



Fonction et service écosystémique de pollinisation

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La pollinisation animale:

une interaction mutualiste extrêmement diversifiée



70 à 90% des angiospermes (~250 000 sp.) dépendent de la pollinisation animale pour leur reproduction

La plus part des pollinisateurs sont des insectes (~30 000 sp. pour les abeilles, mais aussi Diptère, Lépidoptère, Coleoptère...), mais aussi des vertébrés (oiseaux, lézard, chauve-souries)

La pollinisation animale:

un **service écosystémique** important

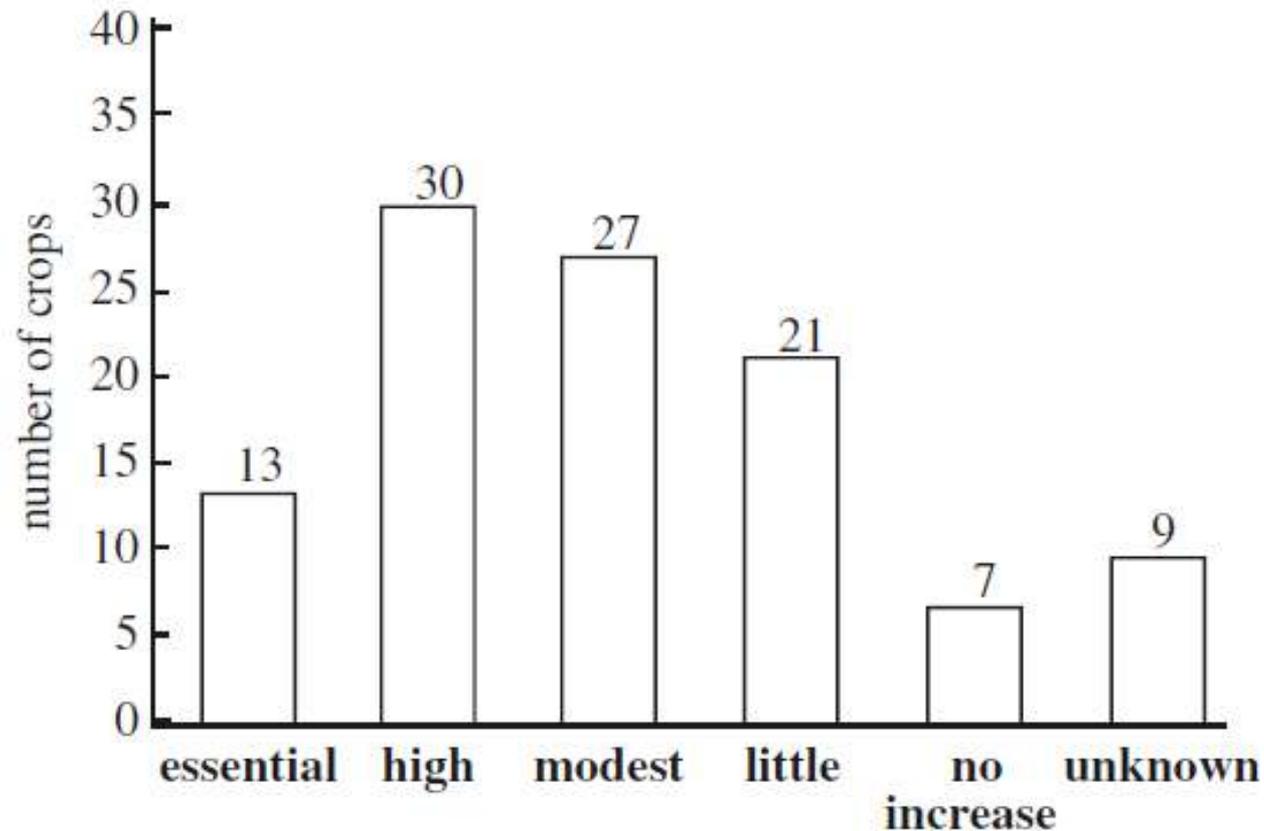


Les services écosystémiques sont des processus par lesquels l'environnement naturel produit des bénéfices directs ou indirects aux populations humaines.

Un service écosystémique important



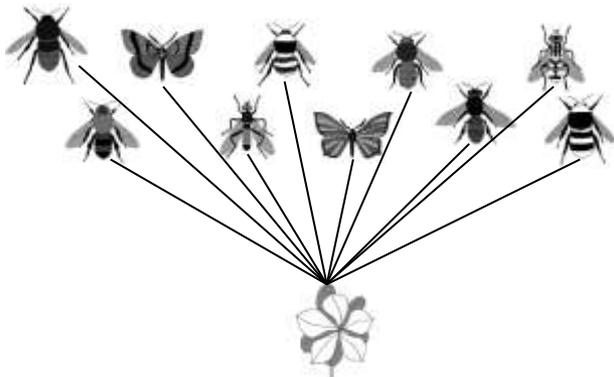
Analyse des 107 plantes cultivées principales



Service



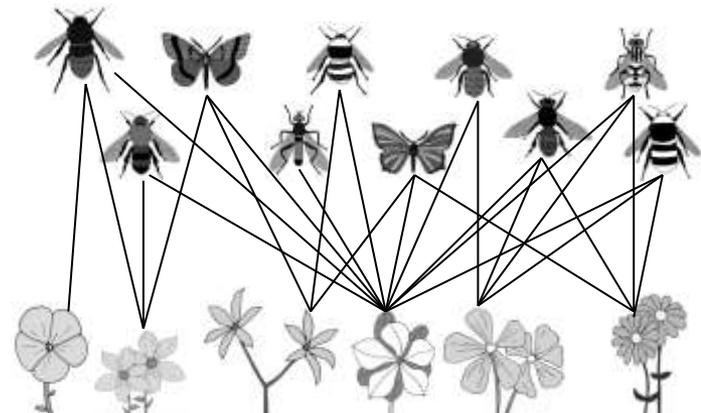
Pollinisation des cultures



Fonction



Pollinisation des communautés naturelles

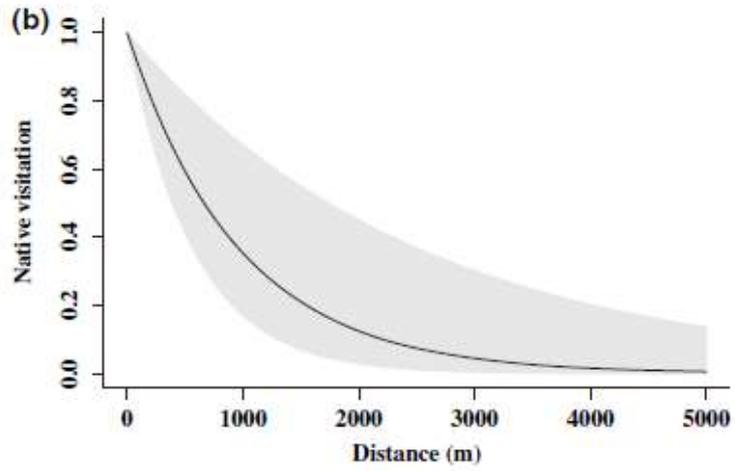
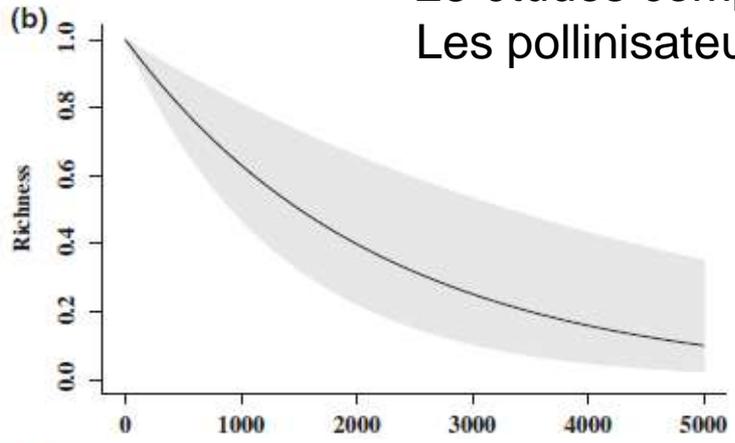


Un service lié aux caractéristiques du paysage

...



23 études comprenant 16 plantes cultivées
Les pollinisateurs suivis sont les abeilles

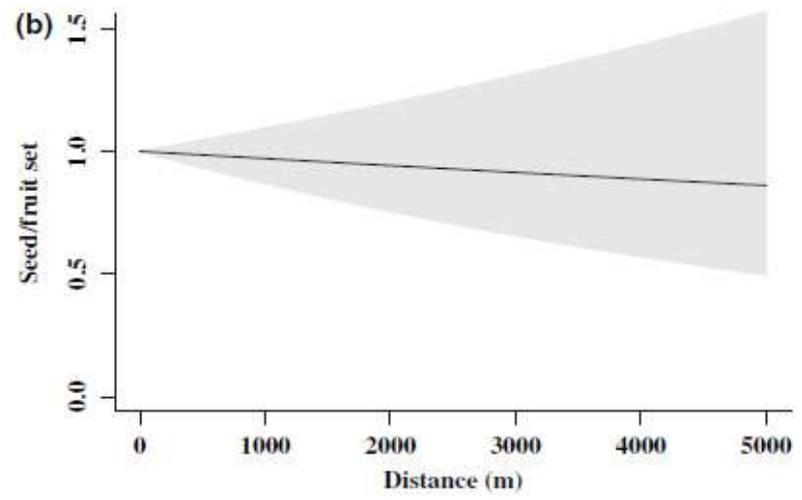
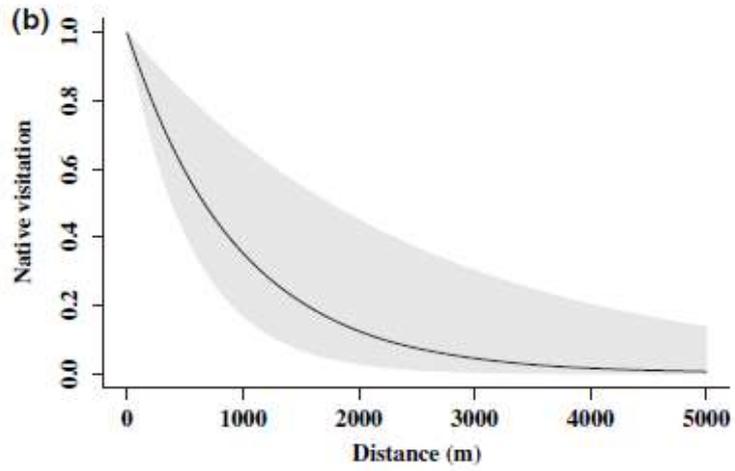
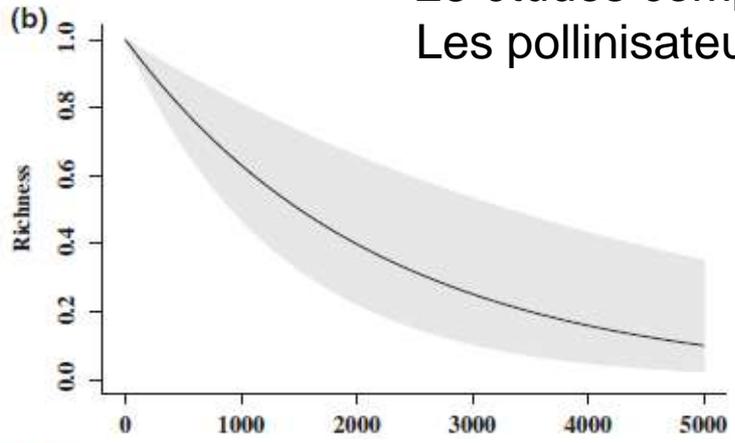


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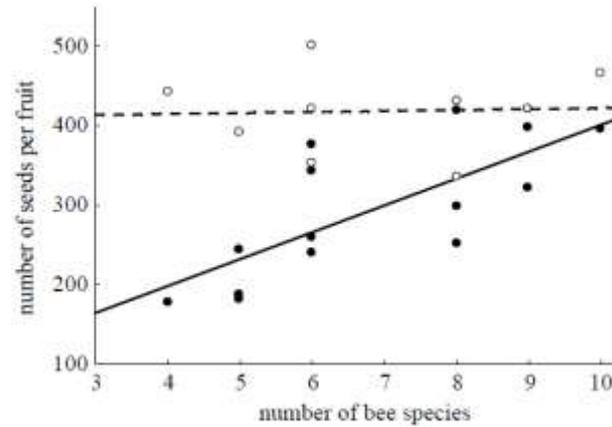


Diversité des pollinisateurs et service de pollinisation

Proc. R. Soc. B (2008) 275, 2283–2291

Functional group diversity of bee pollinators increases crop yield

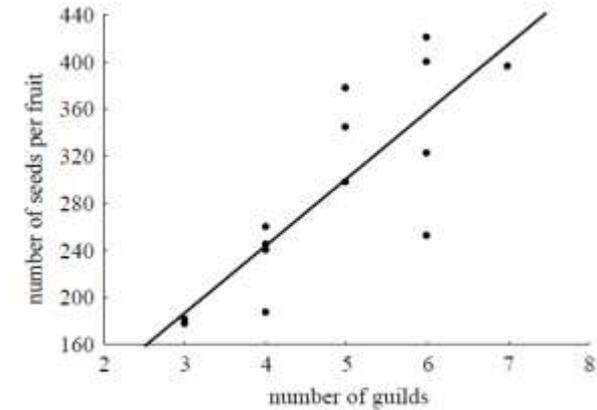
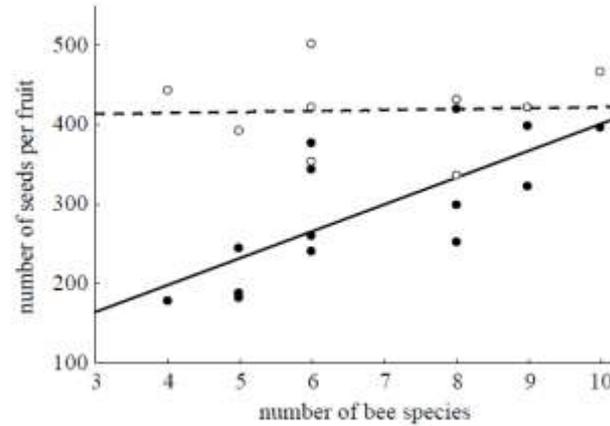
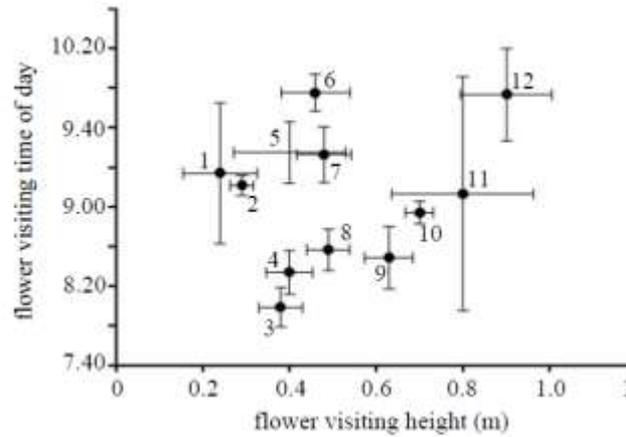
Patrick Hoehn^{1,*}, Teja Tschardt¹, Jason M. Tylianakis²
and Ingolf Steffan-Dewenter³



Functional group diversity of bee pollinators increases crop yield

Patrick Hoehn^{1,*}, Teja Tschardt¹, Jason M. Tylianakis²
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Diversité des pollinisateurs et service de pollinisation



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Diversité des pollinisateurs et service de pollinisation

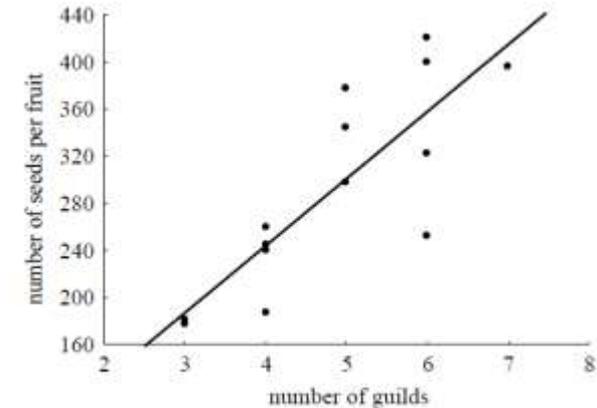
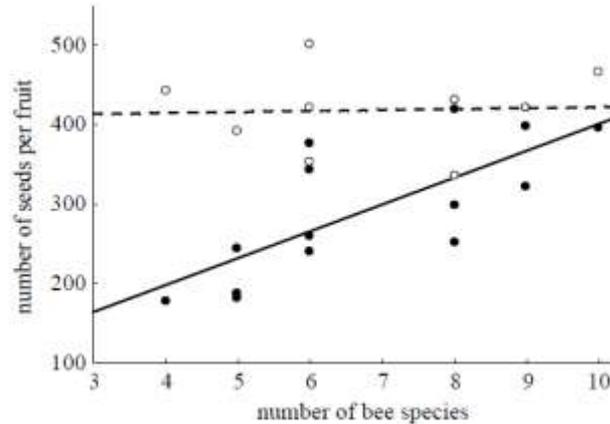
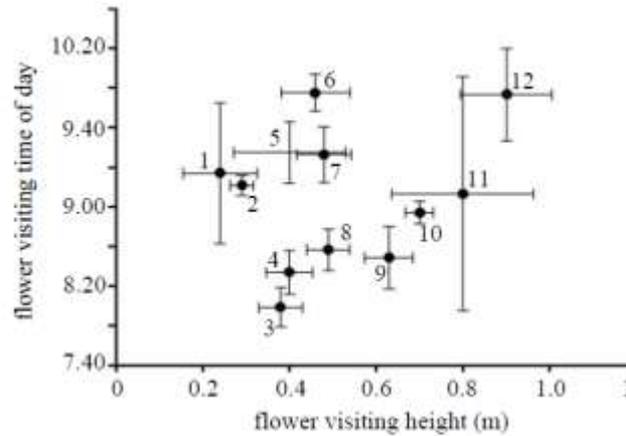


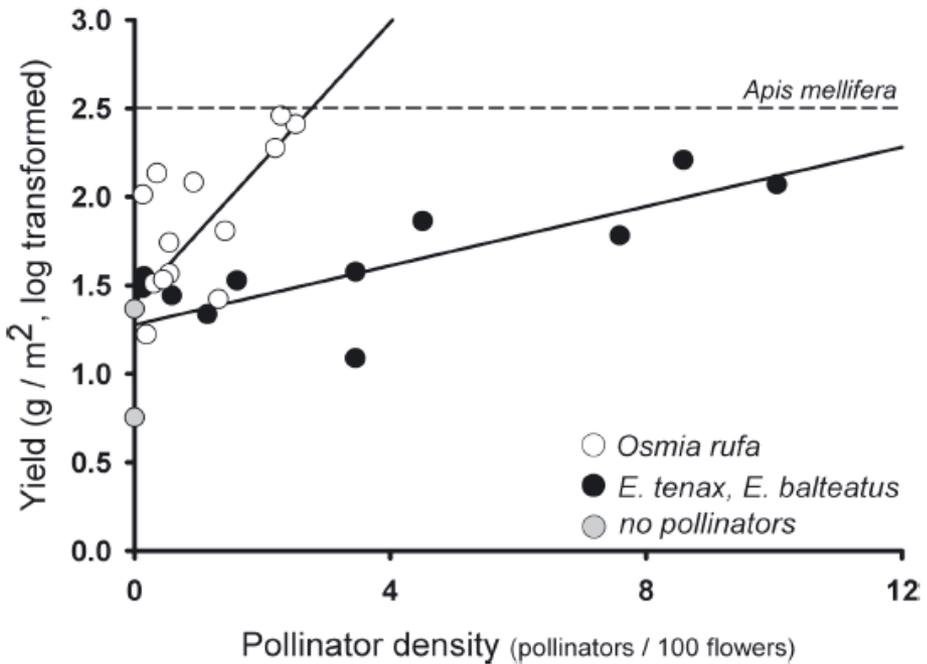
Table 4. Bee species richness and functional guild diversity in relation to the residuals of seed set after correlation with bee abundance. (Italic numbers indicate significant effects.)

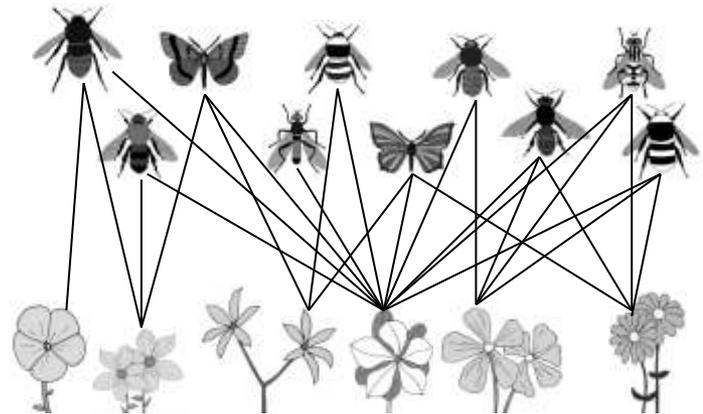
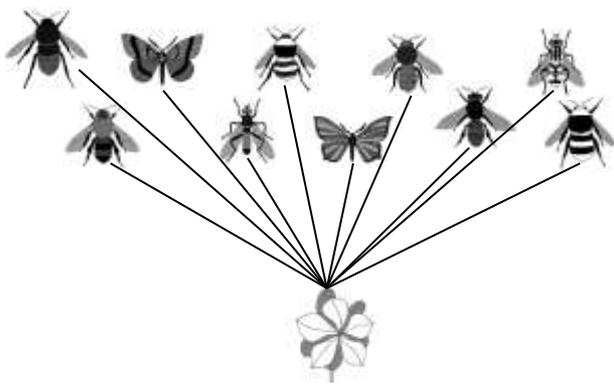
	<i>r</i> ²	<i>F</i> _{1,10}	<i>p</i>
<i>model 1</i>			
bee species richness	<i>0.32</i>	<i>6.08</i>	<i>0.033</i>
functional guild diversity	0.15	2.87	0.121
<i>model 2</i>			
functional guild diversity	<i>0.45</i>	<i>8.47</i>	<i>0.015</i>
bee species richness	0.02	0.47	0.507

Des pollinisateurs autres que les abeilles?

Pollination efficiency of wild bees and hoverflies provided to oilseed rape

Frank Jauker, Birgit Bondarenko*, Heiko C. Becker† and Ingolf Steffan-Dewenter‡,§





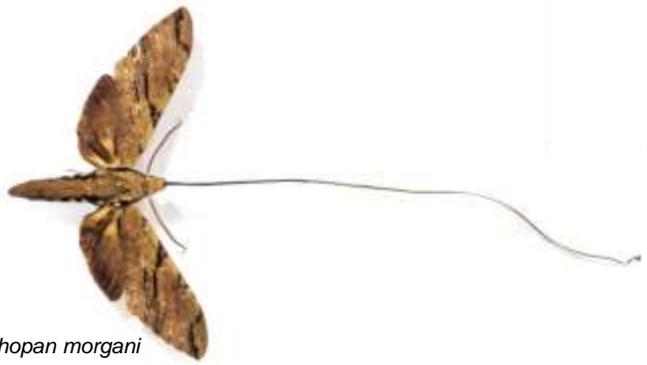
Une vision tournée vers la spécialisation



ON
 THE VARIOUS CONTRIVANCES
 BY WHICH
 BRITISH AND FOREIGN ORCHIDS
 ARE
 FERTILISED BY INSECTS,
 AND ON THE GOOD EFFECTS OF INTERCROSSING.
 By CHARLES DARWIN, M.A., F.R.S., &c.
 WITH ILLUSTRATIONS.
 LONDON:
 JOHN MURRAY, ALBEMARLE STREET.
 1862.
 The right of Translation is reserved.



Angraecum sesquipedale



Xanthopan morgani

Relations between flowers and insect pollinators are archetypes of the results of coevolutionary interactions . . . Constant pollination might allow a maximum number of plant species . . . since . . . each plant species might have an efficient pollinator in spite of relatively high species density.

Crepet 1983:29-30

The flowers of each species are adapted in shape, structure, color, and odor to the particular pollinating agents on which they depend . . . Evolving together, the plants and their pollinators become more finely tuned to each other's peculiarities . . .

Keeton and Gould 1993:476

De la spécialisation au généralisme

Ecology, 77(4), 1996, pp. 1043–1060
© 1996 by the Ecological Society of America

GENERALIZATION IN POLLINATION SYSTEMS, AND WHY IT MATTERS¹

Nickolas M. Waser,^{2,3} Lars Chittka,^{4,5} Mary V. Price,^{2,3}
Neal M. Williams,⁴ and Jeff Ollerton⁶

Journal of Ecology 1996,
84, 767–769

FORUM

Reconciling ecological processes with phylogenetic patterns: the apparent paradox of plant–pollinator systems

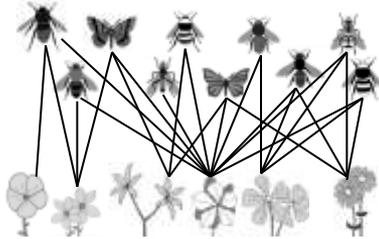
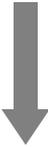
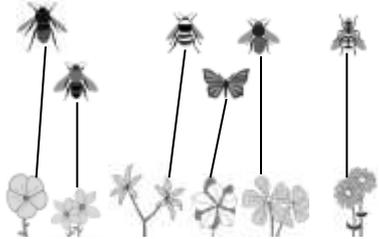
JEFF OLLERTON

TREE vol. 15, no. 4 April 2000

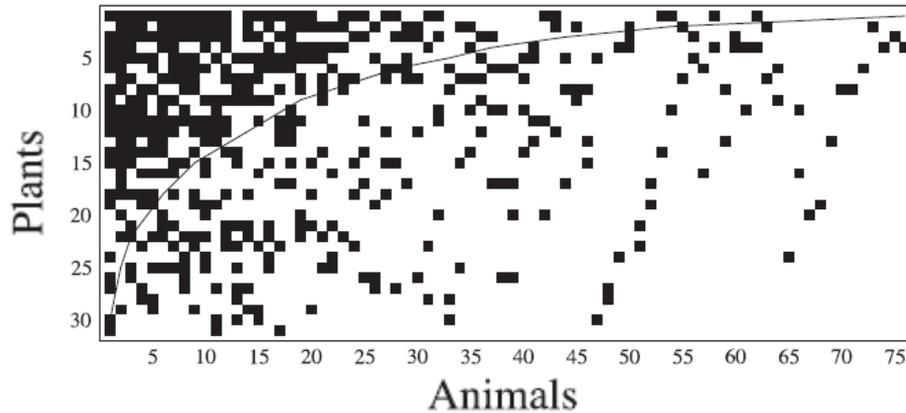
REVIEWS

Generalization versus specialization in plant pollination systems

Steven D. Johnson and Kim E. Steiner



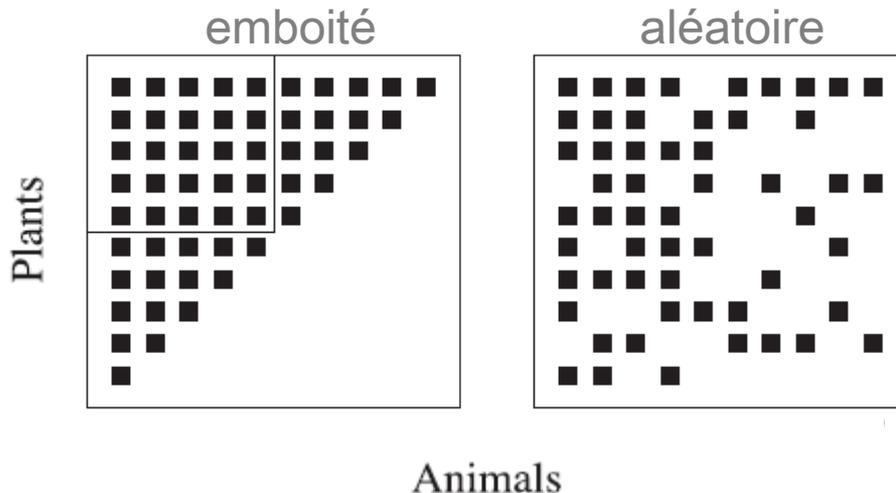
L'architecture des réseaux de pollinisation



Dispersion des graines

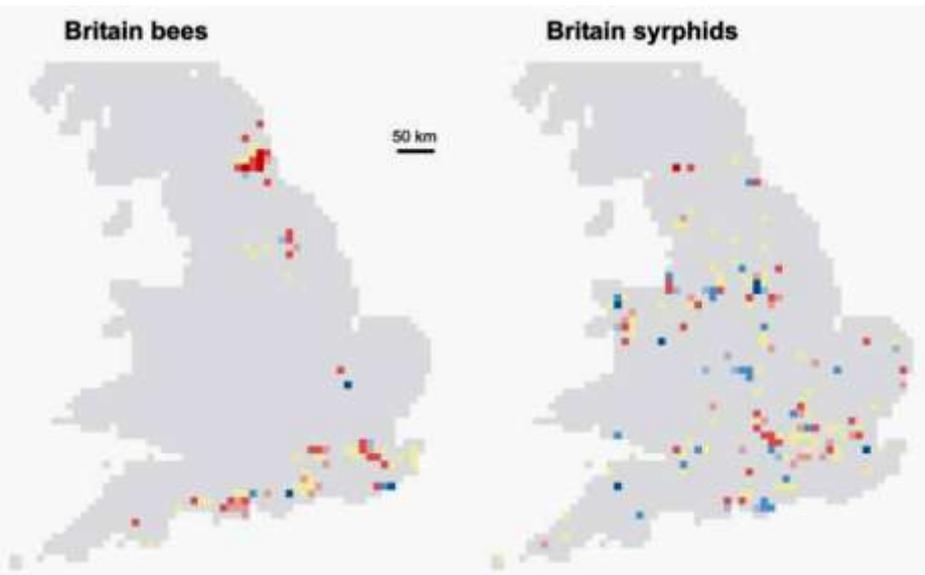


pollinisation

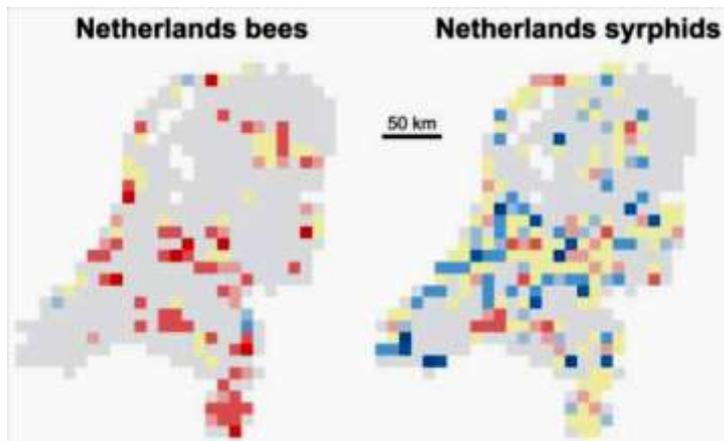
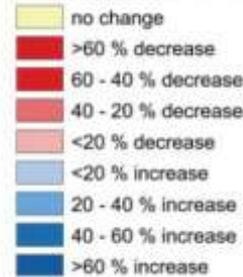


- Continuum entre espèces spécialistes et généralistes
- Spécialisation asymétrique
- Présence d'un cœur d'espèces très connectées

La crise de la pollinisation



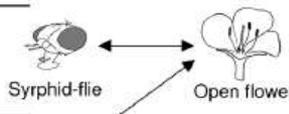
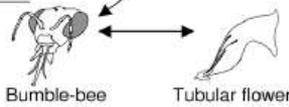
Species richness change



		Britain			
Trait	Trait category (proportion declining)			<i>Solitary bees</i>	
				<i>P</i>	<i>n</i>
Habitat range	Narrow (0.90) / Wide (0.25)			0.0001	32
Flower specificity	Oligo (0.86) / Poly (0.41)			0.034	34
Tongue length	Long (0.70) / Short (0.41)			0.099	56
Generations	Uni (0.60) / Multi (0.14)			0.042	44
				<i>Hoverflies</i>	
Trait	Trait category (proportion declining)			<i>P</i>	<i>n</i>
Habitat range	Narrow (0.96) / Wide (0.28)			0.0001	53
Adult food	Narrow (0.63) / Wide (0.41)			0.095	60
Larval food	Macro (0.74) / Micro (0.43)			0.009	59
Generations	Uni (0.80) / Multi (0.29)			0.0001	50
Migration	Res (0.63) / Mig (0.20)			0.01	64

	Obligatory outcrossing, insect pollinated	Obligatory outcrossing, wind or water pollinated	Predominantly self pollinating	<i>P</i>
Britain	$-0.22 \pm 0.06^*$ (<i>n</i> = 75)	$+0.18 \pm 0.14^+$ (<i>n</i> = 30)	$-0.003 \pm 0.70^{*+}$ (<i>n</i> = 116)	0.009
Netherlands	$+0.10 \pm 0.08$ (<i>n</i> = 182)	$+0.18 \pm 0.08$ (<i>n</i> = 160)	-0.08 ± 0.11 (<i>n</i> = 143)	0.091
NL bee plants	$-0.12 \pm 0.13^*$ (<i>n</i> = 42)	$+0.18 \pm 0.08^+$ (<i>n</i> = 160)	$-0.08 \pm 0.11^{*+}$ (<i>n</i> = 143)	0.036

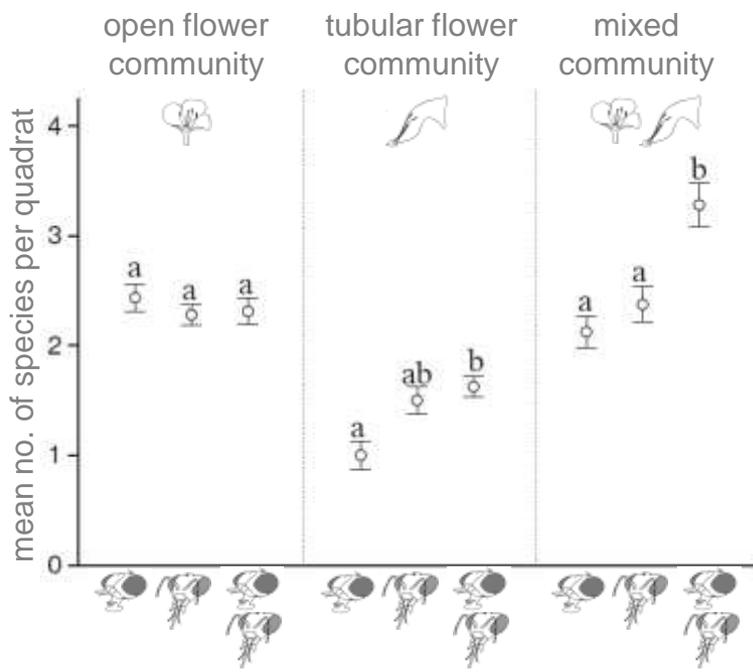
Diversité des pollinisateurs et persistance des communautés végétales

Pollinators species and groups	Mouthpart length (mm \pm S.E.)	Theoretical pollination network		Plants species and groups		Accessibility	
				pollen	nectar		
<i>Sphaerophoria sp.</i>	2.66 \pm 0.35	 Syrphid-fly Open flower	<i>M. officinalis</i>	easy	easy		
<i>E. balteatus</i>	2.3 \pm 0.20		<i>E. cicutarium</i>	easy	easy		
<i>E. tenax</i>	5.47 \pm 0.29		<i>R. raphanistrum</i>	easy	difficult		
<i>B. terrestris</i>	9.02 \pm 0.19	 Bumble-bee Tubular flower	<i>M. guttatus</i>	easy	difficult		
<i>B. hortorum</i>	9.21 \pm 1.02		<i>M. sativa</i>	difficult	difficult		
<i>B. lapidarius</i>	8.10 \pm 0.86		<i>L. corniculatus</i>	difficult	difficult		



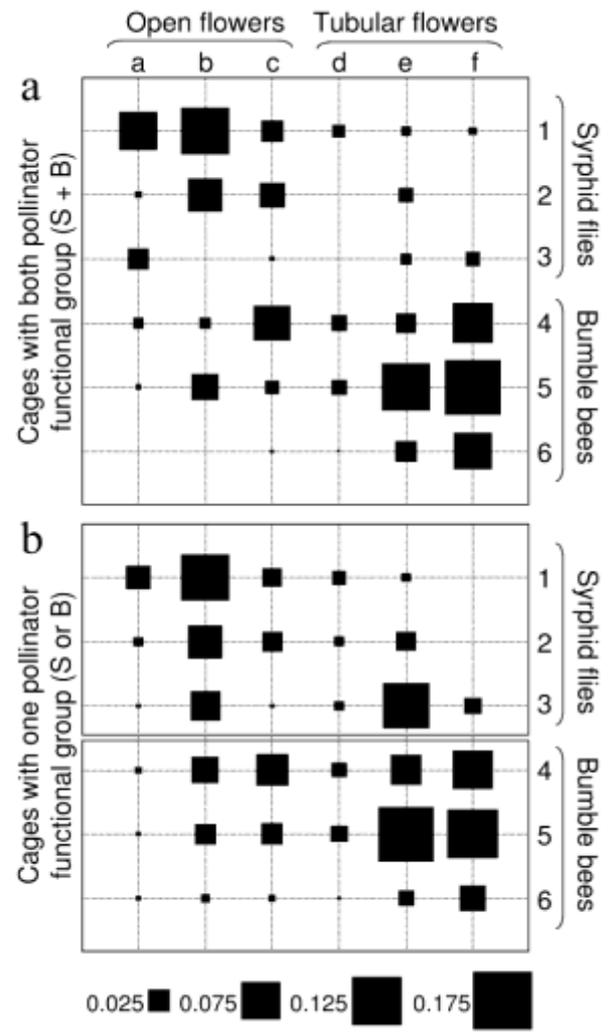
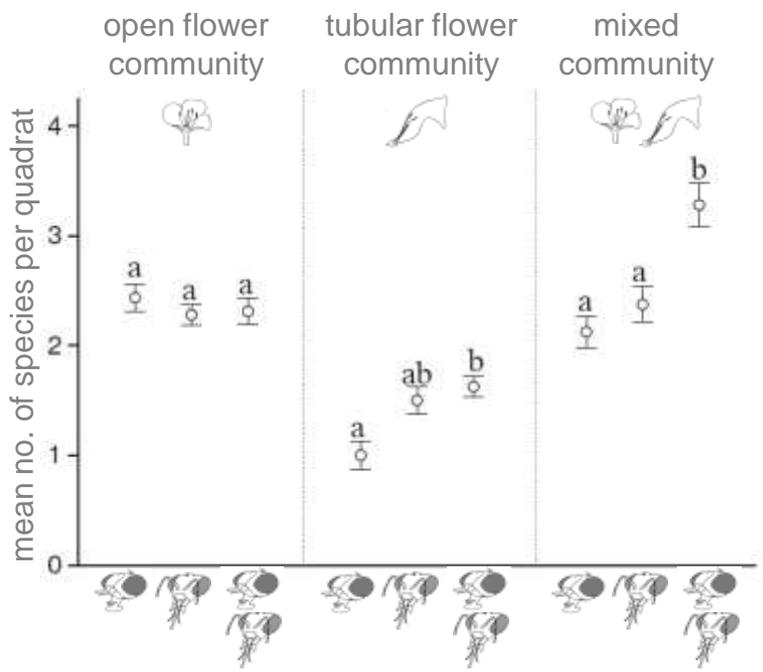
Diversité des pollinisateurs et persistance des communautés végétales

Pollinators species and groups	Mouthpart length (mm ± S.E.)	Theoretical pollination network	Plants species and groups		Accessibility	
					pollen	nectar
<i>Sphaerophoria sp.</i>	2.66 ± 0.35	 Syrphid-fly Open flower	<i>M. officinalis</i>	easy	easy	
<i>E. balteatus</i>	2.3 ± 0.20		<i>E. cicutarium</i>	easy	easy	
<i>E. tenax</i>	5.47 ± 0.29		<i>R. raphanistrum</i>	easy	difficult	
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Diversité des pollinisateurs et persistance des communautés végétales

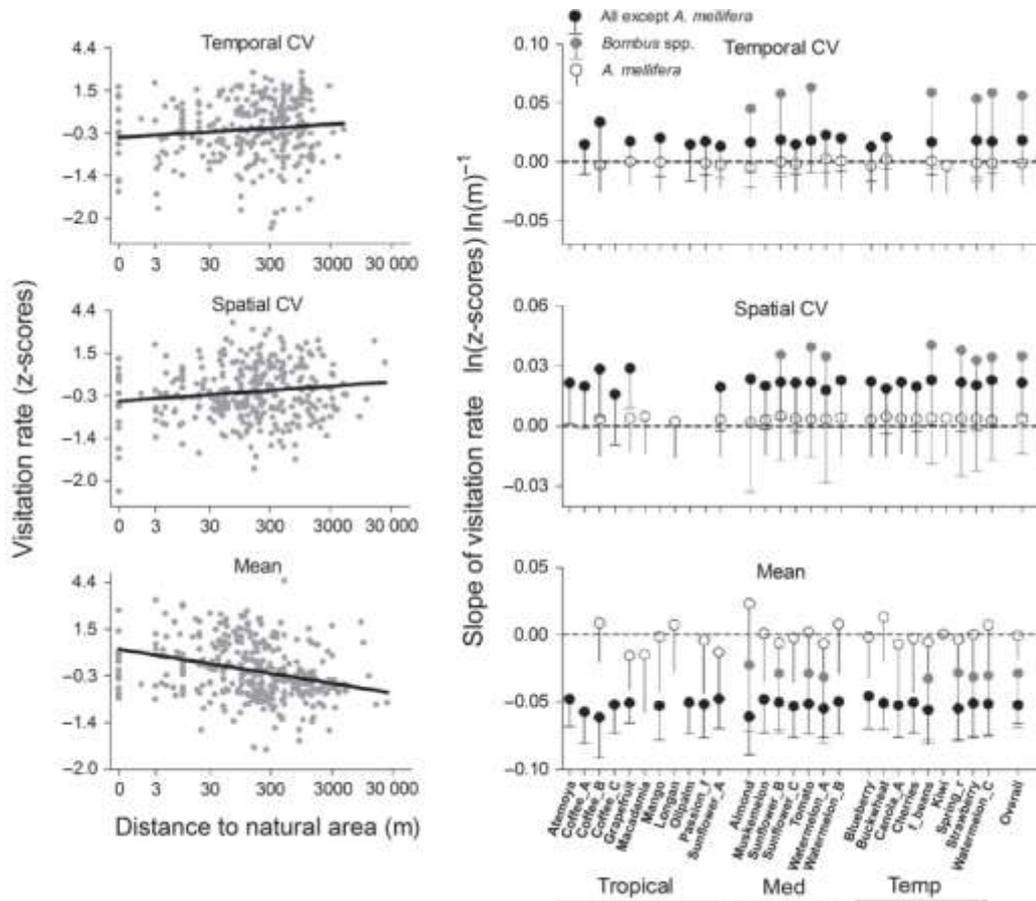
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A service linked to landscape characteristics

Stability of pollination services decreases with isolation from natural areas despite honey bee visits

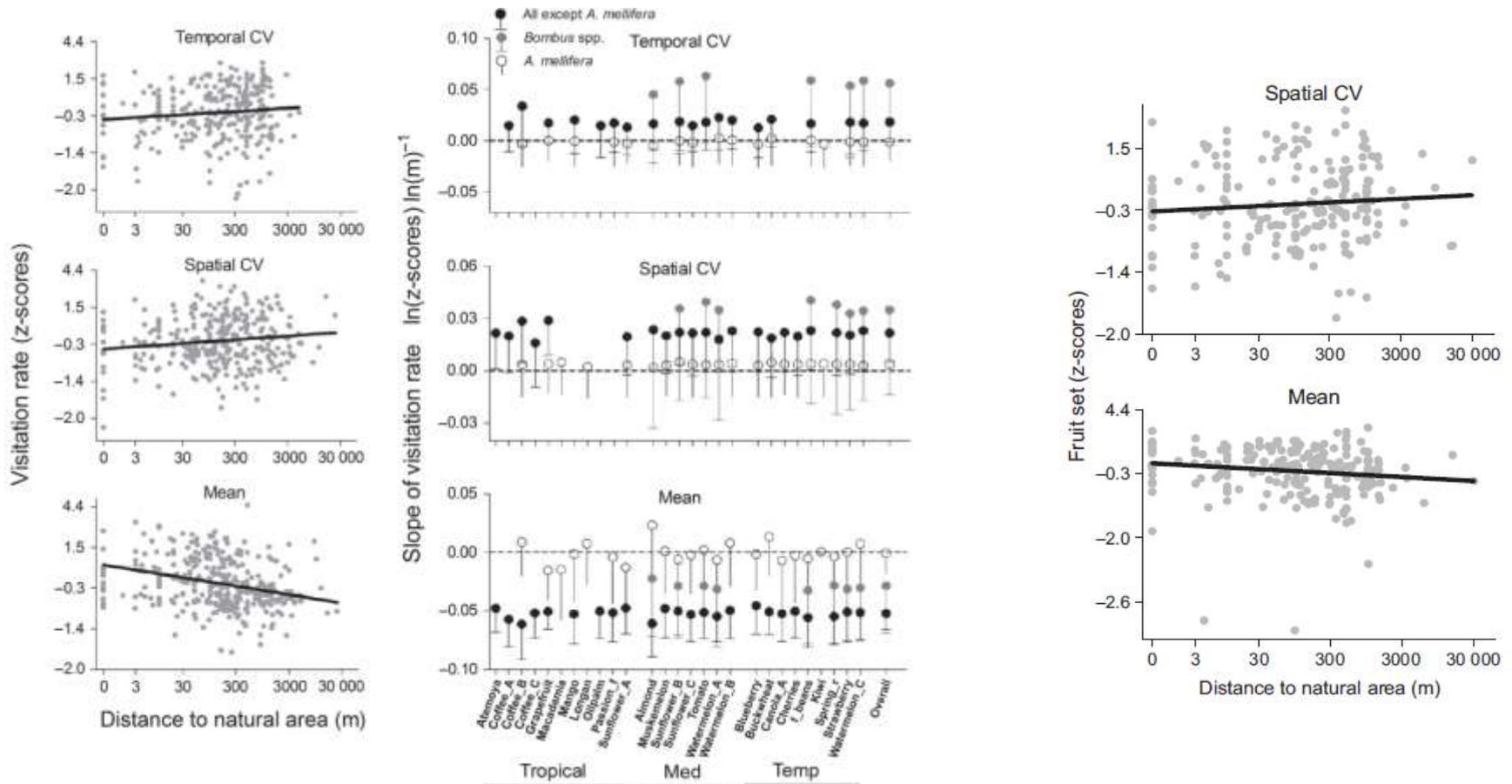
Lucas A. Garibaldi,^{1,2*} Ingolf Steffan-Dewenter,³ Claire Kremen,⁴ Juan M. Morales,¹ Riccardo . . .



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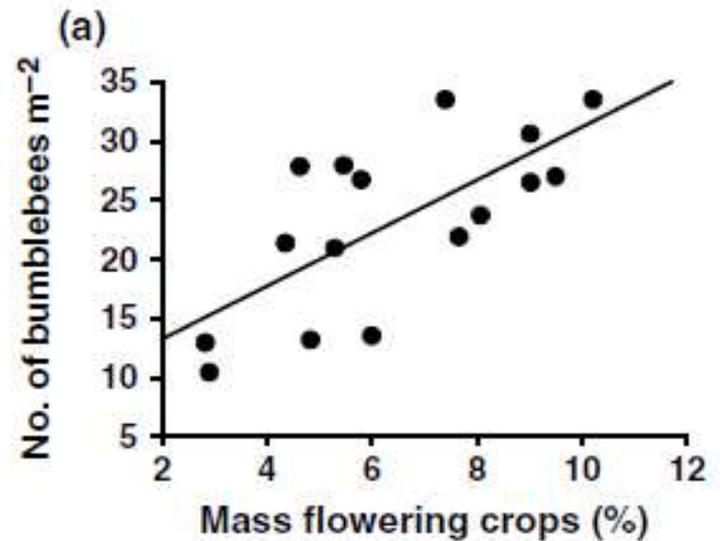
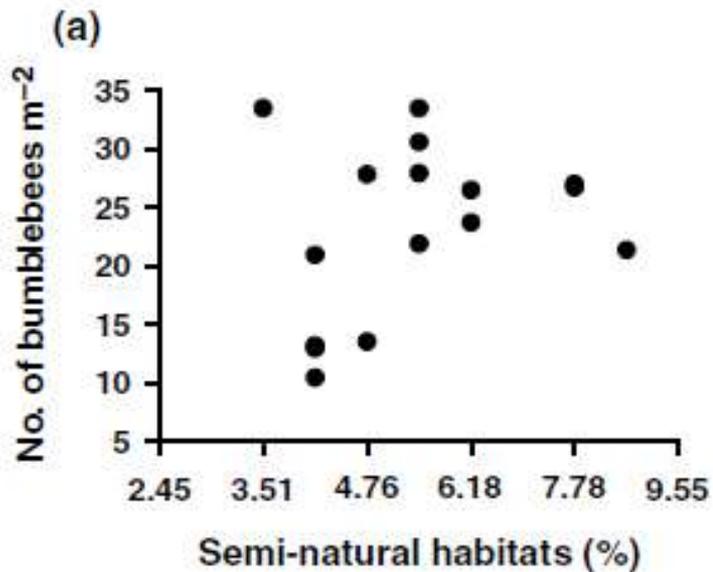
Lucas A. Garibaldi,^{1,2*} Ingolf Steffan-Dewenter,³ Claire Kremen,⁴ Juan M. Morales,¹ Riccardo . . .



Mass flowering crops

Mass flowering crops enhance pollinator densities at a landscape scale

Catrin Westphal,* Ingolf Steffan-Dewenter and Teja Tscharntke



Mass flowering crops

Oilseed rape crops distort plant–pollinator interactions

Tim Diekötter^{1*}, Taku Kadoya², Franziska Peter¹, Volkmar Wolters¹ and Frank Jauker¹



Trifolium p.



Oilseed rape

long tong bumble bee

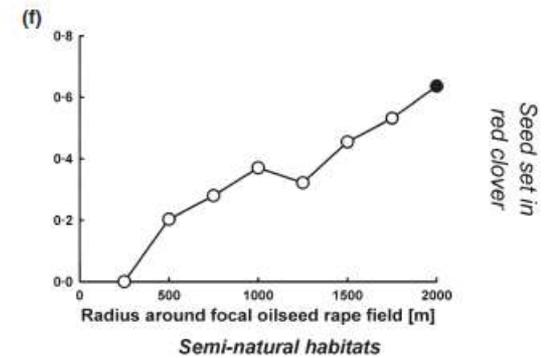
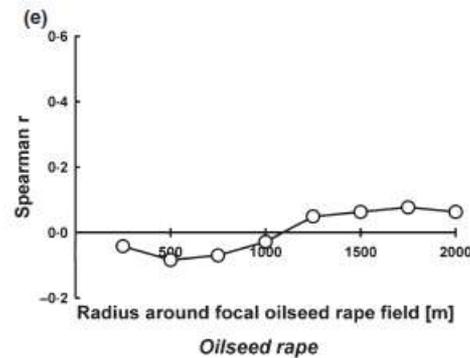
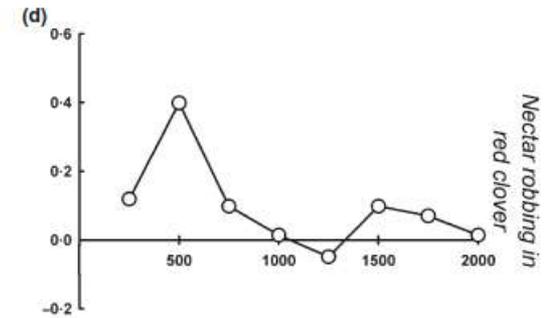
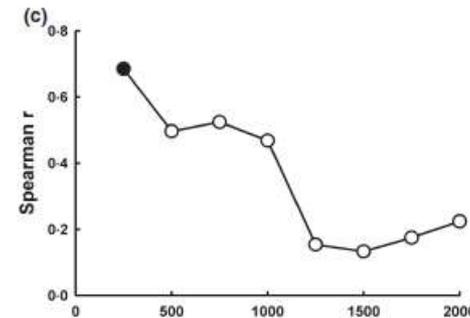
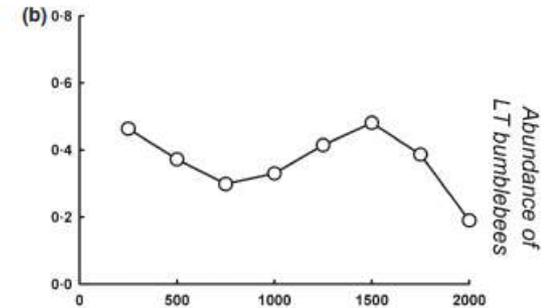
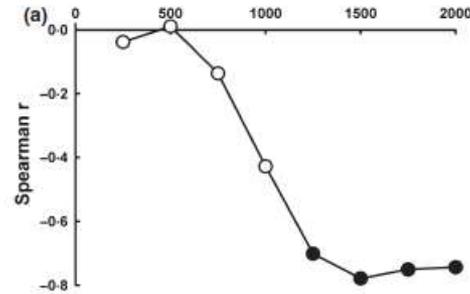


Bombus pascorum

short tong bumble bee



Bombus terrestris

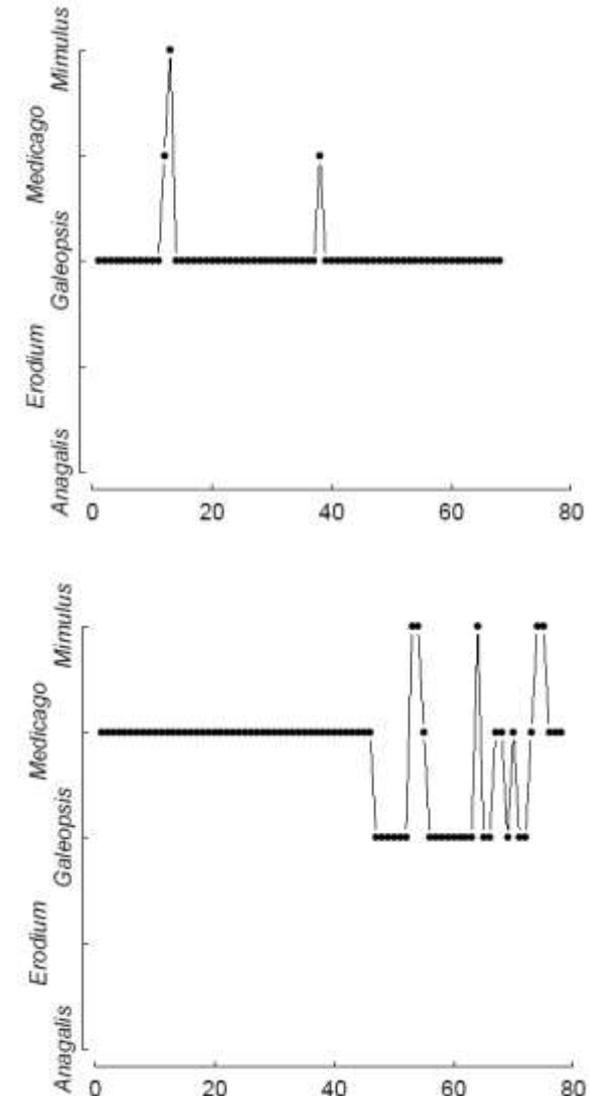
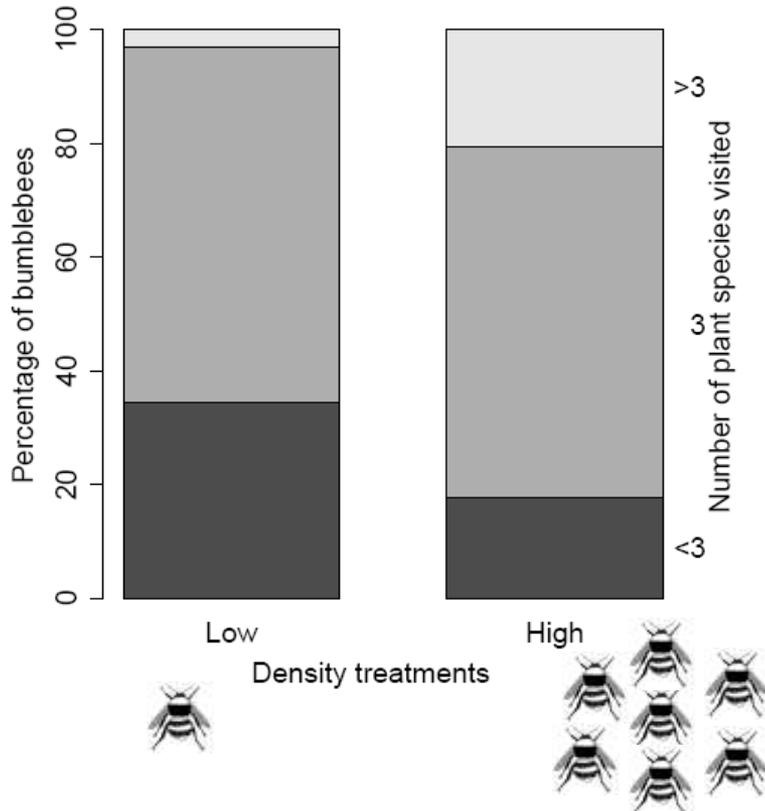


Generalist behaviour and pollinators

Journal of Ecology 2008

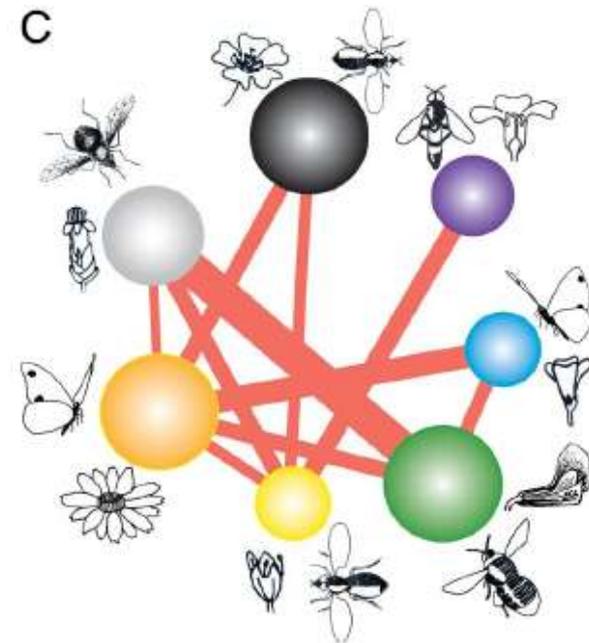
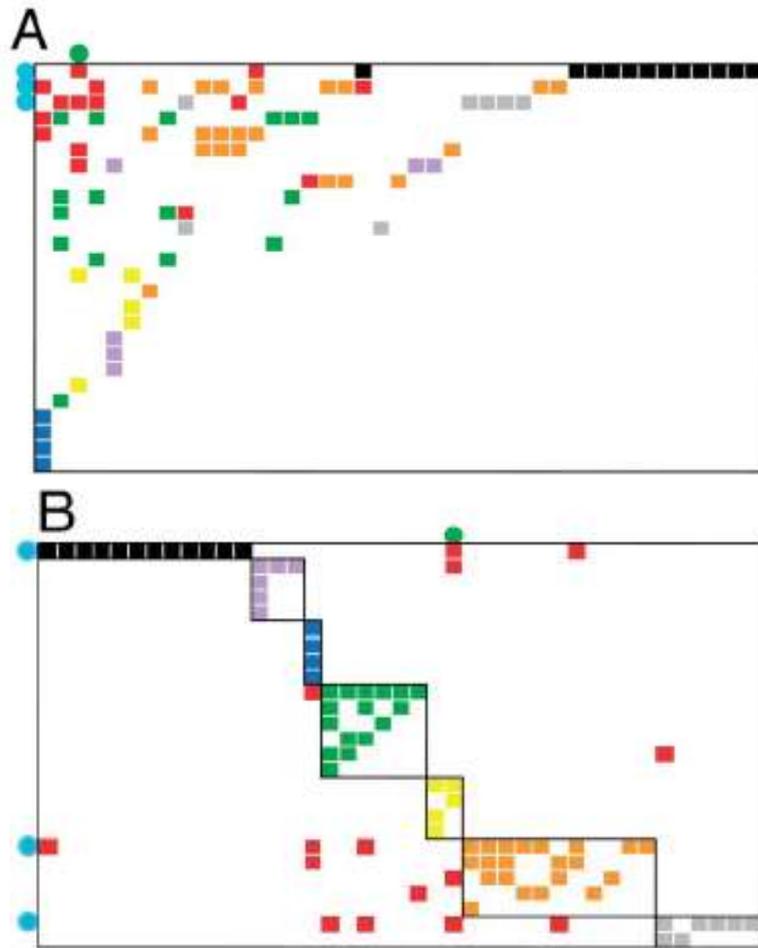
Generalist foraging of pollinators: diet expansion at high density

Colin Fontaine^{1,2*}, Carine L. Collin^{1†‡} and Isabelle Dajoz¹



Fontaine, Collin & Dajoz, *J. Ani. Ecol.* 2009

The modularity of pollination networks

Jens M. Olesen^{*,†}, Jordi Bascompte[‡], Yoko L. Dupont^{*}, and Pedro Jordano[‡]

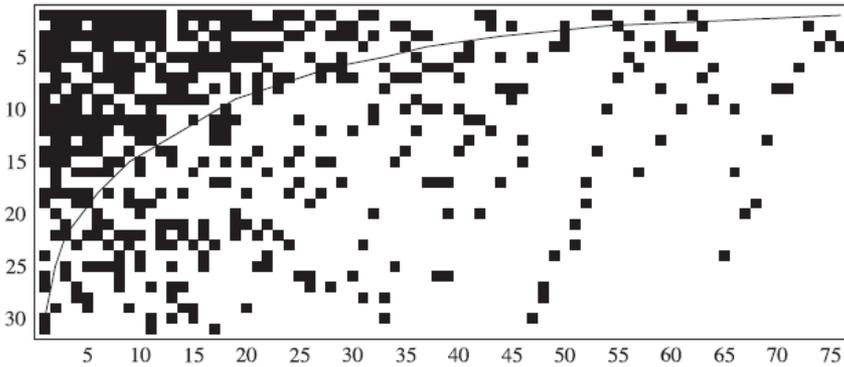
Modular matrix version of the same network as in *A*; species are now sorted according to their modular affinity (order of modules is arbitrary). Red cells are species links gluing the seven modules together into a coherent network, and nonred cells are links within modules (links of the different modules can be identified in *A* by their color). (*C*) Graph of modules. Module links are weighted by both the number of species links between modules and number of species within modules; vignettes show dominant pollinator and flower type: black module: Diptera species and mainly white flowers; purple module: small-to-medium-sized beetles, flies, an ant, and small, white/yellow flowers; blue module: butterflies and one plant species, *Oxalis* species; green module: bees, birds, and large, mainly yellow flowers with a closed morphology; yellow module: large flies and small, yellow umbellifer flowers; orange module: butterflies, a large fly, and white/yellow/pink/purple flowers; and gray module: large flies and mainly small, white flowers. (*D*) *z*-plot of species roles with three module hubs and one connector, but

Implication of the architecture of pollination networks

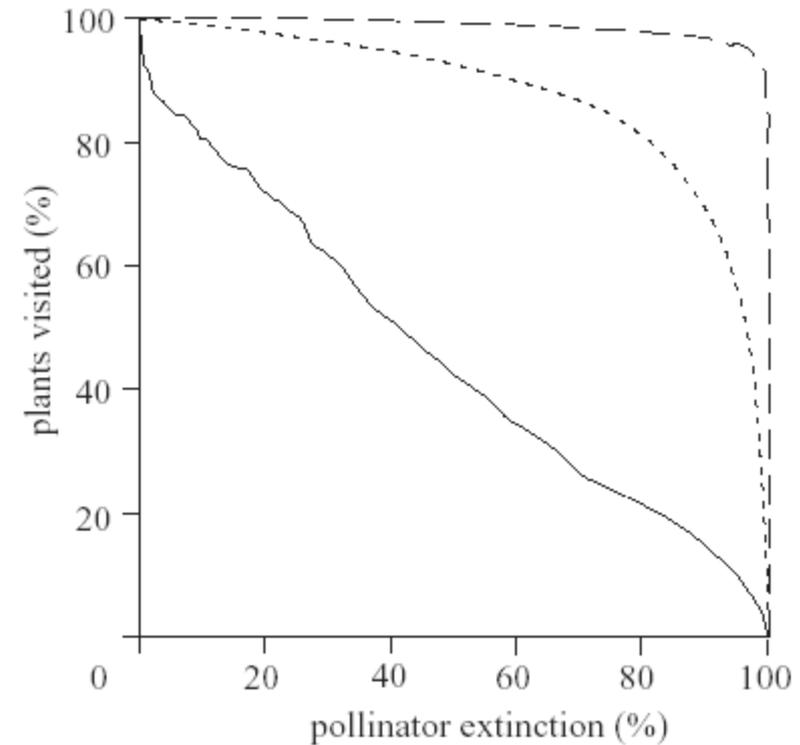
Proc. R. Soc. Lond. B (2004) 271, 2605–2611

Tolerance of pollination networks to species extinctions

Jane Memmott^{1*}, Nickolas M. Waser² and Mary V. Price²



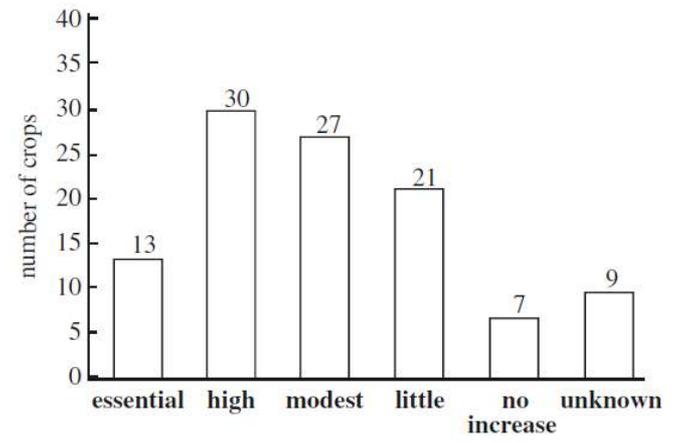
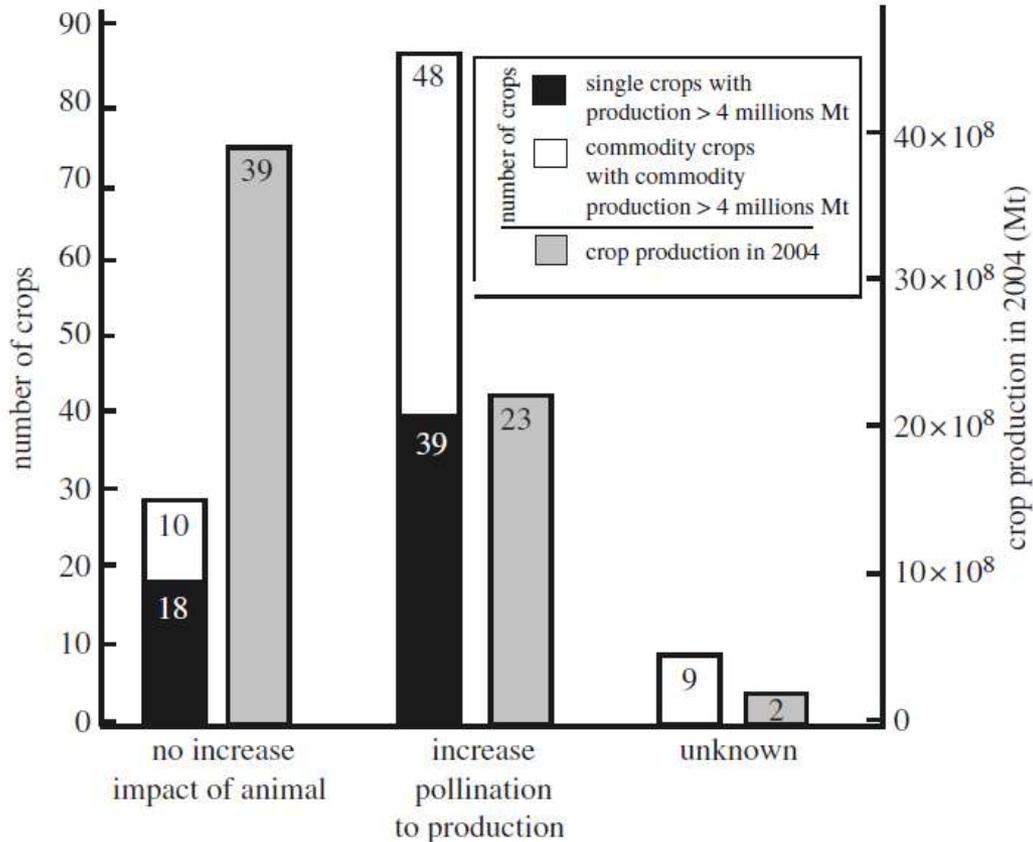
- Different pollinator extinction scenario:
- from **most** to **least** generalist species ———
 - **random**
 - from **least** to **most** generalist species - - - - -



Un service écosystémique important



Analyse des 87 plantes cultivées principales



Un service lié aux caractéristiques du paysage

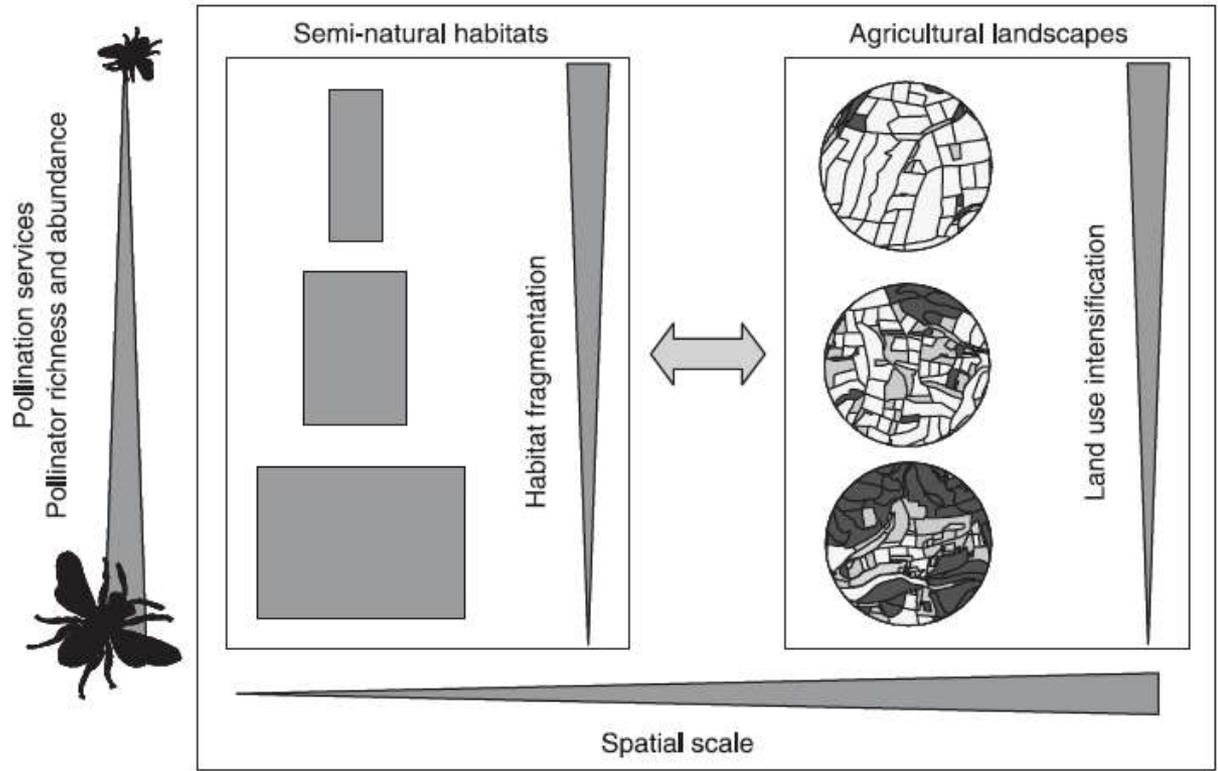


Fig. 1. Interplay of pollination services, pollinator richness and abundance and land use changes (habitat fragmentation and land use intensification). Both habitat fragmentation and land use intensification affect pollinator communities at different spatial scales and interact with each other.