Environmental stress affects niche breadth in plant-pollinator communities

Supplementary information

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Supplementary methods

Data was obtained from the Web of Life database (Fortuna, Ortega, and Bascompte 2014) which includes data from 57 published studies (Abreu and Vieira 2004; Arroyo, Primack, and Armesto 1982; Barrett and Helenurm 1987; Bartomeus, Vilà, and Santamaría 2008; Bek 2006; Bezerra, Machado, and Mello 2009; Bundgaard 2003; Canela 2006; Clements and Long 1923; del Coro Arizmendi and Ornelas 1990; Dicks, Corbet, and Pywell 2002; Dupont and Olesen 2009; Dupont, Hansen, and Olesen 2003; Elberling and Olesen 1999; Gutierrez, Rojas-Nossa, and Stiles 2004; Hattersley-Smith 1985; Herrera 1988; Hocking 1968; Ingversen 2006; INouE et al. 1990; Inouye and Pyke 1988; Kaiser-Bunbury et al. 2014, 2010; Kakutani et al. 1990; Kato 2000; Kato, Matsumoto, and Kato 1993; Kato and Miura 1996; Kato et al. 1990; Kevan 1970; Kohler 2011; Lara 2006; Las-Casas, Azevedo Júnior, and Dias Filho 2012; Lundgren and Olesen 2005; McMullen 1993; Medan et al. 2002; Memmott 1999; Montero 2005; Mosquin 1967; Motten 1986; Olesen, Eskildsen, and Venkatasamy 2002; Ollerton 2003; Percival 1974; Petanidou and Vokou 1993; Philipp et al. 2006; Primack 1983; Ramirez 1989; Ramirez and Brito 1992; Robertson 1929; Rosero and others 2003; Sabatino 2010; Schemske et al. 1978; Small 1976; Smith-Ramírez et al. 2005; Stald, Valido, and Olesen 2003; Vázquez 2002; Vizentin-Bugoni et al. 2016; Yamazaki and Kato 2003).

All together, interaction data from the included studies included 11,171 unique organism names. From these 1,166 were present in more than one study. From the total number of organisms, 159 were identified to the subspecies or variety level, 6,748 to the species level, 1,726 to the genus level, whereas the remaining 2,538 were unidentified. As the species level was the most common taxonomic rank available in our interaction datasets, in all further analysis, we grouped together subspecies or varieties within the same species.

We were able to confirm the validity of 5,255 of the scientific names used to identify organisms (roughly 76%). We assessed the validity of a name by querying the Global Names Resolver database (https://resolver.globalnames.org) which includes data from 98 taxonomic sources. We accessed this database using the function `gnr_resolve` from the R package `taxize` 0.9.6 (Chamberlain and Szocs 2013; Chamberlain et al. 2019).

From the remaining 1,652 names we were unable to validate, we were able to identify and correct 724 that contained spelling mistakes. These spelling mistakes were corrected automatically by fuzzy matching the canonical names in our data sources with those in the Global Names Resolver database. However, on rare occasions, the fuzzy matching algorithm can suggest a scientific name that has a similar spelling, but that corresponds to an organism in a different taxonomic group, often a separate kingdom. To address this potential problem, we checked the taxonomic hierarchy of suggested names and confirmed that it matched our expected taxon. We retrieved all taxonomic hierarchies from the National Center for Biotechnology Information taxonomic database (https://www.ncbi.nlm.nih.gov/taxonomy).

As species names are constantly changing, we subsequently checked for possible synonyms of the canonical names in our data sources. Using data from the Integrated Taxonomic Information System database (http://www.itis.gov), we found synonyms and alternative names for 610 species.
Finding these alternative names was required for two main reasons. First, because we wanted to be able to identify the cases in which the same species might have been recorded with different names in various data sources. This can occur not only when the canonical name has been changed but also when there are widely used orthographic variants. Second, because retrieving occurrence data is often only possible using the latest accepted/valid name for a particular species.

All together, from the 1,652 names we were unable to validate, it was not possible to automatically correct or find synonyms 332 of them. We then manually consulted multiple online databases, chiefly Wikispecies (https://species.wikimedia.org/), and looked for canonical names that both, resembled the unvalidated names and matched the geographic and taxonomic expectations. In this fashion, we were able to further correct 25 names. Most manual corrections were made on names that have been abbreviated or had more than two spelling mistakes. A complete list of manual name corrections can bee seen in Table S1.

This cleaning process allowed us to match further 212 names across data

Table S1: Manually corrected canonnical names. More than one correct name have been included when an accepted/valid synonym the cannonical name exists.

incorrect name	corrected name	guild
Acaena pinn	*Acaena pinnatifida*	plant
Adesmia brachy	*Adesmia brachysemeon*	plant
Aesculus camea	*Aesculus X carnea*	plant
Brachyome sinclairii	*Brachyscome sinclairii*	plant
Calceolaria arac	*Calceolaria arachnoidea*	plant
Equium sabulicola	*Echium sabulicola*	plant
Euonymus fo rtunei	*Euonymus fortunei*	plant
Galvezia leucantha pubescen	*Galvezia leucantha*	plant
Heliconia simulans	*Heliconia angusta*	plant
Pitcaimia flammea	*Pitcairnia flammea*	plant
Psittacanthus flavo viridis	*Psittacanthus flavo-viridis*	plant
Rodophiala bifidum	*Rhodophiala bifida*	plant
Stachys albi	*Stachys albicaulis*	plant
Stenactis annuus	*Erigeron annuus*	plant
Thaspium aureum atropurpurem	*Thaspium trifoliatum*	plant
Tristhema mauritiana	*Tristemma mauritianum*	plant
Tropaeolum polyph	*Tropaeolum polyphyllum*	plant
Tyttnera scabra	*Turnera scabra*	plant
	Turnera ulmifolia	plant
VVedelia biflora	*Melanthera biflora*	plant
	Wedelia biflora	plant
Cateres pennatus	*Kateretes pennatus*	pollinator
Eclimus harrisi	*Condylostylus crinicauda*	pollinator
Ptilandrena g. maculati	*Andrena distans*	pollinator
Rodophiala bifidum	*Rhodophiala bifida*	pollinator
Tapinotaspis caerulea	*Chalepogenus caeruleus*	pollinator
Tapinotaspis herbsti	*Chalepogenus herbsti*	pollinator

sources and, by doing so, identify another 72 species that were present in more than one study. The process also allowed us to identify three problematic data sources in which some names were included as both plants and pollinators. These data sources were removed from further analysis. In seven of our data sources interaction data was recorded at multiple points in time. When this was the case, we combined interaction data into one single interaction network.

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