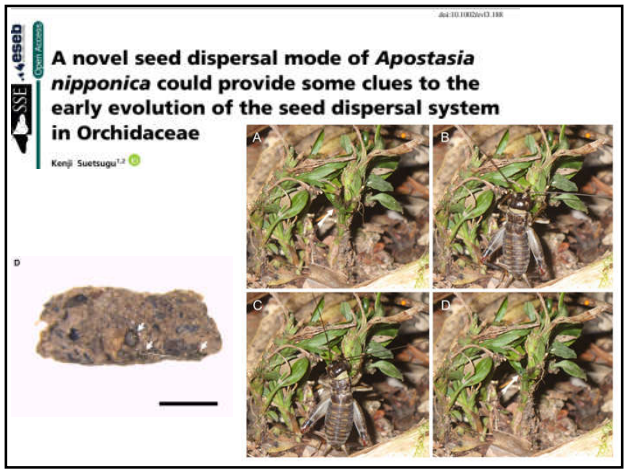
Besouros!

Formigas!

Melhores
condições/recursos

encontrar local com condições
favoráveis para estabelecimento

9



10

Acta Bot. Gallica, 1999, ***146*** *(2), 145-156.*

Examples of seed dispersal by entomochory

by Ignazio Li Vigni and Maria Rita Melati

D. *Isoptera* and *Poaceae* dispersal

It should be noted that many *Isoptera* devour their food on the spot; some termite species, on the other hand, gather seeds, small pieces of wood and other edible materials, and store them as provisions in chambers inside the nest. The termites might "accidentally" disperse some of these seeds during transportation (Scortecci, 1972).

Termites are insects which live mainly in "grassland" areas. There are two such zones. One is the savanna, found in the hottest areas of the world, between the Tropics of Cancer and Capricorn. The second are the temperate grasslands, which cover about 12% of the earth's surface and are found in all continents apart from the icy Antarctic.

The life of grassland animals is closely linked to the life cycle of the *Poaceae* and to the seasons. The animals disperse *Poaceae* seeds, while their excrement and carcasses provide nutritive substances which enrichen the soil and aid the growth of the plants. The long, cold winter is without doubt the most hostile season in the temperate grasslands. The majority of the small animals, including the termites, hibernate (only waking a few times to feed), and they amass supplies of *Poaceae* seeds in their underground nests (Greenaway, 1992).

E. *Vespidae* and *Capparis* dissemination

Finally, we shall now look at the *Capparis spinosa*. In 1911, Borzì, a botanist at the University of Palermo (Italy), noted for the first time that the scent emanating from mature caper fruits attracted wasps. The wasps consumed the pulp and carried off fragments of it together with the seeds, thus acting as dispersal agents.

A nauseating smell (similar to bad meat), and the nutritional value (sugars) of the pulp of its ripe fruit help in the dissemination of these species. In fact, these two characteristics attract wasps (and also ants and lizards, myrmecochory and saurochory respectively) which, besides feeding on the fruit on the spot, carry off fragments together with the small seeds contained within (one or two) — later to be discarded — and they transport them some distance to their nest to feed to their offspring.

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Published: 05 October 2015

Faecal mimicry by seeds ensures dispersal by dung beetles

Jeremy J. Midgley, Joseph D. M. White, Steven D. Johnson & Gary N. Bronner

Nature Plants **1**, Article number: 15141 (2015) | Cite this article

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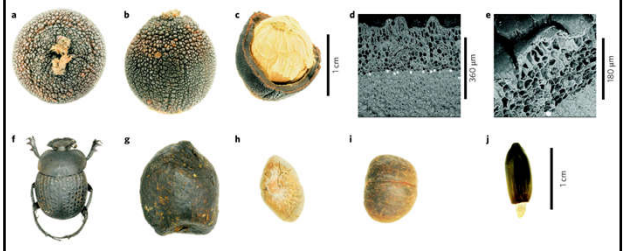
Figura 1: As semelhanças entre sementes *de C. argenteum* e *um pellet de esterco e diferenças com outras sementes de nozes.*

De: Mimetismo fecal por sementes garante dispersão por besouros de esterco



a – **c**, Vistas vertical (**a**) e lateral (**b**) de uma semente *de C. argenteum* , bem como uma que foi aberta (**c**) mostrando o endosperma e a espessa camada lenhosa interna da semente e a camada tuberculada externa que juntas formar a casca. **d** , **e** , Microscopia eletrônica de varredura (MEV) da camada tuberculada externa e do revestimento interno da semente, com grânulos de silício branco no limite entre as duas camadas. **f** , *E. flagellatus* . **g** , Bontebok fezes. **h** , **i** , Vertical (**h**) e lateral (**i**) vistas de uma semente *de L. sessile* . **j** , Semente *de Cannomois grandis* com elaiossomo branco.

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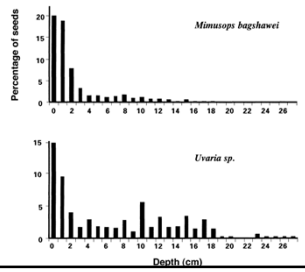
16

Dispersão por besouros

Journal of Tropical Ecology (1998) 14:199–215. With 2 figures

Dung beetles as secondary seed dispersers: impact on seed predation and germination

VIRGINIA E. SHEPHERD *and* COLIN A. CHAPMAN[1]



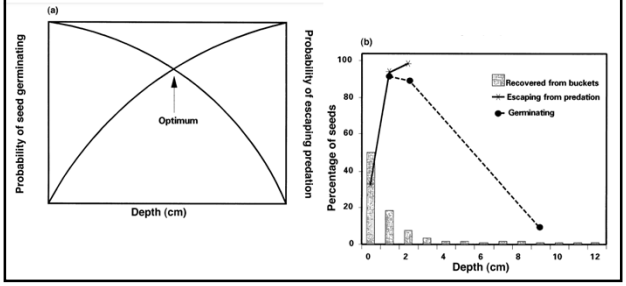
17

Dispersão por besouros

Journal of Tropical Ecology (1998) 14:199–215. With 2 figures

Dung beetles as secondary seed dispersers: impact on seed predation and germination

VIRGINIA E. SHEPHERD *and* COLIN A. CHAPMAN[1]

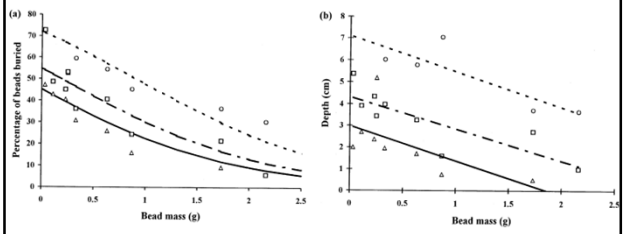


18

Ecological Entomology (2002) **27**, 257–270

Dung beetles in a Central Amazonian rainforest and their ecological role as secondary seed dispersers

ELLEN ANDRESEN Departamento de Ecologia de los Recursos Naturales, Instituto de Ecologia, Universidad Nacional Autónoma de México



5 g (Δ, ——), 10 g (□, - — - —), and 25 g (○, - - - -)

19

Ecological Entomology (2002) **27**, 257–270

Dung beetles in a Central Amazonian rainforest and their ecological role as secondary seed dispersers

ELLEN ANDRESEN Departamento de Ecologia de los Recursos Naturales, Instituto de Ecologia, Universidad Nacional Autónoma de México

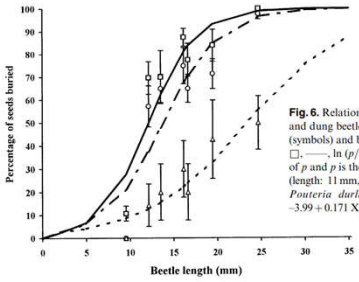


Fig. 6. Relationship between the average percentage of seeds buried and dung beetle size, for three species of seeds, for observed values (symbols) and best-fit lines (lines): *Helicostylis scabra* (length: 5 mm, □, ——, $\ln(p/1-p) = -4.46 + 0.367$ X, where $\ln(p/1-p)$ is the logit of p and p is the proportion of seeds buried), *Pourouma guianensis* (length: 11 mm, ○, - — - —, $\ln(p/1-p) = -4.25 + 0.308$ (X), and *Pouteria durlandii* (length: 27 mm, Δ, - - - -, $\ln(p/1-p = -3.99 + 0.171$ X).

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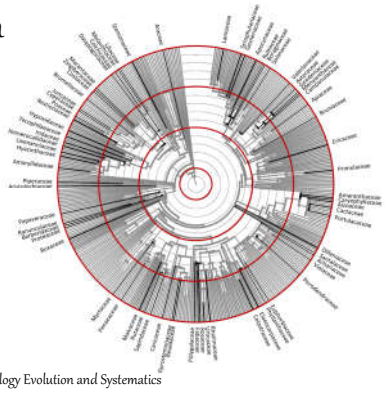
Dispersão clássica por formigas: elaiossomo

21

Mirmecocoria

3000 plantas

80 famílias botânicas



April 2010, Perspectives in Plant Ecology Evolution and Systematics
DOI: 10.1016/j.ppees.2009.08.001

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Elaiossomo

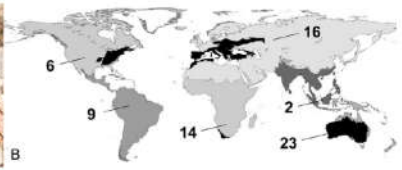

Figure 1. Convergent evolution of elaiosomes as an adaptation for seed dispersal by ants (myrmecochory) in angiosperm plants. (A) *Rhytidoponera metallica* ant holding a seed of *Acacia neurophylla* by the elaiosome during seed transport [Photograph by Benoit Guenard]. (B) Myrmecochore diversity hotspots (in black) and number of myrmecochorous plant lineages in major biogeographic regions (in shades of grey). Lineages distributed in more than one region (not shown) are Holarctic (n = 14), Old World (n = 5), pan-tropical (n = 2), or worldwide (n = 10). doi:10.1371/journal.pone.0005480.g001

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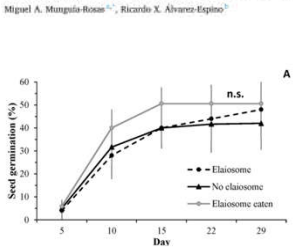
Journal of Arid Environments

What are elaiosomes for? Effects of elaiosomes on ant attraction, seed removal and germination in wild chaya (*Cnidoscolus aconitifolius*)

Miguel A. Munguía-Rosas, Ricardo X. Álvarez-Espino



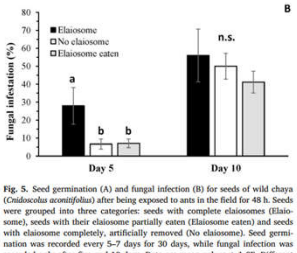


Fig. 5. Seed germination (A) and fungal infection (B) for seeds of wild chaya (*Cnidoscolus aconitifolius*) after being exposed to ants in the field for 48 h. Seeds were grouped into three categories: seeds with complete elaiosomes (Elaiosome), seeds with their elaiosome partially eaten (Elaiosome eaten) and seeds with elaiosome completely, artificially removed (No elaiosome). Seed germination was recorded every 5–7 days for 30 days, while fungal infection was recorded only after five and 10 days. Data are mean values ± 1 SE. Different letters in B indicate statistically significant differences between pairs of means. n.s. = not statistically different.

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Dispersão direcionada

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Ninhos como sítio de deposição: melhores condições

- Umidade
- Compactação
- Nutrientes

Figura 11 – Ninho de formigas abandonado com plântulas de *Hovenia dulcis* germinando.

RAQUEL ELISE MULLER DE LIMA

DISPERSÃO DE SEMENTES DE *Hovenia dulcis* Thunb. (Rhamnaceae) – UMA ESPÉCIE INVASORA EM ÁREA DE FLORESTA ESTACIONAL DECIDUAL

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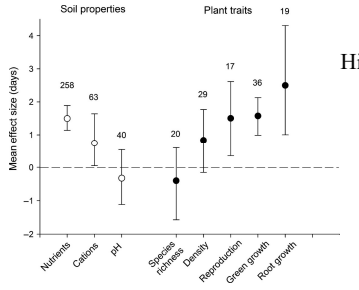
Journal of Animal Ecology
BRITISH ECOLOGICAL SOCIETY
Standard Paper | Free Access

The effects of ant nests on soil fertility and plant performance: a meta-analysis

Alejandro G. Farji-Brener ✉ Victoria Werenkraut

First published: 31 March 2017 | https://doi.org/10.1111/1365-2656.12672 | Citations: 69



Hipótese de dispersão direcionada com suporte em escala global

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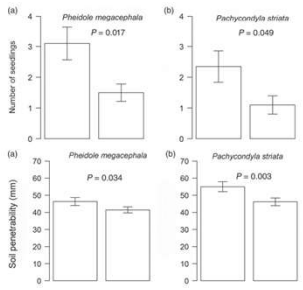
Ecological Entomology (2018), **43**, 665–674 DOI: 10.1111/een.12640

Secondary seed dispersal by ants in Neotropical cerrado savanna: species-specific effects on seeds and seedlings of *Siparuna guianensis* (Siparunaceae)

VERÔNICA B. MAGALHÃES,[1] NÁDIA B. ESPÍRITO SANTO,[1] LUIS F. P. SALLES,[1] HÉLIO SOARES Jr[2] and PAULO S. OLIVEIRA[3] [1]Graduate Program in Ecology, Universidade Estadual de Campinas, Campinas, Brazil, [2]Graduate Program in Animal Biology, Instituto de Biologia, Universidade Estadual de Campinas, Campinas, Brazil and [3]Departamento de Biologia Animal, Universidade Estadual de Campinas, Campinas, Brazil



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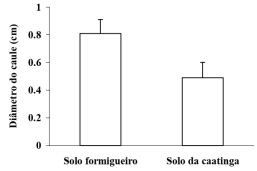
DISPERSÃO DE SEMENTES POR FORMIGAS NA CAATINGA

Euphorbiaceae

Inara R. Leal



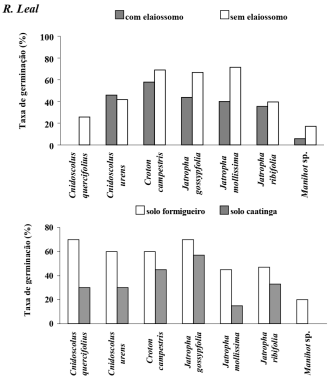


Figura 8. Diâmetro do caule (média + desvio-padrão) de plântulas de *Cnidoscolus quercifolius* crescidas em solos retirados de formigueiro e de pontos aleatórios da caatinga. A diferença entre as médias é significativa ($t = 2.57$, $gl = 3$, $p < 0.004$)

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Mirmecocoria

Vegetações de solos pobres:

- Fynbos na África do Sul
- Vegetação esclerófila na Autrália

30

Dispersão secundária por formigas:

Formiga ao lado de polpa de fruta: "limpeza" deixa semente livre da infestação por fungos no chão úmido da mata, facilitando a germinação

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BIOTROPICA 27(4): 518–522 1995

Seed Cleaning by *Mycocepurus goeldii* Ants (Attini) Facilitates Germination in *Hymenaea courbaril* (Caesalpiniaceae)[1]

Paulo S. Oliveira[2]
Departmento de Zoologia, C. P. 6109
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Fernando Pedroni
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Departamento de Botânica, C. P. 199
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13506-900 Rio Claro SP
Brasil

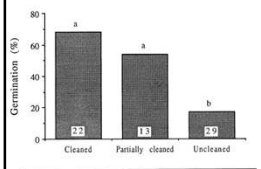

FIGURE 2. Germination success of *Hymenaea courbaril* seeds from cleaned, partially cleaned, and uncleaned broken pods collected under one tree at the Santa Genebra Reserve, SE Brazil. Percentages designated by the same letter are not significantly different (*G* tests). Numbers inside the bars refer to sample sizes. See text for definitions of each seed category.

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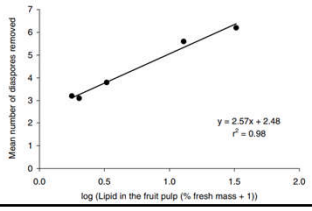
Journal of Tropical Ecology (2007) **23**:343–351. Copyright © 2007 Cambridge University Press
doi:10.1017/S0266467407004087 Printed in the United Kingdom

The role of ants in the removal of non-myrmecochorous diaspores and seed germination in a neotropical savanna

Alexander V. Christianini*, Antônio J. Mayhé-Nunes† and Paulo S. Oliveira‡[1]

Plant species	Number of seeds sown: Treatment	Number of seeds sown: Control	Number of germinated seeds: Treatment	Number of germinated seeds: Control	% difference	G-value
Copaifera langsdorffii	21	12	18	5	+ 43%	7.0**
Erythroxylum pelleterianum	60	60	31	0	+ 52%	54.0***
Guapira noxia	16	13	11	0	+ 69%	18.6***
Miconia albicans	60	60	60	39	+ 35%	33.6***
Miconia rubiginosa	30	30	24	1	+ 77%	42.7***
Ouratea spectabilis	20	20	4	0	–	–

**P < 0.01; ***P < 0.001.



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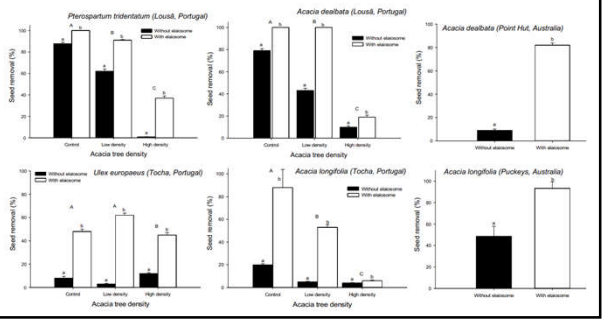
Original Paper | Published: 03 October 2018

Diminishing importance of elaiosomes for acacia seed removal in non-native ranges

Daniel Montesinos, Marta Correia, Sílvia Castro, Kristine French & Susana Rodríguez-Echeverría

Evolutionary Ecology **32**, 601–621 (2018) | Cite this article



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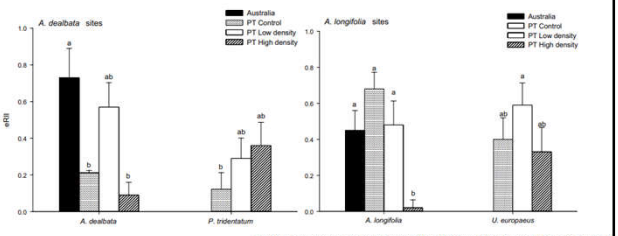

Fig. 2 Elaiosome removal relative interaction index (eRII; mean ± SE) for sites with *A. dealbata* or *A. longifolia* presence. PT stands for Portugal. Different letters indicate statistically significant differences among groups

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Dispersão secundária por formigas:

- Remoção da polpa
- Redução de efeitos negativos: denso-dependentes
- Aumento na germinação

Frutos ricos em:

Carboidratos ← formigas cortadeiras

Lipídeos ← formigas carnívoras

} destinos diferentes

36

Journal of Ecology

Journal of Ecology 2010, **98**, 573–582 doi: 10.1111/j.1365-2745.2010.01653.x

Birds and ants provide complementary seed dispersal in a neotropical savanna

Alexander V. Christianini[1]† and Paulo S. Oliveira[2]*

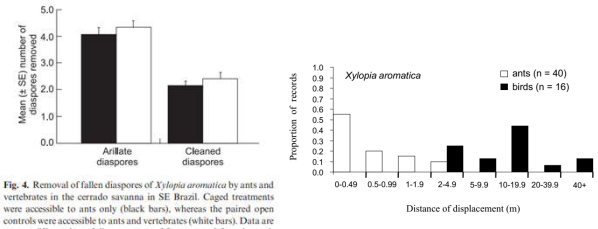

Fig. 4. Removal of fallen diaspores of *Xylopia aromatica* by ants and vertebrates in the cerrado savanna in SE Brazil. Caged treatments were accessible to ants only (black bars), whereas the paired open controls were accessible to ants and vertebrates (white bars). Data are mean ± SE number of diaspores out of five removed from beneath fruiting trees (N = 30 trees) in 2005 fruiting season.

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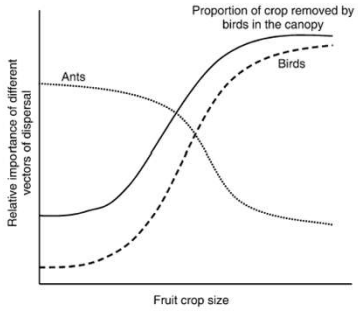

Fig. 4 A conceptual model for the relative importance of different dispersal vectors to the quantitative component of dispersal effectiveness under variable crop sizes of *M. rubiginosa* in the cerrado. The

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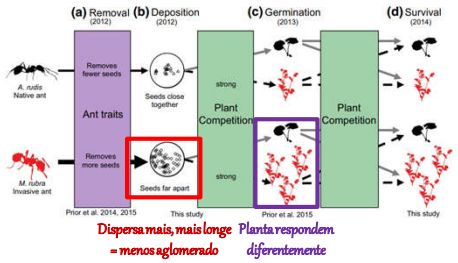
Oecologia (2020) 192:119–132
https://doi.org/10.1007/s00442-019-04553-3

PLANT-MICROBE-ANIMAL INTERACTIONS – ORIGINAL RESEARCH

Invasive ants disperse seeds farther than native ants, affecting the spatial pattern of seedling recruitment and survival

Shannon A. Meadley-Dunphy[1,2] · Kirsten M. Prior[1,3] · Megan E. Frederickson[1]



1. Invasoras recrutadas mais distante da planta-mãe do que mudas nativas;
2. Invasoras com maior sobrevivência quando distante de coespecíficos;
3. Nativas sobreviveram e cresceram mais quando dispersas longe de invasoras

Dispersa mais, mais longe = menos aglomerado

Planta respondem diferentemente

39

Bol. Mus. Para. Emílio Goeldi. Cienc. Nat., Belém, v. 15, n. 1, p. 155-164, jan.-abr. 2020

Relações alométricas entre os tamanhos de sementes artificiais removidas e de formigas em um fragmento florestal na Amazônia Central

Allometric relationships between artificial seeds size and ants size in dispersal events in a fragmented forest in Central Amazonia

Lilian Caroline Nunes de Matos[I, II] | Flavia Delgado Santana[II] | Fabricio Beggiato Baccaro[III, IV]

Figura 3. A-B) Formigas do gênero *Pheidole* consumindo o arilo das sementes artificiais sem removê-las. Em B, também é possível ver uma operária de *E. brunneum* removendo uma semente artificial em meio ao ataque das operárias de *Pheidole*. Fotos: Lilian Matos (2019).

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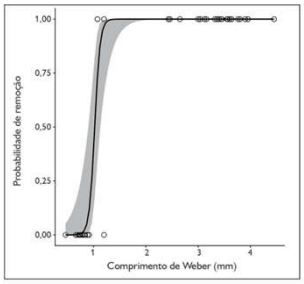

Figura 4. Relação entre remoção de sementes artificiais e comprimento do corpo de formigas no *campus* da UFAM.

41

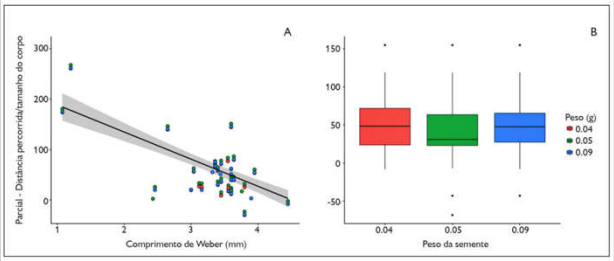

Figura 5. Relação entre distância percorrida proporcional ao tamanho do corpo e o comprimento da formiga (A), e ao peso da semente artificial (B), como indicado pelo modelo linear generalizado misto (GLMM). Cada ponto representa um evento de interação formiga-semente artificial. Os gráficos usam resíduos parciais da variável resposta e, portanto, mostram o efeito do preditor mantendo o efeito do outro preditor em seu valor médio. Isso explica os valores negativos nos dois gráficos.

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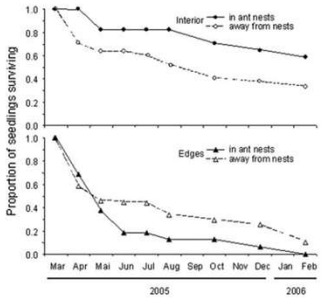
Arthropod-Plant Interactions (2013) 7:191–199
DOI 10.1007/s11829-012-9229-9

ORIGINAL PAPER

Edge effects decrease ant-derived benefits to seedlings in a neotropical savanna

Alexander V. Christianini · Paulo S. Oliveira

"Ponerinae's nests also showed a lower residence time near edges, decreasing possible benefits derived from ant colony activity such as nutrient enrichment and protection against insect herbivores"



43

Diferentes rotas de interações

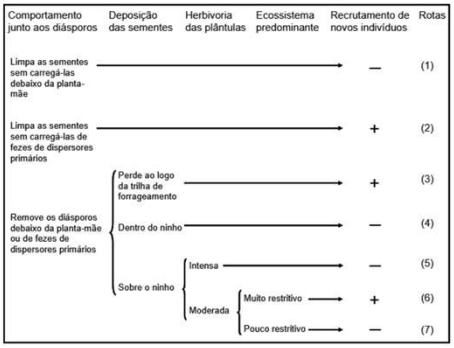


Figura 1. Papel das formigas cortadeiras como dispersores de sementes.

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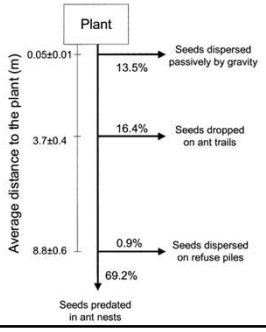
OIKOS 105: 377–385, 2004

Dual role of harvesting ants as seed predators and dispersers of a non-myrmechorous Mediterranean perennial herb

Javier Retana, F. Xavier Picó and Anselm Rodrigo

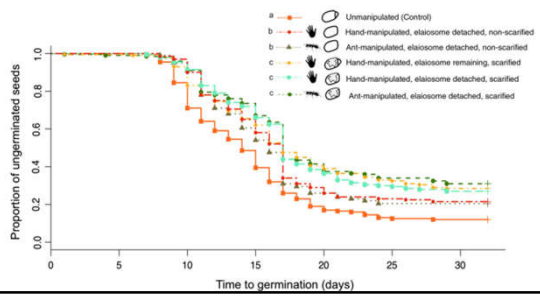


45

Ecological Entomology (2018), **43**, 712–718 DOI: 10.1111/een.12655

Seed manipulation by ants: disentangling the effects of ant behaviours on seed germination

TIAGO V. FERNANDES,[1] LUCAS N. PAOLUCCI,[1,2] FLÁVIA M. S. CARMO,[1] CARLOS F. SPERBER[1] and RICARDO I. CAMPOS[1] [1]Departamento de Biologia Geral, Universidade Federal de Viçosa, Viçosa, Brazil and [2]Instituto de Pesquisa Ambiental da Amazônia, Brasília, Brazil



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4. The present study shows that manipulation by *A. subterraneus* can exert negative effects on germination of a myrmecochorous seed. Accordingly, we suggested that studies evaluating the benefits of myrmecochory for plants, based only on seed removal amount and distance, may be overestimating those benefits. Our results contribute to the understanding of the potential mechanisms influencing plant recruitment, especially for myrmecochorous plants inhabiting tropical forests.

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More specifically, we suggest that the decrease in seed germination caused by elaiosome removal can be associated with one major cause: elaiosome detachment exposes the seed micropyle (a small orifice at the seed coat border) which can be a gateway to pathogen infections (Kulik & Yaklich, 1991). It has been reported that the presence of the elaiosome could increase water absorption by seeds, facilitating germination for some myrmecochorous species (Lisci *et al.*, 1996). However, any

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Formigas tem efeito negativo em manipular as sementes, diminuindo a germinação, mas têm também efeito positivo da dispersão?

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Mensagens para reflexão

- A dispersão de sementes evoluiu através de diversos mecanismos, mesmo a mirmecocoria tem linhagens diversas;
- Formigas tem papel primário e secundário na dispersão de sementes, sendo atraídas por diferentes características;
- Há uma complementariedade funcional da dispersão de sementes por formigas, em alguns casos com efeitos mutualísticos variáveis;
- As formigas contribuem com uma dispersão direcionada aos locais próximos aos ninhos, se o comportamento e localização do ninho favorecem, as plantas prosperam;

50

Leituras sugeridas:

Andresen, E., & Urrea-Galeano, L. A. (2022). Effects of dung beetle activity on tropical forest plants. Frontiers in Ecology and Evolution, 10. https://doi.org/10.3389/fevo.2022.979676

Andresen, E. (2002). Dung beetles in a Central Amazonian rainforest and their ecological role as secondary seed dispersers. Ecological Entomology, 27(3), 257–270. https://doi.org/10.1046/j.1365-2311.2002.00408.x

Rico-Gray, V., & Oliveira, P. S. (2007). *The Ecology and Evolution of Ant-Plant Interactions*. University of Chicago Press. https://doi.org/10.7208/chicago/9780226713540.001.0001

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Obrigado,

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