Chapter 2 Draft

Here I'm going to try to understand our data a bit better and state our hypothesis.

First I start with an abstract that could be our guide for hypothesis testing and analyses.

Abstract (draft)

Plant pollinator interactions are a keystone process for ecosystem functioning. However, we lack comprehensive information from both plants and pollinators that can inform from this mutualistic interaction worldwide. In order to tackle this, we have selected 30 networks distributed across the world and looked for key floral traits of plant-pollinator interactions for a total of 1600 species. Here we look how these floral traits shape the different plant-pollinator networks and the main fuctional groups of insect pollinating species. Giving the different nature of the data collated we do not compare across networks and we focus on the main general patterns/results within network. We have conducted our analysis at 3 levels, 1) unique networks, 2) metawebs and by 3) grouping both. We find that specific traits are associated with different guilds of floral visitors within these networks. We also highlight the lack of information about traits and the reproductive biology of the plant species of these networks. Our work shows the importance of deepen in species traits in order to understand key processes that can be seen with network metrics and highlights the importance of elemental ecology for species conservation.

INTRODUCTION

Paragraph 1

Paragraph 2

There are multiple recent studies that have considered the link between network structure and functional traits. Novella-Fernandez et al. (2019) included floral display on the interaction strength of a plant-pollinator network, finding important changes in species and network metrics. Moreover, Lázaro et al. (2019) shows how different traits, including flower abundance, shape, size, flowering length and nectar can influence the position in the network with important implications for community assembly. A more similar look to this piece is the work conducted by Carvalheiro et al. (2014) that focus on 750 networks and looks how nectar production can modulate the effects between species and found that its effect is dependent on pollinator guilds. The continuum from visitation to species fitness is essential to understand the relative importance of each species on the network. Therefore, there is a need to to include species breeding systems, compatibility level and seed/fruit set in order to fully understand the dependance on pollinators and position in the network. However few works have attempted this due to high demanding nature of these types of experiment (Lázaro et al. 2019) (Gómez and Perfectti 2012)

LAZARO/GOMEZ/TUR

Stang papers correlations trait matching and flower size

TUR –> INSECT POLLINATOR DEPENDANCE

ARCEO GOMEZ NEW PAPER

Paragraph 3

Paragraph 4

Hypothesis

1) How the different pollinator taxonomic groups interact with the distinct plant floral traits. Are these floral traits characteristic of a pollinator syndrome?

2) Are the different selected floral traits affecting the species level metrics such as generalization/specialization or centrality? What is its ecological meaning?

3) Can we predict the diversity of pollinator interactions with the phylogenetic distance of a community? Communities with a higher number o close related species will likely have trait redundancy and less diversity of interactions.

*Species/network metrics centrality/specialization

MATERIALS AND METHODS

This research has collated networks from 25 different studies from very different geographical regions across the world. All of these networks are from natural habitats or systems with a minor human intervention. The nature of these networks is both weighted (N) and unweighted (N) with the former just with visitation data which could serve as proxy of pollinations with limitations (REF). These studies have been counducted with different sampling methodologies and sampling effort and our aim is not to compare them but to get a general picture of how the traits shape these networks and the different taxonomic groups. The networks of these studies that were done in consecutive years or in areas close to each other with a similar species compositon were combined in metawebs. This makes a total of 30 different unique networks/metawebs when all are considered by their maximum level of organization (metaweb if possible). All the species names were searched with the help of the package taxsize (REF) from two different data sources ncbi and itis, that are … (REF). We filled the not found searches manually with the help of [http://www.theplantlist.org/] and [http://www.catalogueoflife.org/]

For all of these studies we have done an extensive literature and online search of different floral traits. These traits are breeding system, compatibility system, selfing rate (with fruit and seed set), flower shape, flower symmetry, flower size (width and length), style length and ovule number. Moreover, we also recorded plant height, life span and life form for these species. These networks have weighted and unweighted data.

All plant and pollinator species names from these networks were searched through the Package taxsize from two different data sources ncbi and itis, respectively. Two of the main data sources for taxonomic names

DESCRIPTION OF THE DATA

What sort of data do we have?

There are approximately 1600 species from 30 different networks. All of these networks are phytocentric (built from plants). The different plant-pollinator communities have been studied with very different sampling effort and methodologies. Therefore, our aim is not to compare across studies but to create a general picture of how floral traits shape the different pollinator taxa and network metrics. Here, we combine studies that have multiple years of sampling and multiple sites within an area in metawebs. These metawebs give a broader perspective of the sampling area and inform about the regional species pool (**???**). The data of these networks is quantitative (visitation) or qualitative (binary), there are in total 19 and 11 networks/metawebs of each, respectively.

Id	Longitude	Latitude	Country	Year	Networks	Plant spp	Pollinator spp	Network size	Sampling method	Sampling	Data type
Bartomeus 2008	3.296797	42.315336	Spain	2005	3	18	37	666	Plots with transects	Phytocentric	Quantitative
Fang 2012	99.63806	27.90139	China	2008-2010	3	130	247	32110	Plots	Phytocentric	Quantitative
Inouye 1990	135.866667	35.166667	Japan	1984-1987	4	114	883	100662	Transects	Phytocentric	Quantitative
Inouye 1988	148.266667	-36.45	Australia	1983-1984	1	40	85	3400	Plots	Phytocentric	Quantitative
Kaiser-Bunbury 2009	57.443254	-20.452076	Republic of Mauritius	2003-2004	2	96	184	17664	Plots	Phytocentric	Quantitative
Kaiser-Bunbury 2014	55.43333	-4.666667	Republic of Seychelles	2007-2008	6	37	341	12617	Transects	Phytocentric	Quantitative
Kato 2000	129.493741	28.377248	Japan	1996-1999	16	110	609	66990	Transects	Phytocentric	Quantitative
Kevan 1970	-71.3	81.816667	Canada	1967	1	20	91	1820	Randow census walks	Phytocentric	Qualitative
Lundgren 2005	-52	71	Greenland	2002	1	17	26	442	Randow census walks	Phytocentric	Quantitative
Olesen 2002 1	57.43	-20.25	Republic of Mauritius	1998-1999	1	17	26	442	Plots	Phytocentric	Quantitative
Mcmullen 1993	-90.600747	-0.290164	Ecuador	NA	All islands	105	54	5670	-	Phytocentric	Qualitative
Bartomeus 2008	3.296797	42.315336	Spain	2005	3	13	37	481	Plots with transects	Phytocentric	Quantitative
Primack 1983 1	171.566667	-42.95	New Zealand	1976-1978	1	18	60	1080	Randow census walks	Phytocentric	Qualitative

(continued)

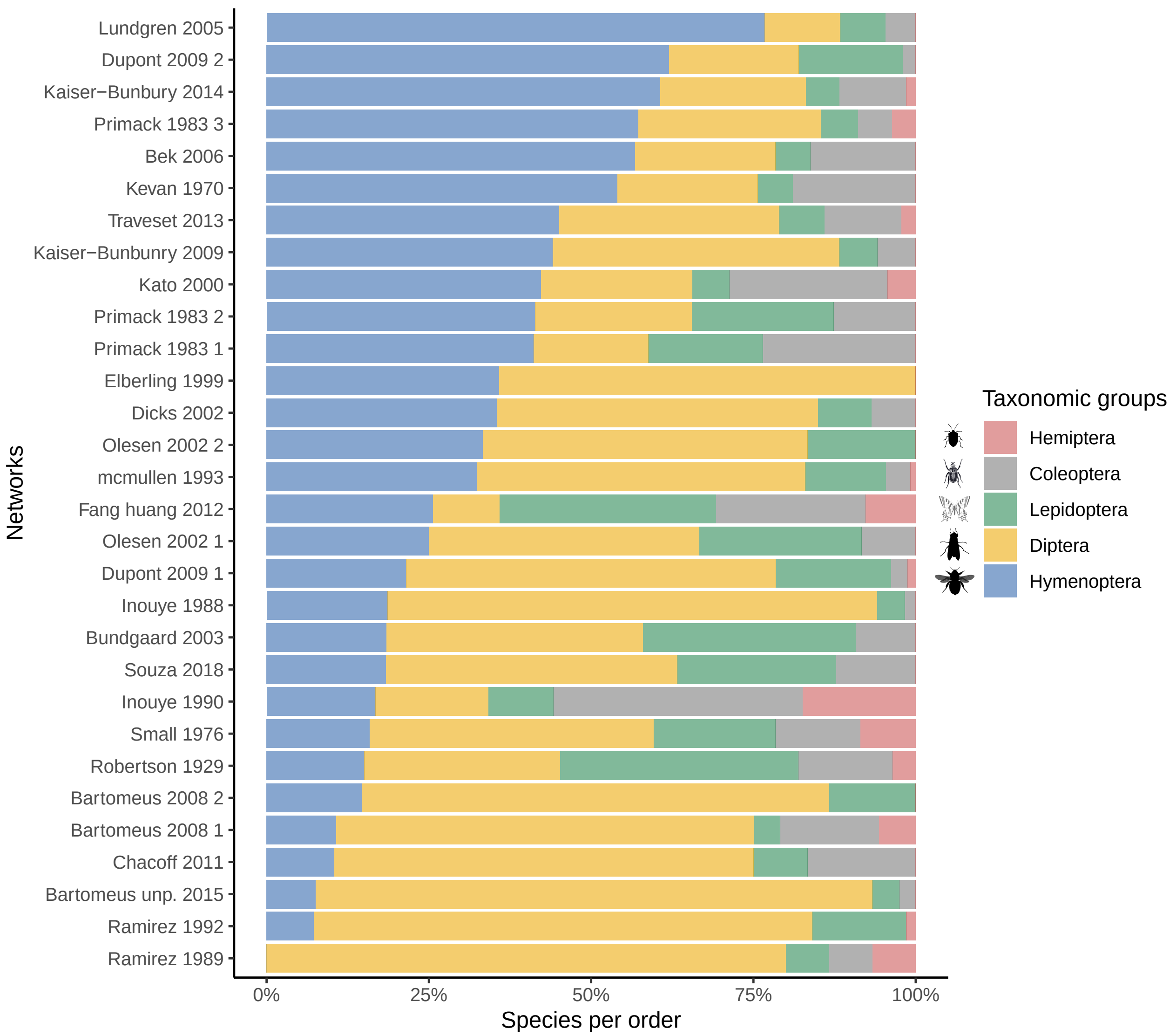
Id	Longitude	Latitude	Country	Year	Networks	Plant spp	Pollinator spp	Network size	Sampling method	Sampling	Data type
Primack 1983 2	171.78466	-43.02823	New Zealand	1976-1978	1	41	139	5699	Randow census walks	Phytocentric	Qualitative
Primack 1983 3	171.720224	-43.099531	New Zealand	1976-1978	1	49	118	5782	Randow census walks	Phytocentric	Qualitative
Ramirez 1989	-61.716667	5.583333	Venezuela	NA	1	48	49	2352	Random census walks	Phytocentric	Qualitative
Ramirez 1992	-67.416667	8.933333	Venezuela	1983,1984,198	1	28	53	1484	Randow census walks	Phytocentric	Qualitative
Robertson 1929	-89.8968771	39.278958	United States	1997-1899	NA	456	1044	476064	-	Phytocentric	Qualitative
Small 1976	-75.5	45.4	Canada	1973	1	13	34	442	10h per spp	Phytocentric	Quantitative
Souza 2018	-57.885	-21.701111	Brazil	2008-2009	1	62	89	5518	Plots	Phytocentric	Quantitative
Traveset 2013	-91.012863	-0.6907	Ecuador	2010-2011	1	60	220	13200	Random census walks	Phytocentric	Quantitative
Bartomeus 2015 unp.	-6.16895	37.234966	Spain	2015	16	57	277	15789	Transects	Phytocentric	Quantitative
Bek 2006	10.216667	56.066667	Denmark	2003	1	37	225	8325	Plots	Phytocentric	Qualitative
Olesen 2002 2	-31	39.4	Azores	2000	1	10	12	120	Plots	Phytocentric	Quantitative
Bundgaard 2003	10.233333	56.066667	Denmark	2003	1	16	44	704	Plots	Phytocentric	Qualitative

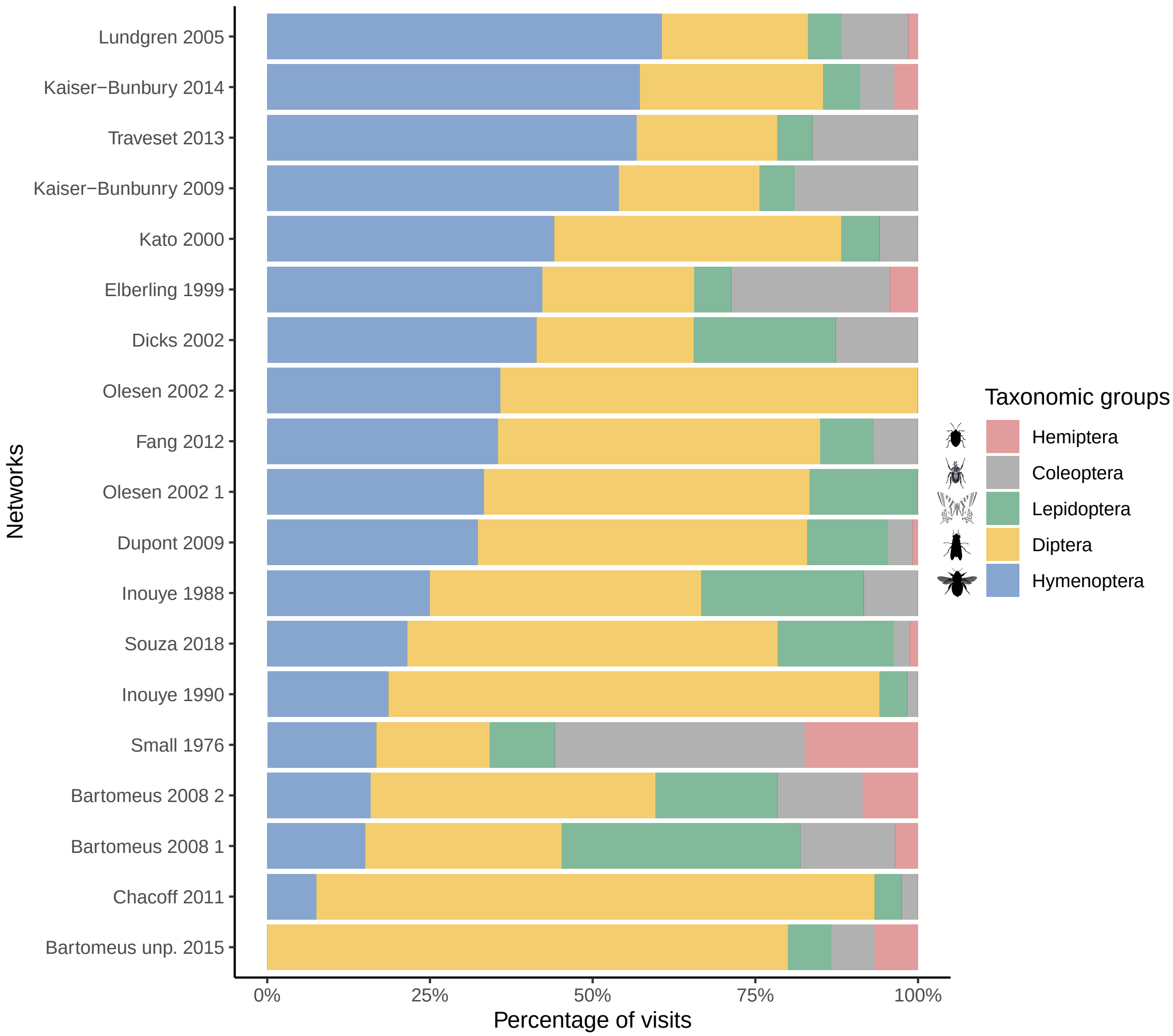
(continued)

Id	Longitude	Latitude	Country	Year	Networks	Plant spp	Pollinator spp	Network size	Sampling method	Sampling	Data type
Chacoff 2011	-68.015892	-32.008985	Argentina	2006-2009	4	59	196	11564	Plots	Phytocentric	Quantitative
Dicks 2002	1.575532	52.762395	England	2001?	2	23	80	1840	Plots	Phytocentric	Quantitative
Dupont 2009	9.1	56.1	Denmark	2005	2	31	329	10199	Plots	Phytocentric	Quantitative
Elberling 1999	18.5	68.35	Sweden	1994	1	24	118	2832	Plots with transects	Phytocentric	Quantitative
Dupont 2009 2	-20.5	74.5	Greenland	1996-1997	1	31	76	2356	Random census walks	Phytocentric	Qualitative

PLOT 1

Here I show the percentage or orders from the different species without consider visitation and just richness of species. Therfore, if we have a network with 4 species from from different orders, each will appear as 25% within the stack bar of the barplot.




Lundgren 2005
Kaiser−Bunbury 2014
Traveset 2013
Kaiser−Bunbunry 2009
Kato 2000
Elberling 1999
Dicks 2002
Olesen 2002 2
Fang 2012
Olesen 2002 1
Dupont 2009
Inouye 1988
Souza 2018
Inouye 1990
Small 1976
Bartomeus 2008 2
Bartomeus 2008 1
Chacoff 2011
Bartomeus unp. 2015
Networks
0%
25%
50%
75%
100%
Percentage of visits
Taxonomic groups
Hemiptera
Coleoptera
Lepidoptera
Diptera
Hymenoptera

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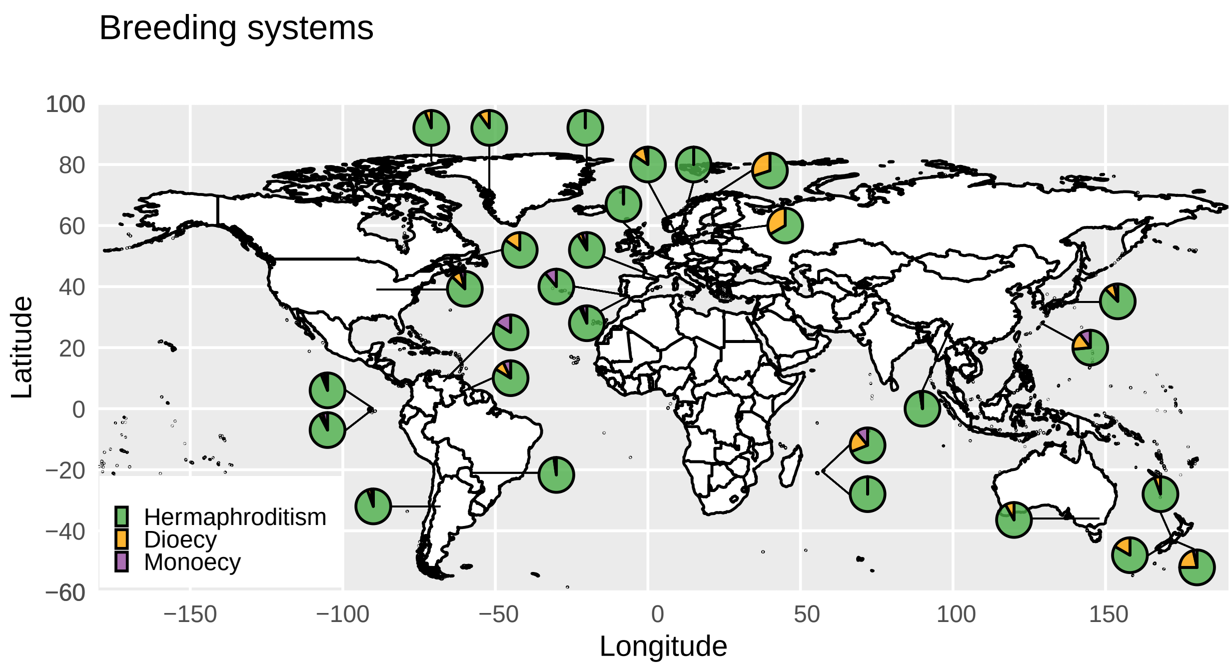
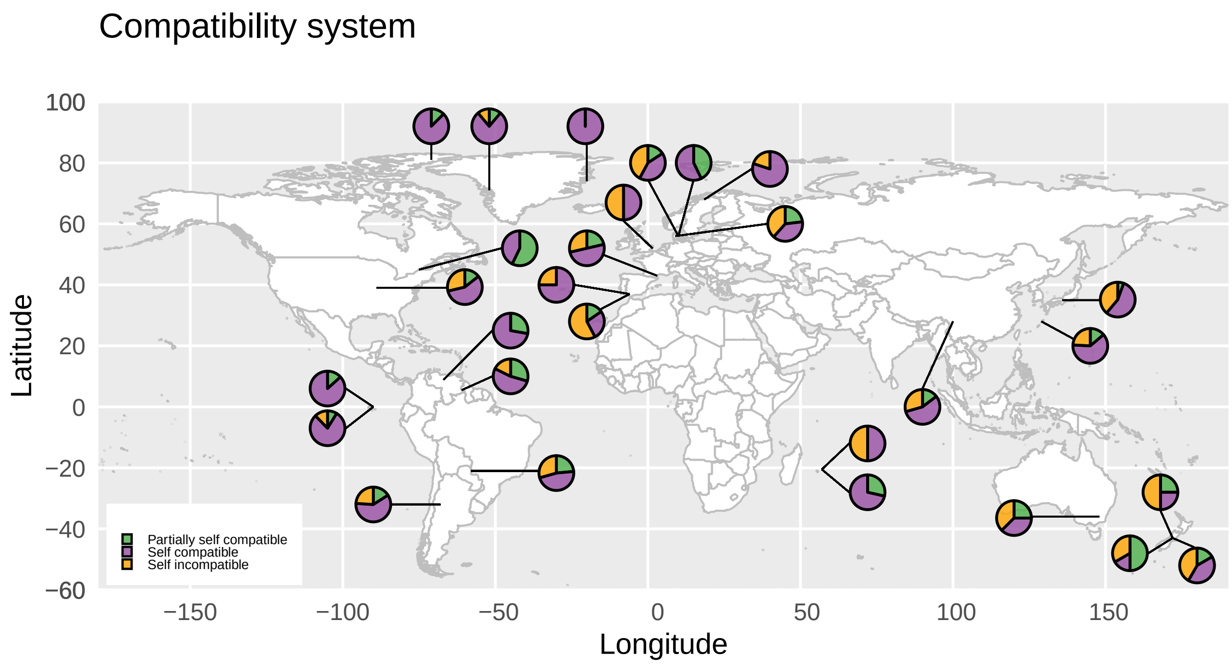
*PLOT 2**

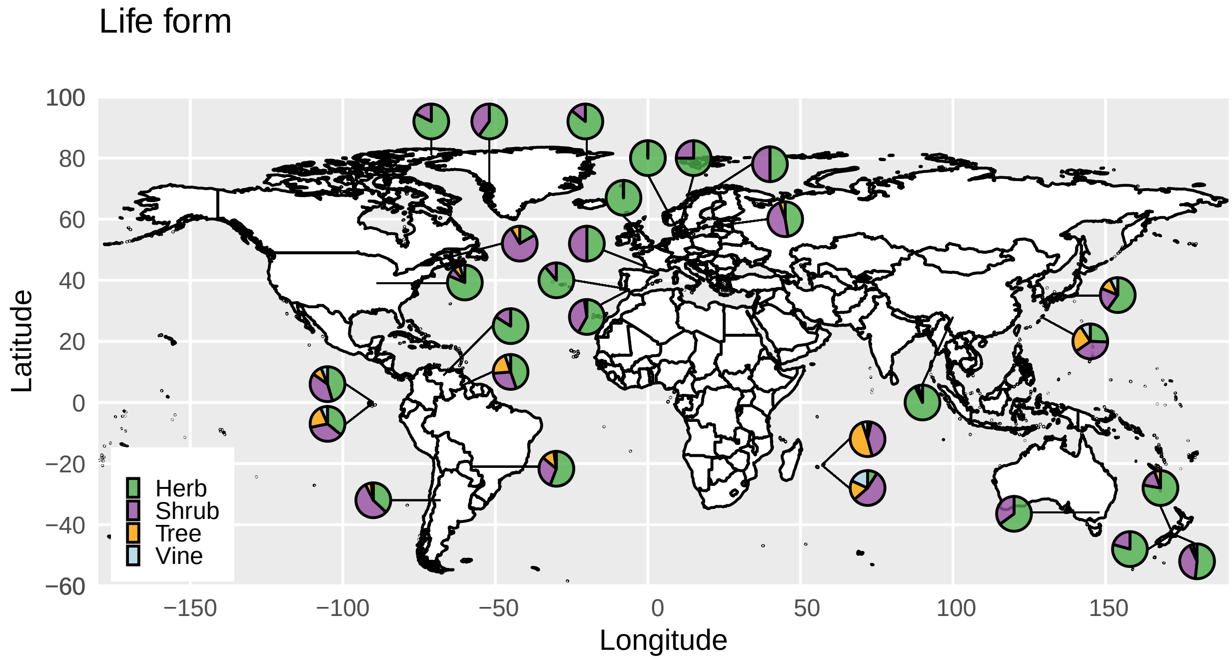

Breeding systems
100
80
60
40
20
0
−20
−40
−60
Latitude
−150
−100
−50
0
50
100
150
Longitude
Hermaphroditism
Dioecy
Monoecy

PLOT 3



Compatibility system
100
80
60
40
20
0
−20
−40
−60
Latitude
−150
−100
−50
0
50
100
150
Longitude
Partially self compatible
Self compatible
Self incompatible

PLOT 4



REFERENCES

Carvalheiro, Luísa Gigante, Jacobus Christiaan Biesmeijer, Gita Benadi, Jochen Fründ, Martina Stang, Ignasi Bartomeus, Christopher N Kaiser-Bunbury, et al. 2014. "The Potential for Indirect Effects Between Co-Flowering Plants via Shared Pollinators Depends on Resource Abundance, Accessibility and Relatedness." *Ecology Letters* 17 (11). Wiley Online Library: 1389–99.

Gómez, José M, and Francisco Perfectti. 2012. "Fitness Consequences of Centrality in Mutualistic Individual-Based Networks." *Proceedings of the Royal Society B: Biological Sciences* 279 (1734). The Royal Society: 1754–60.

Lázaro, Amparo, Carmelo Gómez-Martínez, David Alomar, Miguel A González-Estévez, and Anna Traveset. 2019. "Linking Species-Level Network Metrics to Flower Traits and Plant

Fitness." *Journal of Ecology*. Public Library of Science.

Novella-Fernandez, Roberto, Anselm Rodrigo, Xavier Arnan, and Jordi Bosch. 2019. "Interaction Strength in Plant-Pollinator Networks: Are We Using the Right Measure?" *PloS One* 14 (12). Public Library of Science.