At a global scale, conservation of pollinators and herbivores between related plants varies widely across communities and between plant families
Supporting Information

Alyssa R. Cirtwill, Giulio V. Dalla Riva, Nick J. Baker,
Mikael Ohlsson, Isabelle Norström, Inger-Marie Wohlfarth,
Joshua A. Thia, & Daniel B. Stouffer

1

Notes S1: Sources for networks

Table S1: Original sources for each network used in our analyses. All networks beginning
'M_PL_' were collected from Ortega *et al.* (Accessed Nov. 22, 2019). Further details for
unpublished networks may be found there.

Network	Network type	Country	Original source
M_PL_001	Pollination	Chile	Arroyo *et al.* (1982)
M_PL_002	Pollination	Chile	Arroyo *et al.* (1982)
M_PL_003	Pollination	Chile	Arroyo *et al.* (1982)
M_PL_004	Pollination	Canada (New Brunswick)	Barrett & Helenurm (1987)
M_PL_005	Pollination	U.S.A. (Colorado)	Clements & Long (1923)
M_PL_006	Pollination	U.K. (Norfolk)	Dicks *et al.* (2012)
M_PL_007	Pollination	U.K. (Norfolk)	Dicks *et al.* (2012)
M_PL_008	Pollination	Spain (Canary Islands)	Dupont *et al.* (2003)
M_PL_009	Pollination	Sweden	Elberling & Olesen (1999)
M_PL_010	Pollination	Denmark (Greenland)	Elberling, H. & Olesen, J. M. Unpub.
M_PL_011	Pollination	Mauritius	Olesen *et al.* (2002)
M_PL_012	Pollination	Portugal (Azores)	Olesen *et al.* (2002)
M_PL_013	Pollination	South Africa (KwaZulu-Natal)	Ollerton *et al.* (2003)
M_PL_014	Pollination	Canada (N.W.T.)	Hocking (1968)
M_PL_015	Pollination	Greece (Athens)	Petanidou (1991)
M_PL_016	Pollination	Spain (Andalucia)	Herrera (1988)
M_PL_017	Pollination	U.K. (England)	Memmott (2002)
M_PL_018	Pollination	Denmark	Olesen, J. M. Unpublished.
M_PL_019	Pollination	U.S.A. (Colorado)	Inouye & Pyke (1988)
M_PL_020	Pollination	Canada (N.W.T.)	Kevan (1970)
M_PL_021	Pollination	Japan (Kyoto)	Kato *et al.* (1990)
M_PL_022	Pollination	Argentina (Mendoza)	Medan *et al.* (2002)
M_PL_023	Pollination	Argentina (Mendoza)	Medan *et al.* (2002)
M_PL_024	Pollination	Canada (N.W.T.)	Mosquin & Martin (1967)
M_PL_025	Pollination	U.S.A. (North Carolina)	Motten (1986)
M_PL_026	Pollination	Ecuador (Galápagos Islands)	McMullen (1993)
M_PL_027	Pollination	New Zealand (South Island)	Primack (1983)
M_PL_028	Pollination	New Zealand (South Island)	Primack (1983)
M_PL_029	Pollination	New Zealand (South Island)	Primack (1983)
M_PL_030	Pollination	Venezuela	Ramirez & Brito (1992)
M_PL_031	Pollination	Venezuela	Ramirez (1989)

Network	Network type	Country	Original source
M_PL_032	Pollination	U.S.A. (Illinois)	Schemske *et al.* (1978)
M_PL_033	Pollination	Canada (Ontario)	Small (1976)
M_PL_034	Pollination	Chile	Smith-Ramírez *et al.* (2005)
M_PL_035	Pollination	Jamaica	Percival (1974)
M_PL_036	Pollination	Portugal (Azores)	Olesen, J. M. Unpublished.
M_PL_037	Pollination	Denmark	Montero (2005)
M_PL_038	Pollination	Denmark	Montero (2005)
M_PL_039	Pollination	Spain (Canary Islands)	Stald (2003)
M_PL_040	Pollination	Jamaica	Ingversen (2006)
M_PL_041	Pollination	Dominica	Ingversen (2006)
M_PL_042	Pollination	Ecuador (Galápagos Islands)	Philipp *et al.* (2006)
M_PL_043	Pollination	Denmark	Montero (2005)
M_PL_044	Pollination	Japan (Amami Islands)	Kato (2000)
M_PL_045	Pollination	Denmark (Greenland)	Lundgren & Olesen (2005)
M_PL_046	Pollination	Denmark	Bundgaard (2003)
M_PL_047	Pollination	Denmark	Dupont & Olesen (2009)
M_PL_048	Pollination	Denmark	Dupont & Olesen (2009)
M_PL_049	Pollination	Denmark	Bek (2006)
M_PL_050	Pollination	Spain (Canary Islands)	Stald (2003)
M_PL_051	Pollination	Argentina (Río Negro)	Vázquez & Simberloff (2002)
M_PL_052	Pollination	Denmark (Greenland)	Witt (1998)
M_PL_053	Pollination	Japan (Kyusu)	Yamazaki & Kato (2003)
M_PL_054	Pollination	Japan (Kyoto)	Kakutani *et al.* (1990)
M_PL_055	Pollination	Japan (Fukui Prefacture)	Kato & Miura (1996)
M_PL_056	Pollination	Japan (Yamanashi)	Kato *et al.* (1993)
M_PL_057	Pollination	Japan (Kibune)	Inoue *et al.* (1990)
M_PL_058	Pollination	Spain (Catalonia)	Bartomeus *et al.* (2008)
M_PL_059	Pollination	Brazil (Buíque)	Bezerra *et al.* (2009)
Basset	Herbivory	Papua New Guinea	Basset & Samuelson (1996)
Blüthgen	Herbivory	Malaysia (Sabah)	Blüthgen *et al.* (2006)
Bodner	Herbivory	Ecuador	Bodner *et al.* (2010)
Coley	Herbivory	Panama	Coley *et al.* (2006)
Ibanez	Herbivory	France (Central French Alps)	Ibanez *et al.* (2013)
Joern_altuda	Herbivory	U.S.A. (Texas)	Joern (1979)
Joern_marathon	Herbivory	U.S.A. (Texas)	Joern (1979)
Novotny	Herbivory	Papua New Guinea	Novotny *et al.* (2012)
Peralta	Herbivory	New Zealand (South Island)	Peralta (2016)
Sheldon	Herbivory	U.S.A. (Washington)	Sheldon & Rogers (1978)
Ueckert	Herbivory	U.S.A. (Colorado)	Ueckert & Hansen (1971)

Notes S2: R implementation of tuple-form regression

We first fit a series of regressions (one per network) relating the Jaccard dissimilarity of the interaction partners of plants i and j (J_{ij}) to the phylogenetic distance between them (δ_{ij}), using the form

$$\text{logit}\,(J_{ij}) \propto \beta_{distance}\delta_{ij}. \tag{1}$$

We fit these regressions using the R (R Core Team, 2016) base function "glm", which will accept J_{ij} formatted as either a single value summarizing the probability of sharing an interaction partner *or* the numbers of shared and un-shared interaction partners (M_{ij} and U_{ij}). As we wished to use the tuple (M_{ij}, U_{ij}) as our input, the command in R was:

   model=glm(cbind(M_ij,U_ij) $\sim$ scale(delta_ij),family="binomial").

   We used the same tuple-input form of the binomial regression for all subsequent regressions.

Notes S3: Repeating our analyses with proportion of shared partners

We repeated some of our analyses using the proportion of shared interaction partners as the response rather than a tuple describing the number of interaction partners that are shared and not shared. This approach is common when performing logistic regressions, but loses information about the varying weights of evidence about different plant pairs. This lost information can limit the power of the regression to detect weak trends.

Across all networks, more distantly-related plants remained less likely to share interaction partners, but this relationship was not significant in herbivory networks ($\beta_{distance}$=-1.07, p=0.477; compare to $\beta_{distance}$=-6.82, p<0.001 in the main text). Plants in pollination networks again tended to share fewer interaction partners overall ($\beta_{pollination}$=-0.881, p<0.001; compare to $\beta_{pollination}$=-1.44, p<0.001 in the main text), and the decrease in overlap with increasing phylogenetic distance was steeper than in herbivory networks ($\beta_{distance:pollination}$=-26.8, p<0.001; compare to $\beta_{distance:pollination}$=-18.5, p<0.001 in the main text). Thus, while we observed the same trends when treating the response as a proportion and as a tuple, the tuple format displayed these trends more clearly. This is likely because of the additional information incorporated in the tuple.

Within networks, using the proportion of shared interaction partners rather than a tuple resulted in significant relationships between phylogenetic distance and overlap in interaction partners in five herbivory networks and seven pollination networks (compare to seven and 34 networks, respectively, in the main text). In each case, the proportion of shared interaction partners decreased with increasing phylogenetic distance. Again, this demonstrates the greater power of a Jaccard regression with a tuple response to capture weak trends. The best-fit models for individual networks show much less variation when framing the response as a proportion (Fig. S1).

Notes S4: A test of connectance

To test whether the relationship between phylogenetic distance and niche overlap depended on connectance, we fit a general linear model for the slope of this relationship inferred from the glm models against connectance (C), network type (again using herbivory networks as a baseline), and their interaction:

$$\beta_{distance} \propto \beta_C \eta_N + \beta_{pollination} I_N + \beta_{C:pollination} \eta_N I_N, \tag{2}$$

where η_N is the number of plant pairs in network N for which distances could be calculated, I_N is an indicator equal to 1 if network N is a pollination network and 0 otherwise.

The strength of the relationship did not depend on network type ($\beta_{pollination}$=-0.015, p=0.860), connectance (β_C=-0.652, p=0.051), or their interaction ($\beta_{C:pollination}$=0.687, p=0.084). If we removed the interaction term and re-fit the model, the strength of the relationships between phylogenetic distance and niche overlap still did not depend on connectance (β_C=-0.169, p=0.356). We conclude that connectance does not constrain pairwise niche overlap in our dataset.
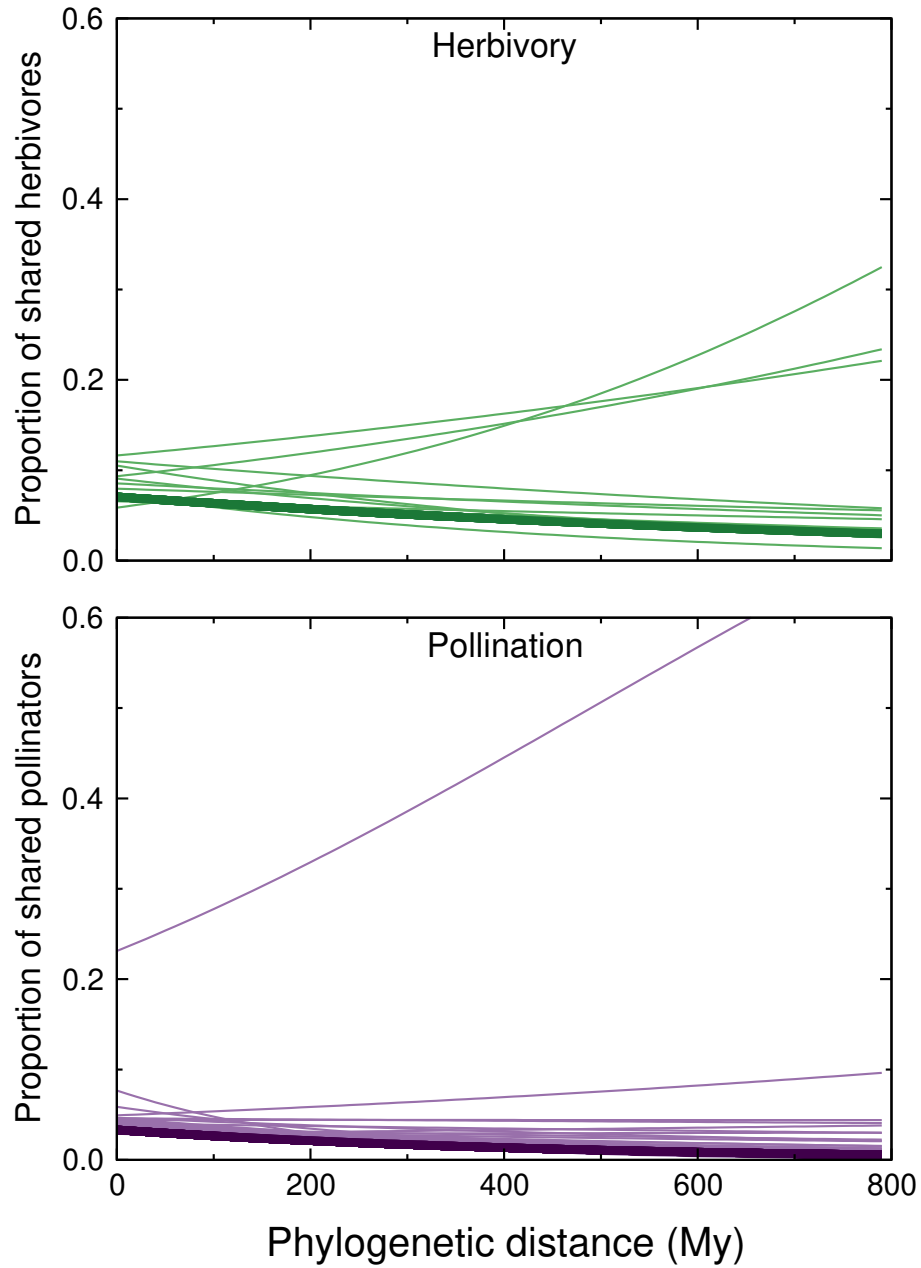
Figure S1: When considering niche overlap as the proportion of shared interaction partners rather than both the number of interaction partners that are shared and not shared, there is much less variability between networks. The overall trends (thicker, darker lines) observed are also much weaker than those detected when using all of the available information. Compare with Fig. 1, main text. Both figures are plotted on the same scale.

Notes S5: Distributions of p-values for permuted networks

Comparing the permuted networks to permutations of the permuted networks, the slope obtained from the initial permuted network showed no clear relationship to the slopes obtained from 500 permutations of the permuted network. Averaged over the 1000 permutations of each observed network, the slope of the permuted network was more extreme than 48.1-51.3% of the permutations of the permuted network. This confirms that shuffling phylogenetic distances between plant pairs destroys the relationship between distance and interaction partner overlap, and that further shuffling distances does not have a predictable effect.

Networks shown in each panel of Figure S2

All names are as in Table S1. Networks included in each panel (from darkest to lightest line colours) are:

A) M_PL_001, M_PL_002, M_PL_003, M_PL_004, M_PL_005;

B) M_PL_006, M_PL_007, M_PL_008, M_PL_009, M_PL_010;

C) M_PL_011, M_PL_012, M_PL_013, M_PL_014, M_PL_015;

D) M_PL_016, M_PL_017, M_PL_018, M_PL_019, M_PL_020;

E) M_PL_021, M_PL_022, M_PL_023, M_PL_024, M_PL_025;

F) M_PL_026, M_PL_027, M_PL_028, M_PL_029, M_PL_030;

G) M_PL_031, M_PL_032, M_PL_033, M_PL_034, M_PL_035;

H) M_PL_036, M_PL_037, M_PL_038, M_PL_039, M_PL_040;

I) M_PL_041, M_PL_042, M_PL_043, M_PL_044, M_PL_045;

J) M_PL_046, M_PL_047, M_PL_048, M_PL_049, M_PL_050;

K) M_PL_051, M_PL_052, M_PL_053, M_PL_054, M_PL_055;

L) M_PL_056, M_PL_057, M_PL_058, M_PL_059;

M) Ibanez, Joern_altuda, Joern_marathon, Peralta, Sheldon;

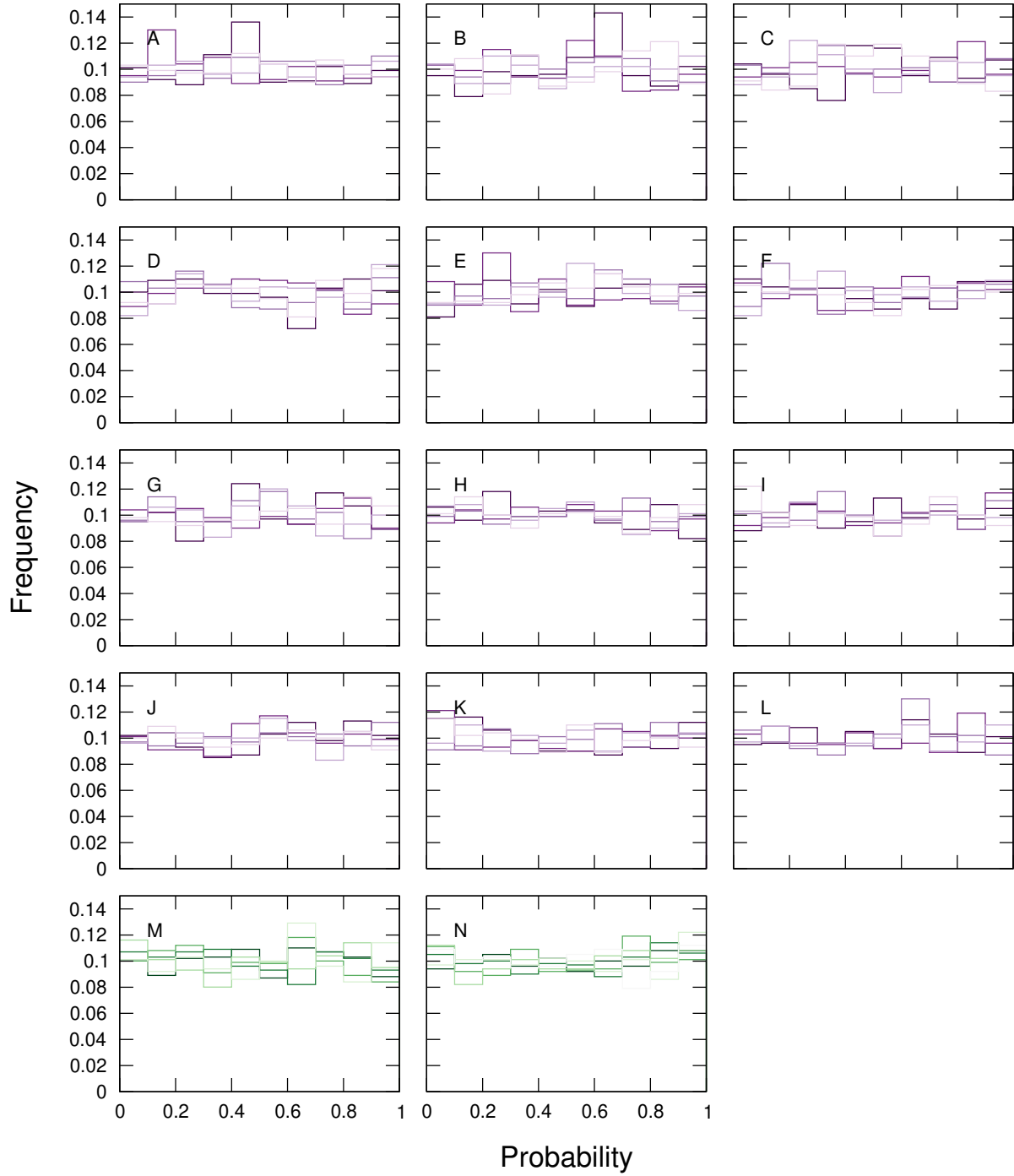**N)** Ueckert, Basset, Bluthgen, Bodner, Coley, Novotny.

Figure S2: Nearly uniform distributions of p-values where obtained when comparing the strength of the relationship between niche overlap and phylogenetic distance in 999 permutations of each network in our dataset with 500 permutations of each permuted network. Each line in each panel represents the histogram of p-values for one network. Bins are 0.1 wide. Purple lines in panels A-L represent pollination networks while green lines in panels M-N represent plant-herbivore networks. A list of networks shown on each panel follows; see Table S1 for original sources.

Notes S6: Details of within-family regressions

Models for nine families could not be fit because there was no variation in the phylogenetic distance between plants, their numbers of shared interaction partners, or both. These families were *Amaranthaceae, Araliaceae, Cactaceae, Cornaceae, Gentianaceae, Liliaceae, Oxalidaceae, Rhamnaceae,* and *Zingiberaceae.* Further, we could not fit a model for *Lauraceae* in pollination networks or *Sapindaceae* in herbivory or pollination networks as only one plant pair in each network type shared any interaction partners.

Only nine families were sufficiently well-represented to fit models for shared herbivores. Five of these were also well-represented in plant-pollinator networks: *Asteraceae, Fabaceae, Melastomataceae, Poaceae,* and *Rubiaceae.* In total, there were 48 families which were well-represented enough to fit models for shared pollinators. Note that singular fits were obtained for *Amaranthaceae, Araliaceae, Boraginaceae, Campanulaceae, Caryophyllaceae, Ericaceae, Geraniaceae, Hydrangeaceae, Malvaceae, Oxalidaceae, Primulaceae, Saxifragaceae,* and *Verbenaceae.*

To account for multiple testing, we compared the p-values of the significant slopes to critical values in a sequential correlated Bonferroni test (Drezner & Drezner, 2016). This test accounts for the increased likelihood of obtaining at least one significant result by chance when conducting multiple hypothesis tests, but is less conservative and less prone to type II errors than the original Bonferroni test. All p-values remained significant after applying this test (Table S2).

Table S2: Below, we show the ranked p-values for the significant slopes in pollination and herbivory networks side-by-side with the critical values from the SCBT. Any p-value which is less than the corresponding critical value remains significant. We obtained critical values separately for the pollination and herbivory networks.

Family	Network type	p-value	Critical value
Apocynaceae	pollination	0.037	0.05000
Rubiaceae	pollination	0.026	0.03952
Amaryllidaceae	pollination	0.015	0.03656
Apiaceae	pollination	0.006	0.03300
Poaceae	pollination	0.003	0.03009
Asteraceae	pollination	<0.001	0.02784
Boraginaceae	pollination	<0.001	0.02610
Cistaceae	pollination	<0.001	0.02473
Fabaceae	pollination	<0.001	0.02363
Lamiaceae	pollination	<0.001	0.02273
Lauraceae	pollination	<0.001	0.02198
Plantaginaceae	pollination	<0.001	0.02134
Polygonaceae	pollination	<0.001	0.02080
Ranunculaceae	pollination	<0.001	0.02033
Moraceae	herbivory	0.046	0.05000
Nothofagaceae	herbivory	0.022	0.03201
Pinaceae	herbivory	0.020	0.02627
Poaceae	herbivory	0.006	0.02231
Rubiaceae	herbivory	<0.001	0.01952

References

Arroyo MTK, Primack R & Armesto J. 1982. Community studies in pollination ecology in the high eemperate Andes of Central Chile. I. Pollination mechanisms and altitudinal variation. *American Journal of Botany* **69**: 82–97.

Barrett SCH & Helenurm K. 1987. The reproductive biology of boreal forest herbs. I. Breeding systems and pollination. *Canadian Journal of Botany* **65**: 2036–2046.

Bartomeus I, Vilà M & Santamaría L. 2008. Contrasting effects of invasive plants in plant-pollinator networks contrasting effects of invasive plants in plant-pollinator networks. *Oecologia* **155**: 761–770.

Basset Y & Samuelson GA. 1996. Ecological characteristics of an arboreal community of Chrysomelidae in Papua New Guinea. *SPB Academic Publishing* (eds. P.H.A. Jolivet & M.L. Cox), pp. 243–262. Amsterdam: SPB Academic Publishing.

Bek S. 2006. *A pollination network from a Danish forest meadow.* Master's thesis, University of Aarhus, Denmark.

Bezerra ELS, Machado IC & Mello MAR. 2009. Pollination networks of oil-flowers: a tiny world within the smallest of all worlds. *Journal of Animal Ecology* **78**: 1096–1101.

Blüthgen N, Metzner A & Ruf D. 2006. Food plant selection by stick insects (Phasmida) in a Bornean rain forest. *Journal of Tropical Ecology* **22**: 35–40.

Bodner F, Brehm G, Homeier J, Strutzenberger P & Fiedler K. 2010. Caterpillars and host plant records for 59 species of Geometridae (Lepidoptera) from a montane rainforest in southern Ecuador. *Journal of Insect Science* **10**: 67.

Bundgaard M. 2003. *Tidslig og rummelig variation i et plante-bestøvernetværk. MSc.-thesis.* Master's thesis, University of Aarhus, Denmark.

Clements FE & Long FL. 1923. *Experimental pollination; an outline of the ecology of flowers and insects.* Washington, D.C.: Carnegie Institution of Washington.

Coley PD, Bateman ML & Kusar TA. 2006. The effects of plant quality on caterpillar growth and defense against natural enemies. *Oikos* **115**: 219–228.

Dicks LV, Corbet SA & Pywell RF. 2012. Compartmentalization in plant-insect flower visitor webs. *Journal of Animal Ecology* **71**: 32–43.

Drezner Z & Drezner TD. 2016. A remedy for the overzealous Bonferroni technique for multiple statistical tests. *The Bulletin of the Ecological Society of America* **97**: 91–98.

Dupont YL, Hansen DM & Olesen JM. 2003. Structure of a plant-flower-visitor network in the high-altitude. *Ecography* **26**: 301–310.

Dupont YL & Olesen JM. 2009. Ecological modules and roles of species in heathland plant-insect flower visitor networks. *Journal of Animal Ecology* **78**: 346–353.

Elberling H & Olesen JM. 1999. The structure of a high latitude plant-pollinator system: the dominance of flies. *Ecography* **22**: 314–323.

Herrera J. 1988. Pollination relationships in southern Spanish Mediterranean shrublands. *Journal of Ecology* **76**: 274–287.

Hocking B. 1968. Insect-flower associations in the High Arctic with special reference to nectar. *Oikos* **19**: 359–.

Ibanez S, Lavorel S, Puijalon S & Moretti M. 2013. Herbivory mediated by coupling between biomechanical traits of plants and grasshoppers. *Functional Ecology* **27**: 479–489.

Ingversen TT. 2006. *Plant-pollinator interactions on Jamaica and Dominica.* Master's thesis, University of Aarhus, Denmark.

Inoue T, Kato M, Kakutani T, Suka T & Itino T. 1990. Insect-flower relationship in the temperate deciduous forest of Kibune, Kyoto: an overview of the flowering phenology and the seasonal pattern of insect visits. *Contributions from the Biological Laboratory, Kyoto University* **27**: 377–463.

Inouye DW & Pyke GH. 1988. Pollination biology in the Snowy Mountains of Australia: comparisons with montane Colorado, USA. *Australian Journal of Ecology* **13**: 191–210.

Joern A. 1979. Feeding patterns in grasshoppers (Orthoptera: Acrididae): factors influencing diet specialization. *Oecologia* **38**: 325–347.

Kakutani T, Inoue T, Kato M & Ichihashi H. 1990. Insect-flower relationship in the campus of Kyoto University, Kyoto: an overview of the flowering phenology and the seasonal pattern of insect visits. *Contributions from the Biological Laboratory, Kyoto University* **27**: 465–521.

Kato M. 2000. Anthophilous insect community and plant-pollinator interactions on Amami Islands in the Ryukyu Archipelago, Japan. *Contributions from the Biological Laboratory, Kyoto University* **29**: 157–254.

Kato M, Makutani T, Inoue T & Itino T. 1990. Insect-flower relationship in the

primary beech forest of Ashu, Kyoto: and overview of the flowering phenology and seasonal pattern of insect visits. *Contributions from the Biological Laboratory, Kyoto University* **27**: 309–375.

Kato M & Miura R. 1996. Flowering phenology and anthophilous insect community at a threatened natural lowland marsh at Nakaikemi in Tsuruga, Japan. *Contributions from Biological Laboratory, Kyoto University* **29**: 1–48.

Kato M, Matsumoto M & Kato T. 1993. Flowering phenology and anthophilous insect community in the cool-temperate subalpine forests and meadows at Mt. Kushigata in the central part of Japan. *Contributions from the Biological Laboratory, Kyoto University* **28**: 119–172.

Kevan PG. 1970. *High arctic insect-flower relations: the inter-relationships of arthropods and flowers at Lake Hazen, Ellesmere Island, NWT, Canada.* Ph.d. thesis, University of Alberta.

Lundgren R & Olesen JM. 2005. The dense and highly connected world of Greenland's plants and their pollinators. *Arctic, Antarctic, and Alpine Researcher* **37**: 514–520.

McMullen CK. 1993. Flower-visiting insects of the Galapagos Islands. *Pan-Pacific Entomology* **69**: 95–106.

Medan D, Montaldo NH, Devoto M, Maniese A, Vasellati V, Roitman GG & Bartoloni NH. 2002. Plant-pollinator relationships at two altitudes in the Andes of Mendoza, Argentina. *Arctic, Antarctic, and Alpine Research* **34**: 233–241.

Memmott J. 2002. The structure of a plant–pollinator food web. *Ecology Letters* **2**: 276–280.

Montero AC. 2005. *The Ecology of pollination networks, MSc.-thesis.* Master's thesis, University of Aarhus, Denmark.

Mosquin T & Martin JEH. 1967. Observations on the pollination biology of plants on Melville Island, N.W.T., Canada. *Canadian Field Naturalist* **81**: 201–205.

Motten AF. 1986. *Pollination ecology of the spring wildflower community of a temperate deciduous forest.* Ph.d. thesis, Duke University, USA. doi: `10.2307/2937269`

Novotny V, Miller SE, Hrcek J, Baje L, Basset Y, Lewis OT, Stewart AJA & Weiblen GD. 2012. Insects on plants: explaining the paradox of low diversity within specialist herbivore guilds. *The American Naturalist* **179**: 351–362.

Olesen JM, Eskildsen LI & Venkatasamy S. 2002. Invasion of pollination networks on oceanic islands: importance of invader complexes and endemic super generalists. *Diversity and Distributions* **8**: 181–192.

Ollerton J, Johnson SD, Cranmer L & Kellie S. 2003. The pollination ecology of an assemblage of grassland asclepiads in South Africa. *Annals of Botany* **92**: 807–834.

Ortega R, Fortuna MA & Bascompte J. Accessed Nov. 22, 2019. The Web of Life dataset. *www.web-of-life.es* .

Peralta G. 2016. Merging evolutionary history into species interaction networks. *Functional Ecology* **30**: 1917–1925.

Percival M. 1974. Floral ecology of coastal scrub in southeast Jamaica. *Biotropica* **6**: 104–129.

Petanidou T. 1991. *Pollination ecology in a phryganic ecosystem.* Ph.d. thesis, Aristotelian University, Thessaloniki.

Philipp M, Böcher J, Siegismund HR & Nielsen LR. 2006. Structure of a plant-pollinator network on a pahoehoe lava desert of the Galápagos Islands. *Ecography* **29**: 531–540.

Primack RB. 1983. Insect pollination in the New Zealand mountain flora. *New Zealand Journal of Botany* **21**: 317–333.

R Core Team. 2016. *R: a language and environment for statistical computing.* Vienna, Austria: R Foundation for Statistical Computing.

Ramirez NBY & Brito Y. 1992. Pollination biology in a palm swamp community in the Venezuelan central plains. *Botanical Journal of the Linnean Society* **110**: 277–302.

Ramirez N. 1989. Biologia de polinizacion en una comunidad arbustiva tropical de la Alta Guayana Venezolana. *Biotropica* **21**: 319–330.

Schemske DW, Willson MF, Melampy MN, Miller LJ, Verner L, Schemske KM & Best LB. 1978. Flowering ecology of some spring woodland herbs. *Ecology* **59**: 351–366.

Sheldon JK & Rogers LE. 1978. Grasshopper food habits within a shrub-steppe community. *Oecologia* **32**: 85–92.

Small E. 1976. Insect pollinators of the Mer Bleue peat bog of Ottawa. *Canadian Field Naturalist* **90**: 22–28.

Smith-Ramírez C, Martinez P, Nuñez M, González C & Armesto JJ. 2005. Diversity, flower visitation frequency and generalism of pollinators in temperate rain forests of Chiloé Island, Chile. *Botanical Journal of the Linnean Society* **147**: 399–416.

Stald L. 2003. *Struktur og dynamik i rum og tid af et bestøvningsnetværk på Tenerife, De Kanariske Øer.* Master's thesis, University of Aarhus, Denmark.

Ueckert DN & Hansen RM. 1971. Dietary overlap of grasshoppers on sandhill rangeland in northeastern Colorado. *Oecologia* **8**: 276–295.

Vázquez DP & Simberloff D. 2002. Ecological specialization and susceptibility to disturbance: conjectures and refutations. *The American Naturalist* **159**: 606–623.

Witt P. 1998. *Witt, P.* Bsc thesis, University of Aarhus, Denmark.

Yamazaki K & Kato M. 2003. Flowering phenology and anthophilous insect community in a grassland ecosystem at Mt. Yufu, western Japan. *Contributions from the Biological Laboratory, Kyoto University* **29**: 255–318.