Aseasonal Pollinators Connect Seasonal Modules in Pollination Networks from the Cerrado, a Highly Diverse Seasonally Dry Neotropical Savanna

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Running head: Seasonality of Neotropical Pollination Networks

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Summary (350 words)

1. Seasonally dry savannas and forests cover about 20% of the Neotropics and are characterized by regular cycles of severe drought periods followed by rainy seasons. Despite their importance in terms of extension and angiosperm diversity, little is known about the influence of such extreme climatic conditions on species interactions and community structure. Because water stress is likely to impose greater restrictions on flowering than pollinator activity, temporal changes in plant-pollinator community structure are expected to occur across seasons.
2. The Cerrado is considered the world's most diverse seasonally dry savanna, especially in terms of plant diversity. Its communities are characterized by the predominance of biotic pollination by bees. Social bees, which are active year-round and demand a constant supply of resources, are especially diverse and abundant in this system. We asked whether seasonal changes in precipitation led to a potential decrease in plant-pollinator interactions ultimately altering community's stability during the dry season. We also investigated the role played by social bees, which are year-round active, in the structure, function, and robustness of Cerrado communities.
3. Changes in the community's structural properties across seasons were quantified using ecological network analyses for two data sets from the Cerrado. We tested for the occurrence of seasonality in species activity and interactions.
4. We find that both plant-pollinator networks undergo a high seasonal turnover in plant species composition despite moderate to low turnover in pollinators. As a consequence, seasonal modules with low levels of overlap (< 6%) in plant-pollinator interactions emerge. Aseasonal pollinators, mainly comprising social but also solitary

bee species with multiple generations per year, span the seasons while plant flowering is mostly seasonal. Simulations of species extinctions indicate that aseasonal pollinators play an essential role for robustness in the communities studied. We provide novel evidence that some solitary bees also function as keystone species of tropical plant-pollinator networks. Given the commonalities of the study systems here analyzed with those from other seasonally dry systems, our results provide an important background to improve the current understanding about the key species and structural properties that promote stability of plant-pollinator communities in Neotropical habitats.

Keywords: Brazil, community ecology, ecological niche, keystone species, mutualistic networks, Neotropical, robustness, seasonality, temporal variation, tropical bees, tropical plants.

Introduction (6,470 words

Some of the most impressive natural phenomena on earth, such as the great wildebeest grazing migration after the first rains promoting grass growth in tropical Africa, are linked to effects of seasonal changes in climate (Bell 1971). The drastic seasonal changes associated with the transition between dry and rainy seasons can affect the dynamics of species interactions, either directly by driving physiological responses of organisms or indirectly by influencing the life cycle of primary producers (i.e., grasses). Despite relatively constant temperatures, regular cycles of extreme drought followed by intense rainfall periods characterize a large proportion of Neotropical habitats (Kricher 2011). These include the unique ecosystems known as seasonally dry forests and savannas with organisms adapted to extreme seasonal changes in climate (Pennington & Ratter 2006). These ecosystems occupy a large proportion of the tropical and subtropical Americas, estimated to be over 3,5 million km^2 and are recognized for their high levels of plant and animal diversity as well as for their poor conservation status (Huber 1987; Myers *et al.* 2000; Pennington, Lewis & Ratter 2006). However, little is known about the antagonistic effects of water stress and intense rainfall on the dynamics of species interactions in communities from seasonally dry habitats. Understanding how these communities are organized, how they change and function under such contrasting climatic conditions is important not only for gaining insight about factors responsible for the maintenance of the high diversity that characterize Neotropical ecosystems but also necessary for predicting their vulnerability to disturbances, such as climate induced changes in plant phenology and animal activity.

The Brazilian Cerrado is a type of seasonally dry savanna characterized by a species rich fauna and a highly diverse flora with many endemic plant species (Klink & Machado 2005). Similar to other tropical habitats, Cerrado communities harbor a variety of pollination systems with bees figuring as major pollinating agents (Oliveira & Gibbs 2002; Pennington, Lewis & Ratter 2006). In this habitat, seasonal changes in precipitation can restrict dry season flowering in species with shallow root systems (e.g., herbs and shrubs) which cannot reach water pockets that occur below 2 m from the soil surface (Batalha & Martins 2004; Gottsberger & Silberbauer-Gottsberger 2006a; Oliveira 2008). In contrast, water stress may not pose equally strong constrains on the foraging activity of most bees, which have been recognized as the primary pollinators of Cerrado plants (Oliveira & Gibbs 2002; Gottsberger & Silberbauer-Gottsberger 2006b; Cappellari 2011). In fact, many Cerrado bees are active all year due to a social life style or the production of multiple generations per year (Silveira & Campos 1995; Oliveira & Gibbs 2002; Pinheiro-Machado *et al.* 2002; Gottsberger & Silberbauer-Gottsberger 2006b). Besides the need to acquire resources to meet the metabolic demand of individuals and that of colonies throughout the year, most social and multi-voltine bees are usually active for periods extending beyond the flowering of most individual plants species (Biesmeijer & Slaa 2006).

Besides being a highly seasonal system, the Cerrado presents an important model system for studies addressing temporal changes in plant-pollinator community structure and function as it harbors an important portion of the Neotropical angiosperm diversity (Myers *et al.* 2000). This tropical biome is the second largest in South America (> 2,000,000 km^{2},) and is considered one of the most threated tropical ecosystems due to a combination of intense past and current deforestation and poor conservation policies that have lead to degradation of more than 50% of its area (Myers *et al.* 2000; Klink & Machado 2005). Climate change models project temperature increases and precipitation decreases across central Brazil, which might affect the original seasonal cycles of rainfall and drought that typify the Cerrado region and its biota. Yet the ecological dynamics of Cerrado's plant and pollinator communities are poorly known and scarce data are available to predict changes in community structure, composition, and function as a result of potential future changes in climate.

Here, we investigated the ecology of plant-pollinator communities from two Cerrado habitats to provide a first characterization of their structure and temporal variation during seasonal cycles of rain and drought (i.e., dry and rainy seasons). Due to the strong seasonality that characterizes this system, we specifically searched for the existence of temporal modularity in the distribution of plant-pollinator interactions corresponding to the periods of rain and drought. In particular, we tested whether such communities tend to shrink in size and present higher vulnerability to disturbance during the dry season, which comprise a period of five months exposing species to a high and continuous level of water stress relative to the wet season. For this purpose, we measured and compared seasonal changes in the community composition, plant-pollinator interactions, and pollination network structure. We also investigated potential biological drivers of seasonal differences in communities' species composition, interactions and structure (modularity) by analyzing species' ecological niche widths and turnover across seasons to identify potential aseasonal elements that play a role in community stability.

The influence of such elements on the robustness of Cerrado communities was evaluated using an ecological network approach and simulated extinctions of these target groups.

Material and methods

Study area and climate information

The Cerrado covers most of Central Brazil and small areas of Paraguay and Bolivia with vegetation comprising comprises a mixture ranging from open grasslands to scrublands with sparse occurrence of trees, and smaller portions of gallery and closed canopy forests, which occur in side-by-side patches creating a highly heterogeneous ecosystem (Eiten 1972; Gottsberger & Silberbauer-Gottsberger 2006a). Our study sites were located near Brasilia in Central Brazil, a region characterized by a well-defined dry winter season that lasts from May until September followed by a summer rainfall period that extends from November until March (Gottsberger & Silberbauer-Gottsberger 2006a) (Fig. 1).

Plant-pollinator interactions were surveyed in the Reserva Ecológica do IBGE (here after ‘IBGE’) and in the Protected Area of the Jardim Botânico de Brasília (Brasília’s Botanical Garden Protected Area; hereafter ‘BBG’), an area of native and preserved Cerrado vegetation and is not used for public display or cultivation. The two areas are situated on the Brazilian plateau (at 1,100 m ASL), within the federally protected conservation site “APA-Gama-Cabeça-de-Viado,” which comprises 10,000 ha and is located approximately 30 km south of Brasília (15º56’S, 47º53’W).

We used data from the IBGE's weather station to obtain monthly average temperature and precipitation for the past 30 years (1980-2010), quantify climatic differences throughout the year, and characterize seasons in the study area (Fig. 1). According to these data, 88% of total annual precipitation (mean monthly precipitation= 6.82 cm; s.d.= 3.22 cm) occurs between October and March, with average temperatures ranging from 25.7 ºC (s.d.= 1.41 ºC) during the day to 19.2 ºC (s.d.= 1.3 ºC) at night. Conversely, mean monthly precipitation drops to 1.15 cm (s.d.= 1.6 cm) in the remaining period with average temperatures during the day at 24.3 ºC (s.d.= 1.83 ºC) to 18 ºC (s.d.= 1.9 ºC) at night (Fig. 1). As already pointed by other authors (Gottsberger & Silberbauer-Gottsberger 2006a), the months of April and October present variable climatic conditions reflecting the transition between the seasons (Fig. 1). For analytical purposes, we assigned the interactions recorded in the transitional months of April and October to the dry and rainy seasons, respectively. The periods defined for each season are in agreement with patterns reported for other Cerrado areas (Gottsberger & Silberbauer-Gottsberger 2006a).

Sampling methods and species identification

Empirical studies have shown that bees are the predominant pollinators in Cerrado communities (~ 70%) followed by moth (~ 12%) with small occurrence of hummingbird (~ 3%), bat (~ 2%), and beetle (~ 2%) pollination systems (Oliveira & Gibbs 2000; Oliveira & Gibbs 2002; Gottsberger & Silberbauer-Gottsberger 2006b; Cappellari 2011). Thus, our study concentrated in capturing interactions between plants and bees. Plant-pollinator interactions at both sites were sampled weekly by walking transects (Sakagami, Laroca & Moure 1967; Krebs 1999). In both communities, bees were collected with an entomological net and killed either in individual vials with paper pellets moistened with ethyl acetate or frozen after each observation. A plant or pollinator species observed in the study plot was considered part of the community and included in each of the surveys only if it was involved in an interaction, thus flowering plant species that did not receive visits, or bees that were not seen foraging on flowers were not recorded in our data set. For every new interaction recorded, the plant was tagged with a unique identification number, photographed, and vouchered. In IBGE, photos of each plant species were added to a database of local floral hosts, and a secondary miniature voucher was made to facilitate re-identification of species in the field. Plant vouchers were identified by using comparative herbarium material, a checklist of local angiosperms, and local botanical expertise (see acknowledgments section). Vouchers of the plants sampled were deposited at the herbaria of the research station (IBGE), University of Brasília (UB), and Ezequias Paulo Heringer (HEPH) at the Brasília Botanical Garden. Insect vouchers were mounted, preserved, and identified to species level by comparison with reference collections, the taxonomic literature, and local records (Moure 1962; Silveira, Melo & Almeida 2002; Michener 2007; Moure, Urban & Melo 2007), and by local entomological experts (see acknowledgments). All insect vouchers were deposited in the entomological collections of the University of Brasília and the Padre Moure Collection at the Federal University of Paraná, Brazil.

The IBGE community comprised a 8-hectare plot (200 x 400 m) covered with the phytophysiognomy known as *campo sujo*, a relatively open type of vegetation mainly composed of grasses mixed with herbaceous plants, and shrubs, with sparse occurrence of lianas and trees (Eiten 1972; Pereira, Silva & Mendonça 1998). This area was sampled by S. C. Rabeling by walking transects covering the entire area for a full day (0800h to 1700h) at a weekly basis from November 2008 to October 2009. The sampling effort totaled 47 sampling days over a 12-month period (mean= 3.91 collections/month). The data collected at IBGE was compared to the pre-existing BBG data set collected by M. C. Boaventura, which aimed at characterizing plant-pollinator community structure and seasonality of interactions with bees at a Cerrado site.

The BBG community comprised an area of *cerrado sensu strictu*, a denser type of vegetation with predominance of large shrubs, lianas, and trees (Eiten 1972). This area was sampled weekly (0730 to 1700h) from June 1996 to May 1997 using two predefined transects (5,280 m and 4,130 m in length) located 4 km apart (Boaventura 1998). The sampling effort in this area totaled 49 collection days over a 12-month period (mean= 4.08 collections/month). Interactions involving the introduced honey bee (*Apis mellifera*) were not included in the BBG data set.

The sampling effort was evaluated in a separate rarefaction analyses for each site and each season considering number of new unique interactions recorded (i.e., recorded links) as sampling units. We used number of links instead of days in this analysis to prevent confounding effects associated with variation in the number of sampling hours per day as a result of inclement weather conditions that interrupted field work during the rainy season, and due to minor differences in the sampling protocol employed in each study (e.g., length of transects). Furthermore, the sequence of links recorded was randomized a hundred times before accumulation curves for network features were generated. We calculated 95% Confidence Intervals (CIs) around each curve to determine the overlap between the observed and the expected curves for each network feature with regard to the number of new links sampled. Among many community features, we focused this analysis on mean and maximum degrees (i.e., number of interaction partners per species) of each trophic level because the results of our study depend strongly upon this feature, especially for investigating the occurrence and importance of highly connected and aseasonal species. The data analyzed were used to generate rarefaction curves for each specific network feature to determine completeness of sampling.

Data Analysis

Using our calculated climate data and seasonal boundaries, we recorded interactions in both studies as occurring in either the dry or rainy season. Each interaction recorded between a given plant species and a particular bee species was considered to be a link. We calculated specific standard network measures based on interactions recorded during each season to test for qualitative and quantitative seasonal changes in interactions and their overall influence on key community structural features. Each measure was evaluated for both the dry and rainy season communities as well as the overall community (i.e., cumulative accounts for the entire year).

Network size and connectance were evaluated to determine if communities shrink in size and present a higher proportion of species with narrower niche breadths during the dry season. Network size was calculated as the total number of interacting species observed in each season. Connectance was calculated as the proportion of interactions observed as a function of the total number of possible interactions (undirected bipartite connectance = 2 * links / (number of plant species × number of pollinator species)).

We used weighted and unweighted estimates of *species degree*, a common proxy that uses the number of visits to a plant species by a given pollinator to measure of ecological niche width and ecological specialization in mutualistic network analyses (Jordano 1987; Futuyma & Moreno 1988), to compare seasonal variation in niche use or the number of partners and interactions observed for plants and pollinators in each network. Because lower diversity of species, especially of floral hosts expected during the dry season in the Cerrado, can reduce the number of potential partners available at a given time, narrower niche widths are expected for species active during the dry versus rainy season in the communities studied. To test this hypothesis, we calculated species degree and weighted degree based on interaction frequency counts for each species in each season. Degrees were compared within and between trophic levels across seasons. Interaction frequency rates were first converted to daily rates for each plant-bee species pair by dividing the number of visits by a particular bee species to a particular plant species by the number of days that plant was observed interacting (with any bee) across the sampling period and during each season. This approach reduces underestimation of interaction rates by accounting for plants not flowering during the entire period in which pollinators were active. Interaction frequency was then used to estimate weighted degree to determine the relevance of different interaction types (i.e., links) at different times of the year (Vázquez, Morris & Jordano 2005). This was calculated as the number of visits to i^{th} plant by j^{th} pollinator relative to the number of flowering instances recorded for that plant (by counting all instances of that plant having been visited by any bee). Visitation frequency was also used to evaluate species seasonality and species for which proportional degree or interaction frequency were equal or greater than 75% in one season were considered seasonal.

We examined the degree distribution (i.e., frequency distribution of interaction partners per species) in each season for the two communities to determine if the proportion of species with very narrow or broad niches (i.e., specialists versus generalists) varied substantially between seasons. We compared the distributions to three alternative models (exponential, power-law, and truncated power-law) and used the Akaike Information Criteria (AIC) to evaluate each fit. We also calculated degree distribution, and the Nestedness metric based on Overlap and Decreasing Fill (NODF) (Almeida Neto, Guimarães Jr & Lewinsohn 2007) to compare and evaluate variation in the proportion of species with few (specialized) versus many (generalized) interaction partners in each season. Degree distribution was used to determine and compare seasonal variation in specialization levels within each season and for the overall community. NODF was used to analyze the structural distribution of interactions according to species degree as nested networks have been associated with increased levels of stability (Bascompte *et al.* 2003; Bascompte & Jordano 2007). Shortest paths and network diameter were calculated to determine whether communities expanded or shrunk during a specific season. All analyses were performed using code written in Octave.

To test whether plant-pollinator communities from seasonally dry habitats show a significant level of modularity, the overall network structure as the corresponding seasonal differences in network measures were assessed against a null model obtained by 1,000 randomizations. In each randomization, each observed interaction was randomly re-assigned to "dry" or "rainy" season with equal probability, thus creating a random temporal partition of the whole sample into two seasons. The proportion of the 1,000 randomly partitioned seasonal networks that had fewer links in common than those shared between the observed seasonal networks then provided a one-tailed p-value (asymptotically exact) of significance of the observed seasonal modularity. Similarly, the significance in observed differences in each structural feature between seasonal networks was calculated by comparing the null distribution of differences (rainy–dry) between randomized seasons with the observed difference. The proportion of randomized differences in a structural feature less than or equal to the observed difference is the left-tailed p-value (feature has significantly smaller value in rainy season than in dry season). Additionally, the proportion of randomized differences in a structural feature greater than or equal to the observed difference is the right-tailed p-value (feature has significantly larger value in rainy season than in dry season).

Robustness analyses

We performed species extinction simulations to examine how seasonality-driven variation in plant and pollinator composition as well as niche breadth (represented by weighted and unweighted degrees) would relate to a community's robustness to loss of functionally important species in the seasonal modules of IBGE and BBG. Unweighted robustness analyses followed established methodology (Dunne, Williams & Martinez 2002; Memmott *et al.* 2006): upon removal of a plant or pollinator node, every pollinator or plant species left without interaction partners was considered extinct. For the weighted robustness analyses, we considered targeted removal of species according to their importance in terms of connections maintained in each seasonal module as well as the overall network, i.e., from widest to narrowest niche breadth in order of decreasing degree. In addition, we also considered scenarios of targeted removal from weakly to highly connected species (i.e., in order of increasing niche breadth), as well as at random.

Weighted robustness was analyzed following standardized methods (Kaiser–Bunbury *et al.* 2010) and we measured proportional loss of visitation rates, using the link weights defined above, instead of just species loss. For this, we first converted each link weight to its fractional contribution to the total visitation rates across the entire network. All robustness simulations of plant and pollinator removals were performed individually. When multiple nodes with the same niche width values (degree) were encountered in targeted removal sequences we simply permuted the removal sequence among them to break ties. Thus, random as well as targeted removals yielded a sample of extinction curves. The values at each point on this curve were then averaged to obtain a single curve. For both weighted and unweighted robustness analyses, the Area Under the Curve (AUC) was used as a measure of network robustness to species loss. We chose 100 iterations as a compromise between computational complexity and accuracy of the average extinction curve. To estimate whether extinction curves were significantly different, we calculated 95% confidence intervals (CI's) around each mean value on the curve. We also calculated number of dependent species lost after loss of 50% of target species (also with 95% CI's).

Results

Seasonal variation in community composition

Over the 12-month study period, 93 species of plants and 111 species of flower foraging bees were recorded at IBGE. A total of 968 pollinator visits to plants, which constituted 434 unique associations (i.e., links) between plants and pollinators, were observed (Fig. 2). The ten pollinator species with the widest niches (i.e., with degree > 8) in this community maintained a large number of interaction partners in both seasons (Supplementary Table S1; Figs 2 and 3). The majority of these abundant, most-connected, and aseasonal species represented mainly eusocial groups. About one third of all interactions recorded involved social bees and the introduced honey bee (*Apis mellifera*) ranked as the most abundant species (n = 154) sampled on flowers, followed by species of stingless and bumble bees (Table S1). Nonetheless, solitary bee groups presented the largest group of species in this area most of which were seasonal, i.e., recorded in either one of the two seasons (Table S1). Among solitary bees with high numbers of links were some species of oil-collecting bees (i.e., tribes Centridini, Tapinotaspidini, and Tetrapediini), which together comprised one third of all bee species (32 spp.) and 17% of all visits recorded at this site. The pollinator community composition in IBGE was similar to those observed in other Cerrado areas (Silveira & Campos 1995; Pinheiro-Machado *et al.* 2002) with Apidae being the richest group (77 spp.) followed by Halictidae (19 spp.), Megachilidae (13 spp.), Andrenidae (1 sp.), and Colletidae (1 sp.).

Plant species recorded at the site were mostly herbs and shrubs, and belonged to 24 families, Fabaceae (18 spp.) being the most species rich group (Table S1). Among plants recorded in this community, *Dimerostemma vestitum* (Asteraceae; degree= 22), *Palicourea coriacea* (Rubiaceae; degree= 19), and *Diplusodon oblongus* (Lythraceae; degree= 18), which flowered mainly during the rainy season, displayed the widest niches, i.e., had the largest number of visiting pollinator species, and consequently the highest degrees (i.e., highest number of interaction partners) in cumulative accounts of species interactions. These species figured as major nectar and pollen sources for visitors. Unlike the most connected pollinators, plant species that received the largest number of visits by bees bloomed in either season, but usually not in both (Table S1).

Between April 1996 and May 1997, 820 unique links and 1,679 visitation events between 153 plant and 184 bee species were recorded in the *cerrado sensu strictu* area of BBG (Supplementary Table S2). Similar to the pattern observed in IBGE, the top ten most connected pollinator species in this community were aseasonal and maintained a large number of interaction partners throughout the year (Table S2; Figs 2 and 3). Similar to IBGE, the bulk of interactions recorded in this community involved eusocial bees (i.e., stingless bees and bumble bees), which were represented by 11 species (Table S2). At BBG, solitary bee groups were also less abundant but more species rich comprising (Table S2). Even though the BBG area comprised a more species rich pollinator community, bee families were represented in similar proportions as observed in IBGE: Apidae (115 spp.), Halictidae (38 spp.), Megachilidae (27 spp.), Colletidae (3 spp.), and Andrenidae (1 sp.) (Table S2; Figs 2 and 3). Honey bees were not included in the BBG plant-pollinator survey and species of native, stingless and bumble bees ranked as the most abundant species sampled on flowers (Table S2).

The plants observed in this area represented 41 families, comprising mostly shrubs, some trees, and few herbs. Similar to IBGE, Fabaceae was the most species rich group in this area (31 spp.) followed by Asteraceae (20 spp.) and Malpighiaceae (17 spp.). Considering all interactions recorded in this community, *Vernonia aurea* (Asteraceae; degree = 48), *V. eremophila* (degree = 36), and *Palicourea rigida* (Rubiaceae) (degree = 36; Table S2) ranked as top generalists and were mainly visited by bees for nectar. Similar to the pattern observed in the IBGE community and other pollination networks, the bulk of plant species (73%) interacted with few pollinators (< 5 spp.). Similar to IBGE, interaction abundance patterns in this community indicate that most plants flowered in only one season (Table S2; Figs 2 and 3). Both communities had nearly coinciding peaks of plant-pollinator interaction activity preceding each season: in March and April before begin of the dry season and in August, at the end of the dry season (Supplementary Figs S1 and S2).

Our analyses of the sampling effort (Supplementary Figs S3-S7) show that an asymptote was reached for the curve of pollinators' mean number of interaction partners (mean pollinator degree; Fig. S3) in the IBGE site. No asymptote was reached for all other features in either study site indicating that greater sampling efforts, i.e., bi or tri-weekly, would be necessary for complete accounts of the richness and diversity of these communities and their structural features.

Seasonal changes in community structure

We found both networks to be characterized by a strong and significant seasonal modularity, with a remarkably small number of links shared between seasons. The overlap in links between seasons was 2.5% (11/434) in the IBGE community and 5.1% (42/820) in BBG. Seasonal modules arose from significant and substantial turnover in species composition in both communities analyzed ($P < 0.001$; Table 1; Fig. 2). The IBGE community showed a 74% turnover in plant species flowering and 67% turnover in foraging pollinator species. In BBG, species turnover was 79% for plants flowering and 57% for pollinators foraging across seasons.

During the dry season, the IBGE flowering and bee foraging community greatly shrunk in size, displaying only 1/3 of the interactions recorded at this site throughout the year of study. This community showed a greater seasonal variation in network structure than the BBG community with number of species and connectance, with the average degree for plants and pollinators being significantly lower during the dry versus the rainy season at this site (Table 1). In contrast, only pollinator species number and nestedness varied significantly across the seasonal network modules in BBG.

Degree distributions of both plants and pollinators followed a truncated power-law in both communities indicating that species with narrow niches and few interaction partners (≤ 5 links) made up the bulk of species in these communities in both seasons. Few species maintained a large number of partners (Tables S1 and S2). With exception of pollinator degree distribution during the dry season in IBGE, the shape of the distributions did not change seasonally in either community (Supplementary Table S3).

Influence of seasonal changes in community composition and structure on network robustness to species loss

Our weighted as well as unweighted robustness analyses show that both communities were less robust to pollinator removal relative to plant removal (Fig. 4, Supplementary Table S4). This is consistent with the fact that seasonal modules are coupled by bees, which maintain activity through most part of the year, whereas plants tend to flower within either the dry or rainy season (Fig. 3; Tables S1 and S2). Moreover, robustness was lower when most-connected pollinators (i.e., with the highest degrees, also the most aseasonal) were removed first. Overall, communities were less robust to loss of visitation services (weighted robustness) than simple species loss (unweighted robustness). In both communities, the rainy season module was the more robust to species loss as well as visitation loss than the dry season module. However, this difference was more pronounced in the IBGE community (Fig. 4; Table S4), a result consistent with the significant decreases in plant as well as pollinator degree (generality) and connectance during the dry season in IBGE (Tables 1 and S1). We found that ignoring seasonal modularity resulted in an intermediate estimate of robustness in IBGE and had no significant effect for the BBG community. Overall, we found similar changes in robustness with season or aggregation for random species removal or targeted removal in order of increasing degree (Table S4).

Discussion

Seasonal variation in community structure

This is the first characterization of community structure in plant-pollinator networks from the Cerrado, a tropical, highly diverse, and seasonally dry ecosystem that occupies a large portion of South America. Our analyses show that the communities analyzed are modular and undergo substantial changes between seasons. In particular, seasonal transitions are associated with high turnover in the composition plant species in flower and species interactions while only moderate changes in the pollinator assemblage are observed. In both communities, dry and rainy season modules shared a small proportion of the species interactions recorded over the entire year at each site (IBGE= 2.5%; BBG= 5.1%). The small overlap in interactions between seasonal modules can be ascribed to the fact that most plants bloomed in only one of the two seasons while about 1/4 of the pollinators maintained activity and interacted with a relatively high number of floral hosts in both. These 'aseasonal pollinators' have wide niches and mainly comprise species social or semi-social bees but also include solitary and specialized bees that are pollinators adapted to interact with specific groups of plants. The aseasonal activity of pollinators is consistent with a social life style because tropical bee colonies are year-round active and their foraging activity extends beyond the flowering periods of most plants. Thus, over the course of a year all social bees need to establish interactions with multiple host plants to obtain enough resources to meet colony needs (Roubik 1992). On the other hand, aseasonal activity among some solitary bees in these communities can be ascribed to the production of multiple generations per year and diet specialization. For instance, the Cerrado is rich in oil-collecting bee species, which are specialized for the collection of floral oils from particular groups of plants but visit multiple floral hosts to obtain all types of resources they need for their own feeding (nectar), brood provisions (nectar, oils, and pollen), and nest construction (oils) (Neff & Simpson 1981; Silveira & Campos 1995; Pinheiro-Machado *et al.* 2002). Thus, both groups are required to switch between floral hosts as these species become “available” in the community over time and ultimately connect modules by visiting species blooming exclusively in one of the seasons. The relevance of aseasonal pollinators for the stability and dynamics of the communities analyzed here is likely to be common to many, if not most tropical systems, where warm and stable climates can promote plant-pollinator interactions year-round. This structural organization could have important implications for improving our understanding about factors promoting biodiversity and influencing stability of species rich tropical communities.

Overall, the IBGE community showed a greater variation in network structure between seasons than BBG. The reduction in cumbers of plant species in flower observed during the dry season in this community was paired with changes in particular network parameters (e.g., low connectance, average degrees, etc.) that have been linked to high vulnerability to disturbance in plant-pollinator communities (Bascompte *et al.* 2003; Memmott, Waser & Price 2004; Bascompte, Jordano & Olesen 2006; Vázquez *et al.* 2009). For instance, low network connectance is a consequence of a high proportion of species with narrow niches (i.e., ecological specialists), which are strongly affected by species extinctions or population fluctuations because they rely on few other partner species to persist in a habitat over time. Conversely, communities comprising a large proportion of generalists are considered to be more stable because redundancy in partner associations is expected to buffer oscillations of mutualistic partners. It is unclear why similar patterns of seasonal variation in network structure were not observed in BBG. Since both sites were sampled weekly during both seasons, we suggest that these differences could be attributed to the distinct phytophysiognomies or vegetation types that characterize each area. At IBGE the studied area is covered with a vegetation type known as *campo sujo*, which is characterized by a relatively open vegetation mainly composed by grasses interleafed with herbaceous plants, and subshrubs, with sparse occurrence of lianas and trees (Eiten 1972). In contrast, BBG's study area is covered with *cerrado sensu strictu*, a denser type of vegetation with predominance of large shrubs, lianas, and trees (Eiten 1972). During the dry season, woody plants (e.g., lianas, shrubs, and trees) are able to cope with water stress by tapping on water reserves usually stored over two meters deep in the soil (Oliveira 2008). Therefore, germination and flowering during the dry season are more likely to be impaired by water stress in *campo sujo*, where herbs and subshrubs dominate, than in areas of *cerrado sensu strictu*. Additionally, high abundance of trees in *cerrado sensu strictu*, which produce larger numbers of flowers than most herbs and subshrubs that predominate in *campo sujo*, could potentially influence the differences in pollinator attraction and explain seasonal differences in the number of interactions as well as in the pollinator composition between sites.

Intra-annual variation in network structure has been examined in subtropical and arctic communities but data on seasonal variation of tropical systems are scarce (Burkle & Alarcón 2011). A temporal analysis of a year-long active plant-pollinator community in the Talar, a subtropical xeric forest in Argentina, showed that variation in network structural features (e.g., connectance) was associated with expansion and shrinking of the flowering/foraging bee communities during spring/summer versus autumn/winter months (Basilio *et al.* 2006; Medan *et al.* 2006). Similar to the pattern observed in the Cerrado, high seasonal turnover in plant composition was paired with moderate turnover in pollinators which also connected the four seasonal modules observed in this subtropical habitat. Conversely, arctic communities, which are dominated by flies, have lower species richness (i.e., 17-31 plant and 26-76 pollinator species), active for a shorter period of time (e.g., ~ 40-70 days/year) than the tropical and subtropical systems and undergo much temporal change in proportionally less time (Lundgren & Olesen 2005; Olesen *et al.* 2008). For instance, two temporal modules corresponding to "early" and "late" season periods are recognized in an arctic island community from Greenland, which present distinct topologies despite being just nine days apart. Unlike the Cerrado communities analyzed here, a few long-flowering "aseasonal" plant but not pollinator species appear to be the main connectors of these arctic plant-pollinator communities. Together, these studies and ours provide preliminary yet adequate evidence that despite many generalities shared between pollination and other mutualistic networks across latitudes (Jordano, Bascompte & Olesen 2003), some intra-annual variation in pollination networks appears to be system-specific and factors such as seasonality, community size, composition, and length of activity appear to influence the magnitude of change over time. Therefore, detailed characterization of temporal variation, inter- and intra-annually, of plant-pollinator communities may be especially important when estimates of community stability and resilience, which can ultimately guide conservation efforts for target areas, are inferred based on data about network structural set-up and function.

Seasonality and Community Robustness

Our simulations of species extinction events (i.e., species removal) indicated that removal of aseasonal, highly connected pollinator species resulted in faster collapse of the networks than the removal of any other group of species comprised in the communities. Rates of secondary extinctions were higher for pollinators upon plant removal than vice-versa, corroborating the principle that aseasonal pollinators represent key elements for community robustness. This pattern was pronounced in the IBGE and is consistent with the changes in plant and pollinator degree (i.e., ecological generality) as well as connectance, among other properties, observed during the dry season in this community.

Even though species loss in the community exerted a stronger impact on the patterns of secondary extinction (i.e., extinction based on lack of interactions partners) for the dry season versus rainy season networks, these responses were not significantly different. Thus, seasonal networks were generally not less or more robust to species loss than when the complete community was considered. However, our results show that when robustness is analyzed by cumulative accounts of interactions irrespective of seasonality, a different and incorrect picture of network robustness emerges. As already pointed out by others (Basilio *et al.* 2006; Medan *et al.* 2006), our results show that cumulative estimates of species degree can lead to overestimation of partner redundancy as it assumes that in absence of one partner species all other partners would be available at any given time of the year. For instance, most of the species that appear to have a large number of mutualistic partners in a cumulative analysis of the network, which includes interactions from both seasons, have most interactions concentrate in one of the seasons, remaining only weakly connected outside of their main primary season. Our results also highlight the importance of including information not only about timing and seasonality of interactions but also resource use for robustness analyses considering communities comprising large percentages of evolutionary specialized species (Armbruster 2006). In Cerrado communities, several species of oil-collecting bees and oil-producing flowers (Malpighiaceae) ranked as top generalists based on species degree. However, plants that produce oils usually do not produce nectar thus visitors are required to interact with many non-specialized floral hosts to acquire nectar, a resource equally essential to an oil bee as are oil and pollen. Conversely, oil-producing plants lack nectar and rely on a restricted portion of the pollinator community, i.e., oil-collecting bees, for pollination. Hence, a superficial analysis of species degree would likely lead to an overestimation of partner redundancy for such species. Neotropical communities often comprise a large number of similarly specialized plant-pollinator mutualisms, such as perfume producing flowers and orchid bees and resin-producing flowers and bees that use resin for nest construction (Bawa 1990; Roubik 1992). Hence a superficial analysis of species degree as a method to rank species by their relevance in a community can lead to overestimation if floral host or pollinator redundancy. Furthermore, our data shows that some phenotypic specialized bees that have diverse diets and collect several types of resources, such as the solitary species of oil-collecting groups, may play an important role as “keystone mutualists” in Neotropical plant-pollinator communities (Gilbert 1980). Our study provides additional evidence that proper evaluation of community ecology and robustness of these systems can only be achieved with the inclusion of information of timing and resource use of interactions recorded. Given the extent of areas covered by seasonally dry forests and savannas worldwide, their relevance for conservation of biodiversity, and the increasing need for baseline research to estimate effects of climate change for the persistence of natural communities a better understanding of plant-pollinator ecology from such habitats is much needed.

Concluding remarks

Our results corroborate the idea that temporal and seasonal variation in species interactions is likely to influence particular structural features relevant for understanding dynamics and stability of plant-pollinator communities. The inclusion of such information might be especially important in the analyses of communities from highly seasonal habitats such as the seasonally dry savannas and forests from South America. In the systems studied, we show that well-defined modules comprising specific interactions characterize each season and these modules have less than 6% in interactions in common. We ascribe the low overlap in interactions between seasonal modules to strong seasonality in plant phenology while pollinator activity appears to be less affected by climatic conditions. Our findings indicate that long-term water stress in combination with particular vegetation types, as observed in the Cerrado, may lead to drastic changes in community dynamics and structure during the dry season, increasing its vulnerability to disturbance. In the systems studied, aseasonal pollinators, comprising specialized and social bees, function as keystone species and are especially important for the stability of the overall system. We suggest that inclusion of resource use, in addition to seasonal information on species interactions, might be important and necessary for accurate analyses of ecology and stability analyses of Neotropical communities subject to strong seasonality.

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Data accessibility

All data used in this manuscript are present in the manuscript and its supporting information.

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Table 1. Seasonal changes in network structure and species niche breath in the two Cerrado communities. Each nestedness value is a test of the null hypotheses that the observed network is no more nested than a random one, and was calculated from constrained network randomizations ($p < 0.0001$; see methods). Significant differences in parameters between dry and rainy seasons (at one-tailed $p < 0.05$) are flagged with a "*" (see methods).

	Measure	IBGE			BBG		
		Cumulative	Rainy	Dry	Cumulative	Rainy	Dry
Network structure	Total species	204	158*	107*	337	227*	221*
	Plant species (P)	93	66	51	153	92	93
	Pollinator species (A)	111	92*	56*	184	135*	128*
	Number of links (L)	434	318*	127*	820	407	455
	Number of visits recorded (V)	968	608	360	1,679	686	993
	Bipartite connectance (BC= 2*L/A * P)	0.084	0.105*	0.089*	0.058	0.066	0.076
	Standard connectance (C= 100*(L/ A * P))	4.20	5.24	4.45	2.91	3.28	3.82
	Nestedness (NODF)	13.9	13.3	10.2	14.2	12.0*	17.6*
	Mean shortest path	3.6	3.6	4.2	3.6	3.8	3.6
	Network diameter	9	7	9	8	9	8
Niche breadth	Mean plant degree	4.7	4.8*	2.5*	5.4	4.4	4.9
	Min plant degree	1	1	1	1	1	1
	Max plant degree	22	19	12	48	36	45
	Mean pollinator degree	3.9	3.5*	2.3*	4.5	3	3.6
	Min plant degree	1	1	1	1	1	1
	Max pollinator degree	29	20	14	51	24	32

Figure Captions

Figure 1. Summary of climatic conditions at the study site in the period from 1980 to 2010. *Left figure*: Monthly precipitation in centimeters, stars indicate the average in millimeters and bars represent confidence intervals. *Right figure*: Monthly temperature in Celsius degrees, solid circles indicate the average high daytime temperatures, open circles show the average of the lowest nighttime values, and bars represent confidence intervals. Months on the horizontal axis reflect the seasonal periods defined in the analysis (see methods section). Red indicates dry season and blue rainy season months.

Figure 2. Seasonal pollination networks of the two communities. Blue lines indicate interactions recorded during the rainy season, red lines show interactions recorded in the dry season, and black lines show interactions recorded in both seasons (i.e., overlap). Both plants and animal nodes have been ordered by decreasing degree, i.e., with the most connected species on top. Each node is color-coded to reflect its period of activity in the community: blue – only rainy season; red – only dry season; black– both seasons. Black nodes are clustered towards the top, indicating that species with large number of partners (generalists) bloomed or were active in both seasons. The paucity of black links illustrates the low overlap in interactions between seasons and the modularity arising due to floral host switch by pollinators.

Figure 3. Temporal turnover in the number of interaction partners for pollinators (upper panels) and plants (lower panels) in Cerrado communities. Turnover is shown for the five species with the largest number of interaction partners in each community

(i.e., top pollinators and plants). Numbers indicate species node identification number in each respective community (for corresponding species names, see Tables S1 and S2 in the supplementary material). Aseasonality of pollinators is illustrated by links colored in black. All top five pollinators comprised species of social bees (i.e., honey bees, stingless bees, and bumble bees) in both communities. Seasonal transitions are associated with nearly complete turnover in the set of partner species with which plants and pollinators interact in each community. Each node and interaction is color-coded to reflect seasonal period of activity: blue – rainy season only, red – dry season only, and black– both seasons.

Figure 4. Network robustness to the simulated extinctions of pollinator and plant species in each community. Curves reflect extinction simulations results with removal following a decreasing rank of species importance (i.e., from largest to smallest values) in degree for robustness to species loss, and weighted degree for robustness to loss of flow. Dots indicate species loss robustness results as the proportion of species remaining in the community after removal; lines indicate flow robustness as the proportion of visitations being made or received after removal; red indicates dry season results, blue refers to rainy season module, and black refers to the results considering the entire, aseasonal community. Significance of differences in robustness are indicates by asteriscs for the removals by decreasing aseasonality (degree) in terms of overlap in the 95% confidence intervals (CI) around the AUC curves, as well as the proportion of nodes or visitation services remaining after removal (in parentheses, ±95% CI). For significance of

differences in robustness of low to high degree and random removal of species, see Table S4 in the supplementary material.

Figure 1

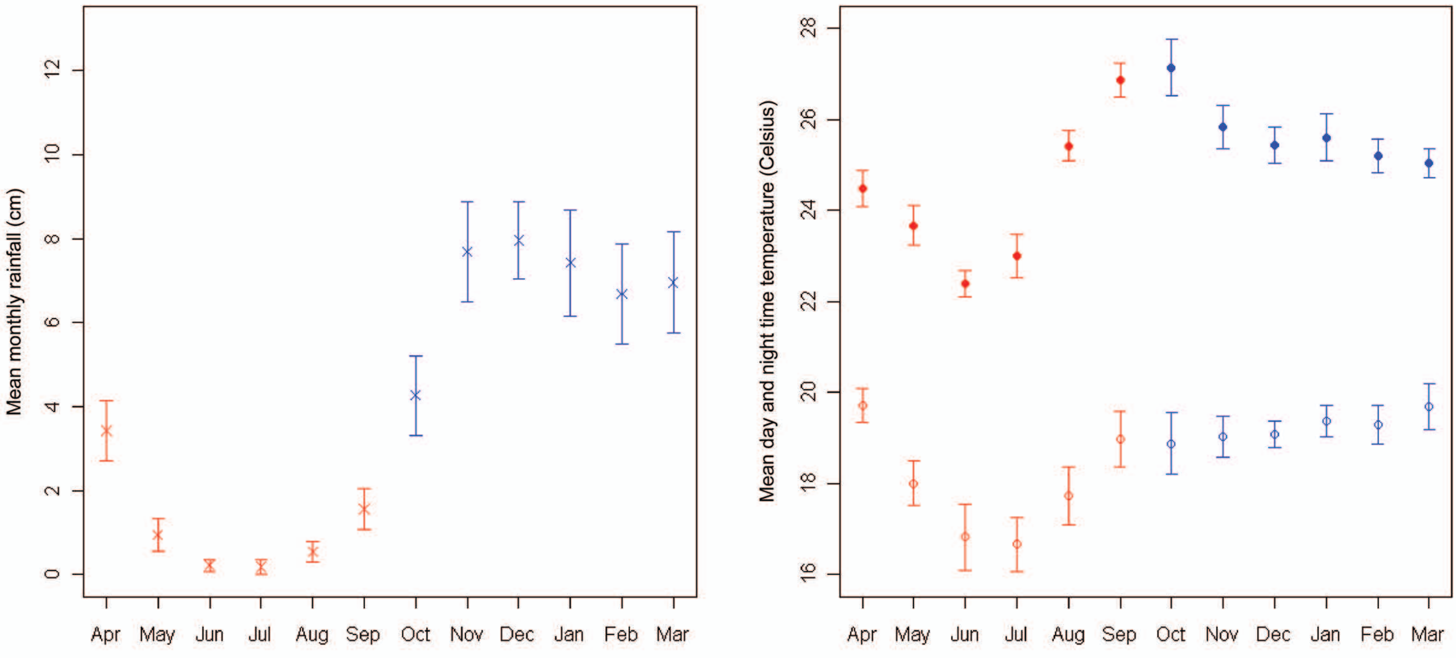

Mean monthly rainfall (cm)
0
2
4
6
8
10
12
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Mean day and night time temperature (Celsius)
16
18
20
22
24
26
28

Figure 2.

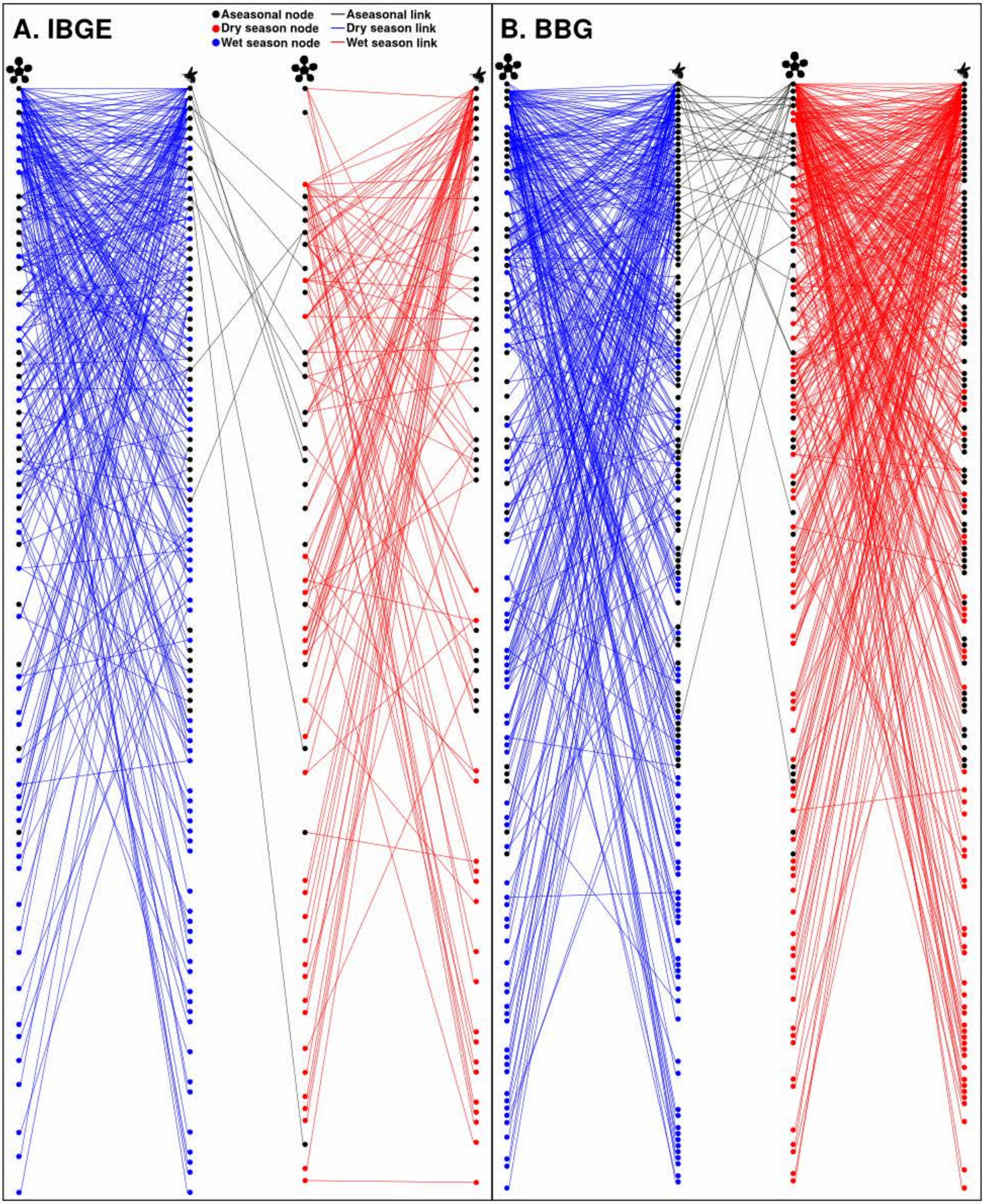

A. IBGE
B. BBG
Aseasonal node
Dry season node
Wet season node
Aseasonal link
Dry season link
Wet season link

Figure 3.

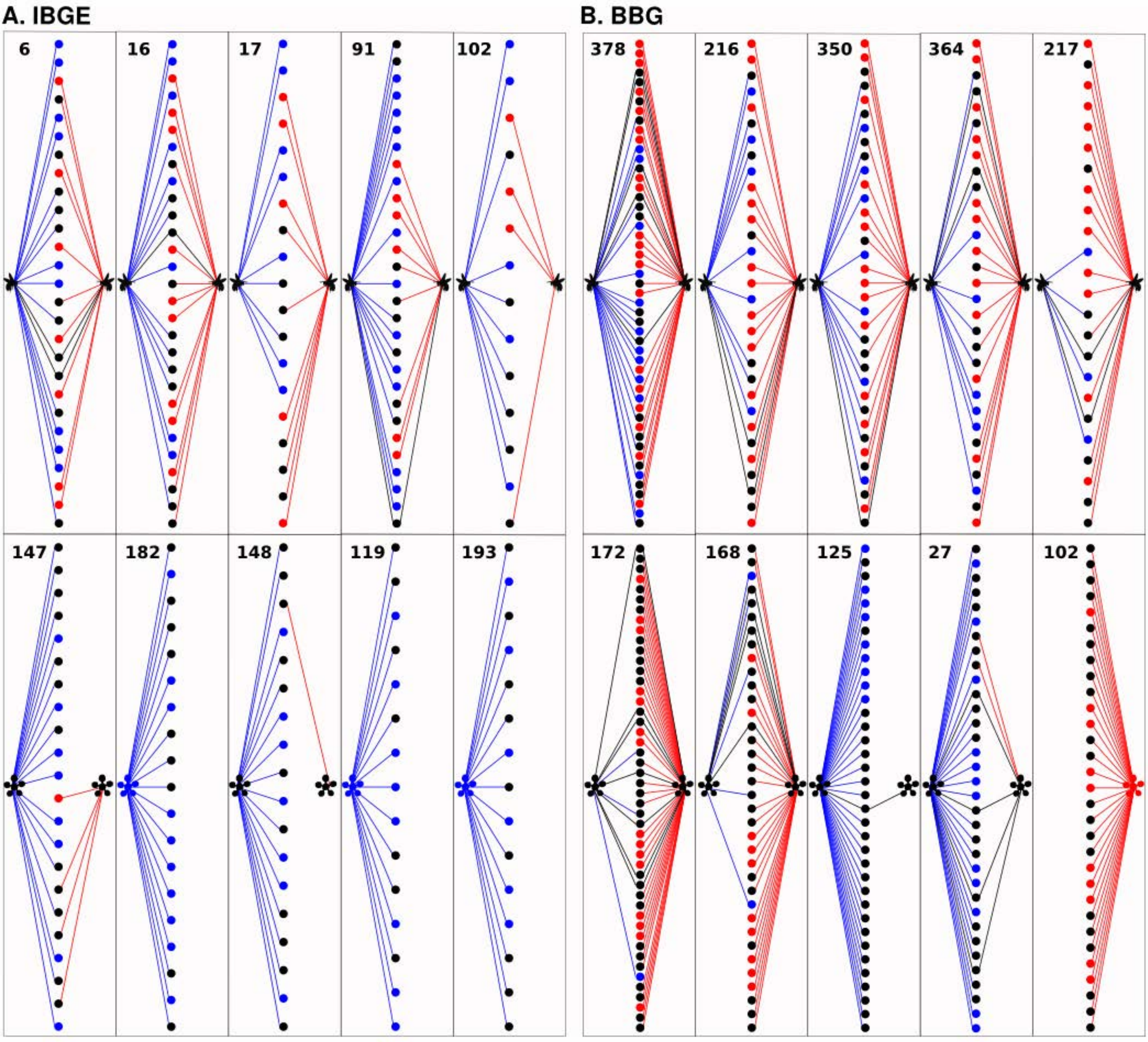
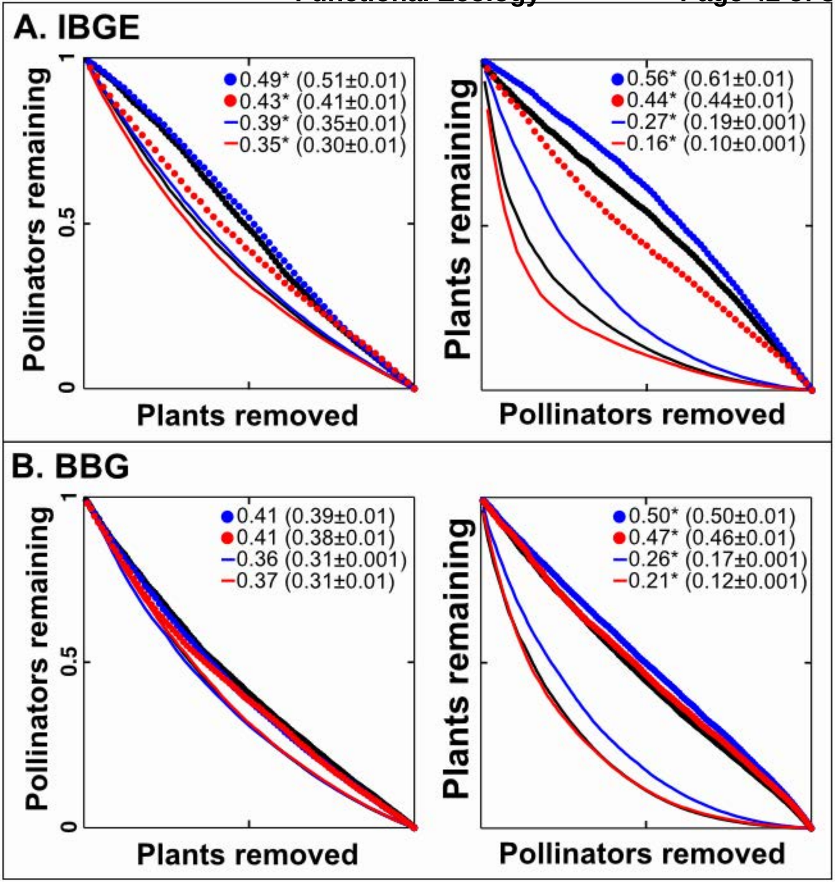

A. IBGE
B. BBG
6
16
17
91
102
378
216
350
364
217
147
182
148
119
193
172
168
125
27
102

Figure 4.


A. IBGE
Pollinators remaining
1
0.5
0
Plants removed
0.49* (0.51±0.01)
0.43* (0.41±0.01)
0.39* (0.35±0.01)
0.35* (0.30±0.01)
Plants remaining
Pollinators removed
0.56* (0.61±0.01)
0.44* (0.44±0.01)
0.27* (0.19±0.001)
0.16* (0.10±0.001)
B. BBG
Pollinators remaining
1
0.5
0
Plants removed
0.41 (0.39±0.01)
0.41 (0.38±0.01)
0.36 (0.31±0.001)
0.37 (0.31±0.01)
Plants remaining
Pollinators removed
0.50* (0.50±0.01)
0.47* (0.46±0.01)
0.26* (0.17±0.001)
0.21* (0.12±0.001)

Supplementary Material

Table S1. Plant (P) and pollinator (A) species recorded from October 2008 to September 2009 at the IBGE site, sorted by decreasing degree (i.e., number of interaction partners) and interaction frequency as proxies of niche breath within each trophic level (TL), pollinators appearing first. *Cum.*= total records independent of seasonality; *Rainy*= records for the rainy season only; *Dry*= records for the dry season only; % = proportion of data recorded in each season relative to the cumulative records. Species were classified as "seasonal" if proportional degree or interaction frequency were equal or greater than 75% in one season. Social bees indicated by *; oil-collecting species indicated by §.

				NICHE BREADTH											
Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
16	Apidae	*Bombus brevivillus**	bee	29	16	14	0.55	0.48	aseasonal	86	40	46	0.47	0.53	aseasonal
91	Apidae	*Paratrigona lineata**	bee	29	20	10	0.69	0.34	aseasonal	106	54	52	0.51	0.49	aseasonal
6	Apidae	*Apis mellifera**	bee	27	17	12	0.63	0.44	aseasonal	154	45	109	0.29	0.71	aseasonal
17	Apidae	*Bombus morio**	bee	19	9	10	0.47	0.53	aseasonal	43	17	26	0.40	0.60	aseasonal
102	Apidae	*Trigona spinipes**	bee	14	10	4	0.71	0.29	aseasonal	60	30	30	0.50	0.50	aseasonal
90	Apidae	*Paratetrapedia punctata*§	bee	13	9	5	0.69	0.38	aseasonal	22	15	7	0.68	0.32	aseasonal
67	Apidae	*Exomalopsis fulvofasciata*	bee	11	11	0	1.00	0.00	seasonal	15	15	0	1.00	0.00	seasonal

Node	Family	Species	TL	NICHE BREADTH											
				Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
36	Apidae	*Ceratina* (*Crewella*) sp. 2	bee	10	7	3	0.70	0.30	aseasonal	12	9	3	0.75	0.25	aseasonal
37	Apidae	*Ceratina* (*Crewella*) sp. 3	bee	9	9	1	1.00	0.11	seasonal	14	13	1	0.93	0.07	seasonal
22	Apidae	*Centris burgdorfi*§	bee	8	5	4	0.63	0.50	aseasonal	13	6	7	0.46	0.54	aseasonal
56	Apidae	*Epicharis iheringii*§	bee	7	7	0	1.00	0.00	seasonal	9	9	0	1.00	0.00	seasonal
57	Apidae	*Epicharis morio*§	bee	7	6	3	0.86	0.43	seasonal	21	18	3	0.86	0.14	seasonal
66	Apidae	*Exomalopsis campestris*	bee	7	6	1	0.86	0.14	seasonal	11	10	1	0.91	0.09	seasonal
100	Apidae	*Tetrapedia diversipes*§	bee	7	7	0	1.00	0.00	seasonal	16	16	0	1.00	0.00	seasonal
30	Apidae	*Centris nitens*§	bee	6	4	2	0.67	0.33	aseasonal	8	6	2	0.75	0.25	aseasonal
52	Apidae	*Epicharis analis*§	bee	6	6	0	1.00	0.00	seasonal	15	15	0	1.00	0.00	seasonal
53	Apidae	*Epicharis bicolor*§	bee	6	5	1	0.83	0.17	seasonal	8	7	1	0.88	0.13	seasonal
54	Apidae	*Epicharis cockerelli*§	bee	6	5	1	0.83	0.17	seasonal	10	9	1	0.90	0.10	seasonal
60	Apidae	*Eufriesea violacens*	bee	6	6	0	1.00	0.00	seasonal	7	7	0	1.00	0.00	seasonal
73	Apidae	*Geotrigona mombuca**	bee	6	4	2	0.67	0.33	aseasonal	21	19	2	0.90	0.10	seasonal
82	Megachilidae	*Megachile rubricate*	bee	6	5	1	0.83	0.17	seasonal	8	7	1	0.88	0.13	seasonal
96	Apidae	*Scaptotrigona postica**	bee	6	5	1	0.83	0.17	seasonal	49	48	1	0.98	0.02	seasonal
108	Apidae	*Xylocopa hirsutissima*	bee	6	6	0	1.00	0.00	seasonal	7	7	0	1.00	0.00	seasonal
18	Apidae	*Bombus pauloensis**	bee	5	2	3	0.40	0.60	aseasonal	8	2	6	0.25	0.75	seasonal

Node	Family	Species	TL	NICHE BREADTH											
				Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
71	Apidae	*Gaesischia belophora*	bee	5	3	2	0.60	0.40	aseasonal	8	5	3	0.63	0.38	aseasonal
87	Apidae	*Monoeca mourei*§	bee	5	5	0	1.00	0.00	seasonal	10	10	0	1.00	0.00	seasonal
99	Apidae	*Tetragona quadrangula**	bee	5	3	2	0.60	0.40	aseasonal	11	5	6	0.45	0.55	aseasonal
101	Apidae	*Tetrapedia peckoltii*§	bee	5	4	1	0.80	0.20	seasonal	10	9	1	0.90	0.10	seasonal
104	Apidae	*Tropidopedia flavolineata*§	bee	5	5	1	1.00	0.20	seasonal	7	5	2	0.71	0.29	aseasonal
31	Apidae	*Centris varia*§	bee	4	4	0	1.00	0.00	seasonal	7	7	0	1.00	0.00	seasonal
21	Apidae	*Centris bicolor*§	bee	4	2	2	0.50	0.50	aseasonal	4	2	2	0.50	0.50	aseasonal
35	Apidae	*Ceratina* (*Crewella*) sp. 1	bee	4	4	0	1.00	0.00	seasonal	6	6	0	1.00	0.00	seasonal
41	Apidae	*Ceratina* (*Crewella*) sp. 7	bee	4	3	1	0.75	0.25	seasonal	4	3	1	0.75	0.25	aseasonal
51	Megachilidae	*Epanthidium tigrinum*	bee	4	4	0	1.00	0.00	seasonal	4	4	0	1.00	0.00	seasonal
63	Apidae	*Eulaema nigrita*	bee	4	4	0	1.00	0.00	seasonal	6	6	0	1.00	0.00	seasonal
65	Apidae	*Exomalopsis auropilosa*	bee	4	1	3	0.25	0.75	seasonal	5	1	4	0.20	0.80	seasonal
69	Apidae	*Exomalopsis* sp. 2	bee	4	2	2	0.50	0.50	aseasonal	4	2	2	0.50	0.50	aseasonal
84	Apidae	*Melissoptila richardia*	bee	4	3	1	0.75	0.25	seasonal	5	3	2	0.60	0.40	aseasonal
5	Megachilidae	*Anthodioctes megachiloides*	bee	3	2	1	0.67	0.33	aseasonal	3	2	1	0.67	0.33	aseasonal
9	Halictidae	*Augochloropsis smithiana**	bee	3	1	2	0.33	0.67	aseasonal	3	1	2	0.33	0.67	aseasonal
11	Halictidae	*Augochloropsis* sp. 2*	bee	3	3	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal

Node	Family	Species	TL	NICHE BREADTH											
				Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
28	Apidae	*Centris scopipes*§	bee	3	3	1	1.00	0.33	seasonal	4	3	1	0.75	0.25	aseasonal
40	Apidae	*Ceratina* (*Crewella*) sp. 6	bee	3	3	0	1.00	0.00	seasonal	8	8	0	1.00	0.00	seasonal
55	Apidae	*Epicharis flava*§	bee	3	3	0	1.00	0.00	seasonal	5	5	0	1.00	0.00	seasonal
61	Apidae	*Euglossa melanotricha*	bee	3	3	0	1.00	0.00	seasonal	4	4	0	1.00	0.00	seasonal
62	Apidae	*Euglossa* sp.	bee	3	3	0	1.00	0.00	seasonal	4	4	0	1.00	0.00	seasonal
68	Apidae	*Exomalopsis* sp. 1	bee	3	3	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
80	Megachilidae	*Megachile aureiventris*	bee	3	3	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
83	Megachilidae	*Megachile terrestris*	bee	3	3	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
88	Andrenidae	*Oxaea flavescens*	bee	3	3	0	1.00	0.00	seasonal	9	9	0	1.00	0.00	seasonal
109	Apidae	*Xylocopa* sp.	bee	3	0	3	0.00	1.00	seasonal	3	0	3	0.00	1.00	seasonal
2	Apidae	*Ancyloscelis* cft. *romeroi*	bee	2	2	0	1.00	0.00	seasonal	4	4	0	1.00	0.00	seasonal
4	Megachilidae	*Anthidium sertanicola*	bee	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
12	Halictidae	*Augochloropsis* sp. 3*	bee	2	0	2	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
13	Halictidae	*Augochloropsis* sp. 4*	bee	2	1	1	0.50	0.50	aseasonal	2	1	1	0.50	0.50	aseasonal
14	Halictidae	*Augochloropsis* sp. 5*	bee	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
29	Apidae	*Centris tarsata*§	bee	2	1	1	0.50	0.50	aseasonal	2	1	1	0.50	0.50	aseasonal
32	Apidae	*Ceratalictus clonius**	bee	2	1	1	0.50	0.50	aseasonal	2	1	1	0.50	0.50	aseasonal

Node	Family	Species	TL	NICHE BREADTH											
				Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
34	Apidae	*Ceratina* (*Ceratinula*) sp. 2	bee	2	1	1	0.50	0.50	aseasonal	2	1	1	0.50	0.50	aseasonal
38	Apidae	*Ceratina* (*Crewella*) sp. 4	bee	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
45	Apidae	*Ctenioschelus goryi*	bee	2	1	1	0.50	0.50	aseasonal	2	1	1	0.50	0.50	aseasonal
75	Megachilidae	*Larocanthidium* sp.	bee	2	1	1	0.50	0.50	aseasonal	2	1	1	0.50	0.50	aseasonal
47	Halictidae	*Lasioglossum* (*Dialictus*) sp. 2*	bee	2	1	1	0.50	0.50	aseasonal	2	1	1	0.50	0.50	aseasonal
78	Apidae	*Lophopedia pygmaea*§	bee	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
93	Apidae	*Partamona cupira**	bee	2	2	0	1.00	0.00	seasonal	6	6	0	1.00	0.00	seasonal
94	Halictidae	*Pseudoagapostemon* sp.*	bee	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
95	Halictidae	*Rhinocorynura* sp.	bee	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
110	Apidae	*Xylocopa subcyanea*	bee	2	2	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
111	Apidae	*Xylocopa vestita*	bee	2	0	2	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
1	Halictidae	*Agapostemon chapadensis**	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
3	Apidae	*Ancyloscelis* sp.	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
7	Apidae	*Arhysoceble* sp. §	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
8	Halictidae	*Augochlorella ephyra**	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
10	Halictidae	*Augochloropsis* sp. 1*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
15	Halictidae	*Augochloropsis* sp. 6*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal

				NICHE BREADTH											
Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
19	Apidae	*Centris aenea*[§]	bee	1	1	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
20	Apidae	*Centris analis*[§]	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
23	Apidae	*Centris fuscata*[§]	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
24	Apidae	*Centris lateritia*[§]	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
25	Apidae	*Centris machadoi*[§]	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
26	Apidae	*Centris mocsaryi*[§]	bee	1	1	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
27	Apidae	*Centris rupestris*[§]	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
33	Apidae	*Ceratina* (*Ceratinula*) sp. 1	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
39	Apidae	*Ceratina* (*Crewella*) sp. 5	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
42	Apidae	*Ceratina* (*Rhysoceratina*) sp. 1	bee	1	1	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
43	Megachilidae	*Coelioxys* sp.	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
44	Colletidae	*Colletes* sp.	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
50	Megachilidae	*Epanthidium aureocinctum*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
58	Apidae	*Epicharis picta*[§]	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
59	Apidae	*Epicharis xanthogastra*[§]	bee	1	1	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
64	Apidae	*Exaerete dentata*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
70	Apidae	*Exomalopsis* sp. 3	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal

Node	Family	Species	TL	NICHE BREADTH											
				Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
72	Apidae	*Gaesischia nigra*	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
74	Megachilidae	*Hypanthidium nigritulum*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
76	Halictidae	*Lasioglossum* (*Dialictus*) sp. 1*	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
46	Halictidae	*Lasioglossum* (*Dialictus*) *rostratum**	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
48	Halictidae	*Lasioglossum* (*Dialictus*) sp. 3*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
49	Halictidae	*Lasioglossum* (*Dialictus*) sp. 4*	bee	1	0	1	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
77	Megachilidae	*Lithurgus huberi*	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
79	Megachilidae	*Megachile* (*Pseudocentron*) sp.	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
81	Megachilidae	*Megachile frankieana*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
85	Apidae	*Melissoptila* sp.	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
86	Apidae	*Monoeca pluricincta*§	bee	1	0	1	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
89	Apidae	*Paratetrapedia flaveola*§	bee	1	0	1	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
92	Halictidae	*Paraxystoglossa mimetica**	bee	1	1	0	1.00	0.00	seasonal	7	7	0	1.00	0.00	seasonal
97	Apidae	*Schwarziana quadripunctata**	bee	1	0	1	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
98	Halictidae	*Temnosoma* sp.	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
103	Apidae	*Tropidopedia carinata*§	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
105	Apidae	*Xanthopedia larocai*§	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal

Node	Family	Species	TL	NICHE BREADTH											
				Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
106	Apidae	*Xylocopa cearensis*	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
107	Apidae	*Xylocopa grisescens*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
147	Asteraceae	*Dimerostemma vestitum*	plant	22	18	4	0.82	0.18	seasonal	31	26	5	0.84	0.16	seasonal
182	Rubiaceae	*Palicourea coriacea*	plant	19	19	0	1.00	0.00	seasonal	48	48	0	1.00	0.00	seasonal
148	Lythraceae	*Diplusodon oblongus*	plant	18	17	1	0.94	0.06	seasonal	70	69	1	0.99	0.01	seasonal
119	Fabaceae	*Bauhinia dumosa*	plant	15	15	0	1.00	0.00	seasonal	25	25	0	1.00	0.00	seasonal
193	Vochysiaceae	*Qualea parviflora*	plant	15	15	0	1.00	0.00	seasonal	23	23	0	1.00	0.00	seasonal
121	Malpighiaceae	*Byrsonima basiloba*	plant	14	14	0	1.00	0.00	seasonal	24	24	0	1.00	0.00	seasonal
144	Lythraceae	*Cuphea linarioides*	plant	13	13	0	1.00	0.00	seasonal	19	19	0	1.00	0.00	seasonal
153	Fabaceae	*Galactia stereophylla*	plant	13	13	0	1.00	0.00	seasonal	19	19	0	1.00	0.00	seasonal
138	Asteraceae	*Chresta sphaerocephala*	plant	12	0	12	0.00	1.00	seasonal	18	0	18	0.00	1.00	seasonal
166	Asteraceae	*Lessingianthus brevipetiolatus*	plant	12	8	4	0.67	0.33	aseasonal	15	11	4	0.73	0.27	aseasonal
175	Fabaceae	*Mimosa albolanata*	plant	12	11	2	0.92	0.17	seasonal	55	47	8	0.85	0.15	seasonal
165	Asteraceae	*Lessingianthus bardanoides*	plant	11	7	4	0.64	0.36	aseasonal	13	8	5	0.62	0.38	aseasonal
117	Malpighiaceae	*Banisteriopsis schizoptera*	plant	10	7	5	0.70	0.50	aseasonal	14	7	7	0.50	0.50	aseasonal
143	Euphorbiaceae	*Croton goyazensis*	plant	10	3	7	0.30	0.70	aseasonal	87	7	80	0.08	0.92	seasonal
116	Malpighiaceae	*Banisteriopsis campestris*	plant	9	9	0	1.00	0.00	seasonal	16	16	0	1.00	0.00	seasonal

				NICHE BREADTH											
Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
155	Malpighiaceae	*Heteropterys campestris*	plant	8	8	1	1.00	0.13	seasonal	13	12	1	0.92	0.08	seasonal
159	Lamiaceae	*Hyptis lythroides*	plant	8	0	8	0.00	1.00	seasonal	32	0	32	0.00	1.00	seasonal
178	Fabaceae	*Mimosa radula*	plant	8	7	1	0.88	0.13	seasonal	45	44	1	0.98	0.02	seasonal
120	Asteraceae	*Bidens graveolens*	plant	7	7	0	1.00	0.00	seasonal	19	19	0	1.00	0.00	seasonal
137	Fabaceae	*Chamaecrista planaltoana*	plant	7	0	7	0.00	1.00	seasonal	53	0	53	0.00	1.00	seasonal
152	Fabaceae	*Galactia heringeri*	plant	7	7	0	1.00	0.00	seasonal	12	12	0	1.00	0.00	seasonal
160	Convolvulaceae	*Ipomoea contorquens*	plant	7	7	0	1.00	0.00	seasonal	9	9	0	1.00	0.00	seasonal
161	Gentianaceae	*Irlbachia speciosa*	plant	7	2	6	0.29	0.86	seasonal	10	2	8	0.20	0.80	seasonal
164	Asteraceae	*Lessingianthus argyrophyllus*	plant	7	5	2	0.71	0.29	aseasonal	15	12	3	0.80	0.20	seasonal
168	Asteraceae	*Lessingianthus ligulaefolius*	plant	7	5	3	0.71	0.43	aseasonal	20	16	4	0.80	0.20	seasonal
131	Fabaceae	*Centrosema bracteosum*	plant	6	6	0	1.00	0.00	seasonal	9	9	0	1.00	0.00	seasonal
142	Fabaceae	*Crotalaria unifoliata*	plant	6	6	0	1.00	0.00	seasonal	6	6	0	1.00	0.00	seasonal
195	Acanthaceae	*Ruellia incompta*	plant	6	1	5	0.17	0.83	seasonal	6	1	5	0.17	0.83	seasonal
205	Velloziaceae	*Vellozia squamata*	plant	6	5	2	0.83	0.33	seasonal	10	8	2	0.80	0.20	seasonal
122	Malpighiaceae	*Byrsonima coccolobifolia*	plant	5	5	0	1.00	0.00	seasonal	5	5	0	1.00	0.00	seasonal
149	Lamiaceae	*Eriope complicata*	plant	5	4	2	0.80	0.40	seasonal	13	9	4	0.69	0.31	aseasonal
176	Fabaceae	*Mimosa gracilis*	plant	5	5	1	1.00	0.20	seasonal	8	7	1	0.88	0.13	seasonal

Node	Family	Species	TL	NICHE BREADTH											
				Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
183	Rubiaceae	*Palicourea rigida*	plant	5	5	0	1.00	0.00	seasonal	8	8	0	1.00	0.00	seasonal
196	Rubiaceae	*Sabicea brasiliensis*	plant	5	4	1	0.80	0.20	seasonal	6	5	1	0.83	0.17	seasonal
124	Malpighiaceae	*Byrsonima rigida*	plant	4	4	0	1.00	0.00	seasonal	5	5	0	1.00	0.00	seasonal
135	Fabaceae	*Chamaecrista claussenii*	plant	4	2	2	0.50	0.50	aseasonal	5	2	3	0.40	0.60	aseasonal
154	Rubiaceae	*Galianthe ramosa*	plant	4	4	0	1.00	0.00	seasonal	10	10	0	1.00	0.00	seasonal
115	Asteraceae	*Aspilia foliacea*	plant	3	3	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
118	Malpighiaceae	*Banisteriopsis stellaris*	plant	3	2	1	0.67	0.33	aseasonal	3	2	1	0.67	0.33	aseasonal
128	Asteraceae	*Calea fruticosa*	plant	3	0	3	0.00	1.00	seasonal	4	0	4	0.00	1.00	seasonal
132	Fabaceae	*Chamaecrista desvauxii*	plant	3	3	0	1.00	0.00	seasonal	6	6	0	1.00	0.00	seasonal
136	Fabaceae	*Chamaecrista lundii*	plant	3	0	3	0.00	1.00	seasonal	17	0	17	0.00	1.00	seasonal
150	Erythroxylaceae	*Erythroxylum campestre*	plant	3	0	3	0.00	1.00	seasonal	14	0	14	0.00	1.00	seasonal
157	Lamiaceae	*Hypenia macrantha*	plant	3	1	2	0.33	0.67	aseasonal	3	1	2	0.33	0.67	aseasonal
162	Acanthaceae	*Justicia picnophylla*	plant	3	3	0	1.00	0.00	seasonal	5	5	0	1.00	0.00	seasonal
180	Ochnaceae	*Ouratea floribunda*	plant	3	0	3	0.00	1.00	seasonal	5	0	5	0.00	1.00	seasonal
185	Malpighiaceae	*Peixotoa goiana*	plant	3	0	3	0.00	1.00	seasonal	16	0	16	0.00	1.00	seasonal
194	Rubiaceae	*Richardia brasiliensis*	plant	3	0	3	0.00	1.00	seasonal	5	0	5	0.00	1.00	seasonal
199	Verbenaceae	*Stachytarpheta chamissonis*	plant	3	1	2	0.33	0.67	aseasonal	3	1	2	0.33	0.67	aseasonal

				NICHE BREADTH											
Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
203	Melastomataceae	*Tibouchina candollea*	plant	3	3	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
113	Lamiaceae	*Amasonia hirta*	plant	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
123	Malpighiaceae	*Byrsonima pachyphylla*	plant	2	0	2	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
126	Malpighiaceae	*Byrsonima verbascifolia*	plant	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
134	Fabaceae	*Chamaecrista pohliana*	plant	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
158	Lamiaceae	*Hyptis euneata*	plant	2	0	2	0.00	1.00	seasonal	5	0	5	0.00	1.00	seasonal
169	Fabaceae	*Lupinus velutinus*	plant	2	2	1	1.00	0.50	seasonal	6	3	3	0.50	0.50	aseasonal
172	Convolvulaceae	*Merremia contorquens*	plant	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
177	Fabaceae	*Mimosa lanuginosa*	plant	2	0	2	0.00	1.00	seasonal	4	0	4	0.00	1.00	seasonal
179	Myrtaceae	*Myrcia* sp.	plant	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
187	Malvaceae	*Peltaea obsita*	plant	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
190	Melastomataceae	*Pterolepis repanda*	plant	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
192	Vochysiaceae	*Qualea multiflora*	plant	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
202	Malpighiaceae	*Tetrapterys ambigua*	plant	2	1	1	0.50	0.50	aseasonal	2	1	1	0.50	0.50	aseasonal
112	Fabaceae	*Acosmium dasycarpum*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
114	Bignoniaceae	*Arrabidhea sceptrum*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
125	Malpighiaceae	*Byrsonima subterranea*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal

Node	Family	Species	TL	NICHE BREADTH											
				Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
127	Malpighiaceae	*Byrsonima viminifolia*	plant	1	0	1	0.00	1.00	seasonal	4	0	4	0.00	1.00	seasonal
129	Fabaceae	*Calliandra dysantha*	plant	1	0	1	0.00	1.00	seasonal	3	0	3	0.00	1.00	seasonal
130	Malpighiaceae	*Camarea affinis*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
139	Asteraceae	*Chromolaena leucocephala*	plant	1	0	1	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
141	Connaraceae	*Connarus* sp.	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
140	Connaraceae	*Connarus suberosus*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
145	Euphorbiaceae	*Dalechampia linearis*	plant	1	1	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
146	Gentianaceae	*Deianira chiquitana*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
151	Myrtaceae	*Eugenia complicata*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
156	Asteraceae	*Hoehnephytum trixoides*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
163	Asteraceae	*Lepidaploa aurea*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
167	Asteraceae	*Lessingianthus durus*	plant	1	0	1	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
170	Apocynaceae	*Macrosiphonia velame*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
171	Apocynaceae	*Mandevilla novocapitalis*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
173	Convolvulaceae	*Merremia tomentosa*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
174	Melastomataceae	*Miconia albicans*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
181	Ochnaceae	*Ouratea hexasperma*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal

Node	Family	Species	TL	NICHE BREADTH: Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
184	Malvaceae	*Pavonia rosacampestris*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
186	Malpighiaceae	*Peixotoa reticulata*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
188	Burseraceae	*Protium ovatum*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
189	Myrtaceae	*Psidium salutare*	plant	1	0	1	0.00	1.00	seasonal	11	0	11	0.00	1.00	seasonal
191	Vochysiaceae	*Qualea grandiflora*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
197	Solanaceae	*Solanum lycocarpum*	plant	1	1	1	1.00	1.00	seasonal	2	1	1	0.50	0.50	aseasonal
198	Solanaceae	*Solanum* sp.	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
200	Fabaceae	*Stylosanthes* sp.	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
201	Styracaceae	*Styrax ferrugineus*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
204	Rubiaceae	*Tocoyena formosa*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal

Table S2. Plant (P) and pollinator (A) species recorded from June 1996 to May 1997 at the Brasilia Botanical Garden (BBG) site, sorted by decreasing degree (i.e., number of interaction partners) and interaction frequency as proxies of niche breath within each trophic level (TL), pollinators appearing first. *Cum.*= total records independent of seasonality; *Rainy*= records for the rainy season only; *Dry*= records for the dry season only; % = proportion of data recorded in each season relative to the cumulative records. Species were classified as "seasonal" if proportional degree or interaction frequency were equal or greater than 75% in one season. Social and semi-social bees indicated by *; solitary, oil-collecting bees indicated by §.

Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
378	Apidae	*Trigona sp.**	bee	51	24	32	0.47	0.63	aseasonal	159	70	89	0.44	0.56	aseasonal
350	Apidae	*Paratrigona lineata**	bee	35	15	21	0.43	0.60	aseasonal	67	19	48	0.28	0.72	aseasonal
216	Apidae	*Bombus atratus**	bee	31	13	20	0.42	0.65	aseasonal	99	34	65	0.34	0.66	aseasonal
364	Apidae	*Tetragona clavipes**	bee	31	13	20	0.42	0.65	aseasonal	64	25	39	0.39	0.61	aseasonal
217	Apidae	*Bombus morio**	bee	24	6	20	0.25	0.83	seasonal	114	12	102	0.11	0.89	seasonal
213	Halictidae	*Augochloropsis* sp. 3*	bee	17	10	8	0.59	0.47	aseasonal	30	16	14	0.53	0.47	aseasonal
214	Halictidae	*Augochloropsis* sp. 4*	bee	16	10	6	0.63	0.38	aseasonal	32	23	9	0.72	0.28	aseasonal
341	Andrenidae	*Oxaea flavescens*	bee	16	10	9	0.63	0.56	aseasonal	56	27	29	0.48	0.52	aseasonal
325	Apidae	*Melipona quinquefasciata**	bee	15	5	10	0.33	0.67	aseasonal	23	5	18	0.22	0.78	seasonal
235	Apidae	*Centris longimana*§	bee	14	8	8	0.57	0.57	aseasonal	36	25	11	0.69	0.31	aseasonal

Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
249	Apidae	*Ceratina gossypii*	bee	14	7	8	0.50	0.57	aseasonal	25	9	16	0.36	0.64	aseasonal
362	Apidae	*Scaptotrigona postica**	bee	14	4	10	0.29	0.71	aseasonal	38	10	28	0.26	0.74	aseasonal
279	Apidae	*Epicharis* sp. 1[§]	bee	13	8	7	0.62	0.54	aseasonal	39	19	20	0.49	0.51	aseasonal
190	Halictidae	*Augochloropsis* sp. 5*	bee	12	9	5	0.75	0.42	seasonal	20	15	5	0.75	0.25	aseasonal
377	Apidae	*Trigona amalthea**	bee	12	7	5	0.58	0.42	aseasonal	12	7	5	0.58	0.42	aseasonal
197	Halictidae	*Augochloropsis* sp. 11*	bee	11	3	8	0.27	0.73	aseasonal	17	7	10	0.41	0.59	aseasonal
253	Apidae	*Ceratina* sp. 3	bee	11	7	5	0.64	0.45	aseasonal	14	8	6	0.57	0.43	aseasonal
277	Apidae	*Epicharis iheringii*[§]	bee	11	11	2	1.00	0.18	seasonal	22	20	2	0.91	0.09	seasonal
292	Apidae	*Exomalopsis fulvofasciata*	bee	11	5	6	0.45	0.55	aseasonal	16	5	11	0.31	0.69	aseasonal
349	Apidae	*Paratetrapedia* sp. 6[§]	bee	11	10	2	0.91	0.18	seasonal	20	14	6	0.70	0.30	aseasonal
251	Apidae	*Ceratina* cf. *rupestris*[§]	bee	10	5	5	0.50	0.50	aseasonal	14	6	8	0.43	0.57	aseasonal
281	Apidae	*Dasyhalonia* sp. 2	bee	10	5	7	0.50	0.70	aseasonal	33	8	25	0.24	0.76	seasonal
234	Apidae	*Centris* cf. *labrosa*[§]	bee	9	4	5	0.44	0.56	aseasonal	12	4	8	0.33	0.67	aseasonal
381	Apidae	*Xylocopa ciliate*	bee	9	4	5	0.44	0.56	aseasonal	15	5	10	0.33	0.67	aseasonal
386	Apidae	*Xylocopa vestita*	bee	9	4	6	0.44	0.67	aseasonal	12	4	8	0.33	0.67	aseasonal
387	Apidae	*Xylocopa fimbriata*	bee	9	1	8	0.11	0.89	seasonal	12	2	10	0.17	0.83	seasonal
250	Apidae	*Ceratina maculifrons*	bee	8	6	4	0.75	0.50	seasonal	21	6	15	0.29	0.71	aseasonal
185	Megachilidae	*Anthodioctes megachiloides*	bee	7	3	4	0.43	0.57	aseasonal	8	4	4	0.50	0.50	aseasonal
290	Apidae	*Exomalopsis auropilosa*	bee	7	1	6	0.14	0.86	seasonal	7	1	6	0.14	0.86	seasonal

Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
295	Apidae	*Exomalopsis sp. 2*	bee	7	3	4	0.43	0.57	aseasonal	14	3	11	0.21	0.79	seasonal
298	Apidae	*Gaesischia belophora*	bee	7	1	7	0.14	1.00	seasonal	32	2	30	0.06	0.94	seasonal
351	Apidae	*Partamona cupira**	bee	7	0	7	0.00	1.00	seasonal	11	0	11	0.00	1.00	seasonal
193	Halictidae	*Augochloropsis* sp. 7*	bee	6	2	4	0.33	0.67	aseasonal	7	2	5	0.29	0.71	aseasonal
203	Halictidae	*Augochloropsis* sp. 17*	bee	6	2	4	0.33	0.67	aseasonal	7	2	5	0.29	0.71	aseasonal
222	Apidae	*Centris mocsaryi*[§]	bee	6	2	4	0.33	0.67	aseasonal	18	3	15	0.17	0.83	seasonal
233	Apidae	*Centris fuscata*[§]	bee	6	0	6	0.00	1.00	seasonal	9	0	9	0.00	1.00	seasonal
276	Apidae	*Epicharis cockerelli*[§]	bee	6	6	1	1.00	0.17	seasonal	14	13	1	0.93	0.07	seasonal
278	Apidae	*Epicharis flava*[§]	bee	6	5	2	0.83	0.33	seasonal	13	9	4	0.69	0.31	aseasonal
284	Apidae	*Euglossa melanotricha*	bee	6	3	3	0.50	0.50	aseasonal	8	5	3	0.63	0.38	aseasonal
289	Apidae	*Exomalopsis analis*	bee	6	4	2	0.67	0.33	aseasonal	7	4	3	0.57	0.43	aseasonal
326	Apidae	*Melissoptila richardiae*	bee	6	0	6	0.00	1.00	seasonal	32	0	32	0.00	1.00	seasonal
375	Apidae	*Trigona branneri**	bee	6	3	3	0.50	0.50	aseasonal	6	3	3	0.50	0.50	aseasonal
380	Apidae	*Xylocopa hirsutissima*	bee	6	3	3	0.50	0.50	aseasonal	15	4	11	0.27	0.73	aseasonal
184	Halictidae	*Agapostemon chapadensis**	bee	5	2	4	0.40	0.80	seasonal	17	11	6	0.65	0.35	aseasonal
207	Halictidae	*Augochloropsis cleopatra**	bee	5	5	0	1.00	0.00	seasonal	5	5	0	1.00	0.00	seasonal
199	Halictidae	*Augochloropsis* sp. 13*	bee	5	5	0	1.00	0.00	seasonal	5	5	0	1.00	0.00	seasonal
206	Halictidae	*Augochloropsis wallacei**	bee	5	2	3	0.40	0.60	aseasonal	10	5	5	0.50	0.50	aseasonal
219	Apidae	*Centris* sp. 3[§]	bee	5	2	3	0.40	0.60	aseasonal	7	4	3	0.57	0.43	aseasonal

Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
221	Apidae	*Centris collaris*	bee	5	3	2	0.60	0.40	aseasonal	10	8	2	0.80	0.20	seasonal
223	Apidae	*Centris* sp. 4[§]	bee	5	0	5	0.00	1.00	seasonal	13	0	13	0.00	1.00	seasonal
231	Apidae	*Centris denudans*[§]	bee	5	5	0	1.00	0.00	seasonal	7	7	0	1.00	0.00	seasonal
239	Apidae	*Centris tarsata*[§]	bee	5	2	3	0.40	0.60	aseasonal	21	3	18	0.14	0.86	seasonal
315	Megachilidae	*Megachile* sp. 5	bee	5	1	5	0.20	1.00	seasonal	12	1	11	0.08	0.92	seasonal
333	Apidae	*Monoeca* sp. 1[§]	bee	5	0	5	0.00	1.00	seasonal	17	0	17	0.00	1.00	seasonal
192	Halictidae	*Augochloropsis* sp. 1*	bee	4	3	1	0.75	0.25	seasonal	4	3	1	0.75	0.25	aseasonal
191	Halictidae	*Augochloropsis laeta**	bee	4	4	0	1.00	0.00	seasonal	6	6	0	1.00	0.00	seasonal
194	Halictidae	*Augochloropsis* sp. 8*	bee	4	4	0	1.00	0.00	seasonal	4	4	0	1.00	0.00	seasonal
238	Apidae	*Centris spilopoda*[§]	bee	4	1	3	0.25	0.75	seasonal	4	1	3	0.25	0.75	seasonal
242	Apidae	*Centris violacea*[§]	bee	4	0	4	0.00	1.00	seasonal	7	0	7	0.00	1.00	seasonal
248	Apidae	*Ceratina* sp. 1	bee	4	3	1	0.75	0.25	seasonal	4	3	1	0.75	0.25	aseasonal
310	Megachilidae	*Megachile aureiventris*	bee	4	3	2	0.75	0.50	seasonal	6	4	2	0.67	0.33	aseasonal
321	Megachilidae	*Megachile* sp. 4	bee	4	3	1	0.75	0.25	seasonal	6	5	1	0.83	0.17	seasonal
345	Apidae	*Paratetrapedia* sp. 2[§]	bee	4	4	1	1.00	0.25	seasonal	22	21	1	0.95	0.05	seasonal
365	Apidae	*Tetrapedia* sp. 2[§]	bee	4	4	0	1.00	0.00	seasonal	4	4	0	1.00	0.00	seasonal
376	Apidae	*Trigona spinipes**	bee	4	1	3	0.25	0.75	seasonal	4	1	3	0.25	0.75	seasonal
382	Apidae	*Xylocopa frontalis*	bee	4	1	3	0.25	0.75	seasonal	5	1	4	0.20	0.80	seasonal
186	Halictidae	*Augochloropsis cupreola**	bee	3	1	2	0.33	0.67	aseasonal	3	1	2	0.33	0.67	aseasonal

Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
196	Halictidae	*Augochloropsis* sp. 10*	bee	3	3	0	1.00	0.00	seasonal	4	4	0	1.00	0.00	seasonal
224	Apidae	*Centris nitens*§	bee	3	0	3	0.00	1.00	seasonal	3	0	3	0.00	1.00	seasonal
228	Apidae	*Centris* sp. 1§	bee	3	0	3	0.00	1.00	seasonal	3	0	3	0.00	1.00	seasonal
240	Apidae	*Centris trigonoides*§	bee	3	2	1	0.67	0.33	aseasonal	4	2	2	0.50	0.50	aseasonal
246	Megachilidae	*Coelioxys* sp.	bee	3	2	1	0.67	0.33	aseasonal	3	2	1	0.67	0.33	aseasonal
275	Apidae	*Epicharis analis*§	bee	3	3	0	1.00	0.00	seasonal	5	5	0	1.00	0.00	seasonal
285	Apidae	*Euglossa* sp. 1	bee	3	1	2	0.33	0.67	aseasonal	4	1	3	0.25	0.75	seasonal
308	Megachilidae	*Megachile guaranitica*	bee	3	2	1	0.67	0.33	aseasonal	3	2	1	0.67	0.33	aseasonal
329	Apidae	*Melitoma* sp. 2	bee	3	0	3	0.00	1.00	seasonal	3	0	3	0.00	1.00	seasonal
330	Apidae	*Mesonychium coerulescens*	bee	3	0	3	0.00	1.00	seasonal	3	0	3	0.00	1.00	seasonal
334	Apidae	*Monoeca* sp. 2§	bee	3	1	2	0.33	0.67	aseasonal	5	2	3	0.40	0.60	aseasonal
355	Halictidae	*Pseudoauglochlora graminea**	bee	3	2	1	0.67	0.33	aseasonal	5	3	2	0.60	0.40	aseasonal
356	Halictidae	*Pseudoauglochloropsis* sp. 1*	bee	3	2	2	0.67	0.67	aseasonal	5	2	3	0.40	0.60	aseasonal
361	Halictidae	*Lasioglossum (Dialictus) rostratus**	bee	3	1	2	0.33	0.67	aseasonal	4	2	2	0.50	0.50	aseasonal
366	Apidae	*Tetrapedia* sp. 1§	bee	3	2	1	0.67	0.33	aseasonal	4	3	1	0.75	0.25	aseasonal
198	Halictidae	*Augochloropsis* sp. 12*	bee	2	2	0	1.00	0.00	seasonal	5	5	0	1.00	0.00	seasonal
200	Halictidae	*Augochloropsis* sp. 14*	bee	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
225	Apidae	*Centris scopipes*§	bee	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
247	Apidae	*Ceratina asuncionis*	bee	2	0	2	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal

Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
258	Colletidae	*Colletes rufipes*	bee	2	1	1	0.50	0.50	aseasonal	2	1	1	0.50	0.50	aseasonal
260	Apidae	*Dasyhalonia phaeoptera*	bee	2	0	2	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
263	Halictidae	*Lasioglossum* (*Dialictus*) sp. 5*	bee	2	0	2	0.00	1.00	seasonal	3	0	3	0.00	1.00	seasonal
267	Megachilidae	*Epanthidium* sp.	bee	2	2	1	1.00	0.50	seasonal	3	2	1	0.67	0.33	aseasonal
269	Megachilidae	*Epanthidium tigrinum*	bee	2	0	2	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
283	Apidae	*Euglossa imperialis*	bee	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
287	Apidae	*Euglossa viridis*	bee	2	1	1	0.50	0.50	aseasonal	2	1	1	0.50	0.50	aseasonal
296	Apidae	*Exomalopsis* sp. 3	bee	2	1	1	0.50	0.50	aseasonal	2	1	1	0.50	0.50	aseasonal
299	Apidae	*Gaesischia flavoclypeata*	bee	2	0	2	0.00	1.00	seasonal	5	0	5	0.00	1.00	seasonal
300	Apidae	*Gaesischia fulgurans*	bee	2	0	2	0.00	1.00	seasonal	4	0	4	0.00	1.00	seasonal
311	Megachilidae	*Megachile brethesi*	bee	2	1	1	0.50	0.50	aseasonal	2	1	1	0.50	0.50	aseasonal
316	Megachilidae	*Megachile orba*	bee	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
322	Megachilidae	*Megachile terrestris*	bee	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
327	Apidae	*Melitoma segmentaria*	bee	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
332	Apidae	*Mesoplia rufipes*	bee	2	0	2	0.00	1.00	seasonal	4	0	4	0.00	1.00	seasonal
335	Apidae	*Monoeca* sp. 3[§]	bee	2	1	1	0.50	0.50	aseasonal	6	4	2	0.67	0.33	aseasonal
336	Apidae	*Monoeca* sp. 4[§]	bee	2	1	1	0.50	0.50	aseasonal	3	1	2	0.33	0.67	aseasonal
337	Apidae	*Monoeca* sp. 5[§]	bee	2	1	1	0.50	0.50	aseasonal	5	1	4	0.20	0.80	seasonal
344	Apidae	*Paratetrapedia* sp. 1[§]	bee	2	1	1	0.50	0.50	aseasonal	2	1	1	0.50	0.50	aseasonal

Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
346	Apidae	*Paratetrapedia* sp. 3[§]	bee	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
342	Apidae	*Paratetrapedia* sp. 7[§]	bee	2	2	1	1.00	0.50	seasonal	3	2	1	0.67	0.33	aseasonal
357	Halictidae	*Pseudoauglochloropsis* sp. 2*	bee	2	1	1	0.50	0.50	aseasonal	2	1	1	0.50	0.50	aseasonal
358	Halictidae	*Pseudoauglochloropsis* sp. 3*	bee	2	1	1	0.50	0.50	aseasonal	2	1	1	0.50	0.50	aseasonal
363	Halictidae	*Temnosoma* sp. 1	bee	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
367	Apidae	*Tetrapedia rugulosa*[§]	bee	2	1	1	0.50	0.50	aseasonal	2	1	1	0.50	0.50	aseasonal
372	Apidae	*Thygater analis*	bee	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
379	Apidae	*Trigonisca* cf. *pediculana**	bee	2	1	1	0.50	0.50	aseasonal	6	5	1	0.83	0.17	seasonal
384	Apidae	*Xylocopa* sp.	bee	2	1	1	0.50	0.50	aseasonal	3	1	2	0.33	0.67	aseasonal
183	Apidae	*Acanthopus excellens*	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
187	Halictidae	*Augochlora* sp. 1*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
188	Halictidae	*Augochlora* sp. 2*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
209	Halictidae	*Augochloropsis smithiana**	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
195	Halictidae	*Augochloropsis* sp. 9*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
201	Halictidae	*Augochloropsis* sp. 15*	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
202	Halictidae	*Augochloropsis* sp. 16*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
204	Halictidae	*Augochloropsis* sp. 18*	bee	1	1	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
205	Halictidae	*Augochloropsis* sp. 19*	bee	1	1	0	1.00	0.00	seasonal	4	4	0	1.00	0.00	seasonal
208	Halictidae	*Augochloropsis* sp. 6*	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal

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				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
212	Halictidae	*Augochloropsis* sp. 2*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
220	Apidae	*Centris burgdorfi*§	bee	1	0	1	0.00	1.00	seasonal	8	0	8	0.00	1.00	seasonal
226	Apidae	*Centris* sp. 5§	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
227	Apidae	*Centris tetrazona*§	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
229	Apidae	*Centris aenea*§	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
230	Apidae	*Centris analis*§	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
236	Apidae	*Centris lutea*§	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
237	Apidae	*Centris* sp. 2§	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
241	Apidae	*Centris varia*§	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
243	Apidae	*Centris vittata*§	bee	1	1	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
244	Apidae	*Centris xanthocnemis*§	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
252	Apidae	*Ceratina* sp. 2§	bee	1	1	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
254	Apidae	*Ceratina* sp. 4§	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
256	Colletidae	*Colletes* sp. 1	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
257	Colletidae	*Colletes petropolitanus*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
259	Apidae	*Ctenioschelus goryi*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
261	Apidae	*Dasyhalonia* sp. 1	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
264	Megachilidae	*Dianthidium* sp. 1	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
265	Megachilidae	*Dianthidium* sp. 2	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal

Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
266	Megachilidae	*Dianthidium* sp. 3	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
268	Megachilidae	*Epanthidium aureocinctum*	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
270	Apidae	*Epicharis bicolor*§	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
273	Apidae	*Epicharis affinis*§	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
274	Apidae	*Epicharis albofasciata*§	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
280	Apidae	*Epicharis xanthogastra*§	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
282	Apidae	*Euglossa cordata*	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
286	Apidae	*Euglossa* sp. 2	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
288	Apidae	*Eulaema nigrita*	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
291	Apidae	*Exomalopsis campestris*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
293	Apidae	*Exomalopsis* sp. 1	bee	1	0	1	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
297	Apidae	*Gaesischia araguaiana*	bee	1	0	1	0.00	1.00	seasonal	3	0	3	0.00	1.00	seasonal
302	Halictidae	*Habralictus* sp.	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
303	Apidae	*Hopliphora superba*	bee	1	0	1	0.00	1.00	seasonal	8	0	8	0.00	1.00	seasonal
305	Megachilidae	*Lithurgus* sp.	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
306	Megachilidae	*Megachile assumptionis*	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
307	Megachilidae	*Megachile diversa*	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
323	Megachilidae	*Megachile friesei*	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
309	Megachilidae	*Megachile affabilis*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal

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				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
312	Megachilidae	*Megachile curvipes*	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
313	Megachilidae	*Megachile* sp. 1	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
314	Megachilidae	*Megachile gigas*	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
317	Megachilidae	*Megachile rubricata*	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
318	Megachilidae	*Megachile* sp. 2	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
319	Megachilidae	*Megachile* sp. 3	bee	1	0	1	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
324	Megachilidae	*Megachile laeta*	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
328	Apidae	*Melitoma* sp. 1	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
331	Apidae	*Mesoplia decorata*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
339	Halictidae	*Neocorynura* sp. 1	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
340	Halictidae	*Neocorynura* sp. 2	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
343	Apidae	*Paratetrapedia lugubris*[§]	bee	1	1	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
347	Apidae	*Paratetrapedia* sp. 4[§]	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
348	Apidae	*Paratetrapedia* sp. 5[§]	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
352	Apidae	*Plebeia* sp.*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
359	Apidae	*Ptilothrix plumata*	bee	1	1	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
360	Apidae	*Rhathymus fulvus*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
369	Apidae	*Tetrapedia* sp. 3[§]	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
370	Apidae	*Thalestria spinosa*	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal

Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
371	Halictidae	*Thectochlora alaris*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
373	Apidae	*Trichocerapis mirabilis*	bee	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
385	Apidae	*Xylocopa subcyanea*	bee	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
172	Asteraceae	*Lepidaploa rufogrisea*	plant	48	10	48	0.21	1.00	seasonal	132	11	121	0.08	0.92	seasonal
125	Rubiaceae	*Palicourea rigida*	plant	36	36	36	1.00	1.00	seasonal	88	87	1	0.99	0.01	seasonal
168	Asteraceae	*Lepidaploa aurea*	plant	36	9	36	0.25	1.00	seasonal	79	9	70	0.11	0.89	seasonal
27	Malpighiaceae	*Byrsonima* sp.	plant	34	32	34	0.94	1.00	seasonal	87	77	10	0.89	0.11	seasonal
102	Verbenaceae	*Lippia rotundifolia*	plant	31	0	31	0.00	1.00	seasonal	171	0	171	0.00	1.00	seasonal
14	Fabaceae	*Andira* sp.	plant	24	0	24	0.00	1.00	seasonal	45	0	45	0.00	1.00	seasonal
56	Solanaceae	*Solanum lycocarpum*	plant	19	15	19	0.79	1.00	seasonal	57	40	17	0.70	0.30	aseasonal
178	Sapindaceae	*Matayba guianensis*	plant	19	19	0	1.00	0.00	seasonal	29	29	0	1.00	0.00	seasonal
155	Fabaceae	*Periandra mediterranea*	plant	18	17	18	0.94	1.00	seasonal	41	37	4	0.90	0.10	seasonal
165	Fabaceae	*Chamaecrista desvauxii*	plant	18	13	18	0.72	1.00	seasonal	39	30	9	0.77	0.23	seasonal
80	Styracaceae	*Styrax ferrugineus*	plant	17	5	17	0.29	1.00	seasonal	42	6	36	0.14	0.86	seasonal
174	Asteraceae	*Eremanthus sphaerocephalus*	plant	16	4	16	0.25	1.00	seasonal	51	5	46	0.10	0.90	seasonal
31	Vochysiaceae	*Qualea multiflora*	plant	15	15	0	1.00	0.00	seasonal	20	20	0	1.00	0.00	seasonal
133	Melastomataceae	*Tibouchina stenocarpa*	plant	15	4	15	0.27	1.00	seasonal	37	5	32	0.14	0.86	seasonal
91	Lamiaceae	*Hyptis lythroides*	plant	14	0	14	0.00	1.00	seasonal	16	0	16	0.00	1.00	seasonal
175	Vochysiaceae	*Qualea parviflora*	plant	13	13	0	1.00	0.00	seasonal	17	17	0	1.00	0.00	seasonal

Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
59	Bignoniaceae	*Tabebuia caraiba*	plant	12	0	12	0.00	1.00	seasonal	35	0	35	0.00	1.00	seasonal
171	Ochnaceae	*Ouratea hexasperma*	plant	12	0	12	0.00	1.00	seasonal	18	0	18	0.00	1.00	seasonal
117	Sapindaceae	*Serjania lethalis*	plant	11	0	11	0.00	1.00	seasonal	21	0	21	0.00	1.00	seasonal
125	Malvaceae	*Waltheria indica*	plant	11	11	11	1.00	1.00	seasonal	28	27	1	0.96	0.04	seasonal
140	Malpighiaceae	*Banisteriopsis campestris*	plant	11	10	11	0.91	1.00	seasonal	16	13	3	0.81	0.19	seasonal
30	Asteraceae	*Piptocarpha rotundifolia*	plant	10	10	0	1.00	0.00	seasonal	19	19	0	1.00	0.00	seasonal
107	Fabaceae	*Mimosa radula*	plant	10	9	10	0.90	1.00	seasonal	15	14	1	0.93	0.07	seasonal
147	Asteraceae	*Eremanthus glomerulatus*	plant	10	0	10	0.00	1.00	seasonal	15	0	15	0.00	1.00	seasonal
169	Malpighiaceae	*Banisteriopsis malifolia*	plant	10	7	10	0.70	1.00	seasonal	15	9	6	0.60	0.40	aseasonal
88	Malpighiaceae	*Byrsonima verbascifolia*	plant	9	7	9	0.78	1.00	seasonal	10	7	3	0.70	0.30	aseasonal
16	Fabaceae	*Senna rugosa*	plant	8	3	8	0.38	1.00	seasonal	11	4	7	0.36	0.64	aseasonal
49	Malpighiaceae	*Heteropterys byrsonimifolia*	plant	8	8	0	1.00	0.00	seasonal	16	16	0	1.00	0.00	seasonal
51	Malvaceae	*Hibiscus* sp.	plant	8	1	8	0.13	1.00	seasonal	16	1	15	0.06	0.94	seasonal
152	Melastomataceae	*Microlicia loricata*	plant	8	0	8	0.00	1.00	seasonal	16	0	16	0.00	1.00	seasonal
52	Malpighiaceae	*Peixotoa cordistipula*	plant	7	1	7	0.14	1.00	seasonal	14	1	13	0.07	0.93	seasonal
87	Solanaceae	*Solanum paniculatum*	plant	7	7	0	1.00	0.00	seasonal	10	10	0	1.00	0.00	seasonal
138	Convolvulaceae	*Ipomoea argentea*	plant	7	7	0	1.00	0.00	seasonal	8	8	0	1.00	0.00	seasonal
150	Asteraceae	*Vernonia rubriramea*	plant	7	0	7	0.00	1.00	seasonal	14	0	14	0.00	1.00	seasonal
8	Myrtaceae	*Eugenia complicata*	plant	6	0	6	0.00	1.00	seasonal	7	0	7	0.00	1.00	seasonal

Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
9	Lythraceae	*Diplusodon oblongus*	plant	6	3	6	0.50	1.00	seasonal	17	11	6	0.65	0.35	aseasonal
99	Malpighiaceae	*Byrsonima basiloba*	plant	6	6	0	1.00	0.00	seasonal	10	10	0	1.00	0.00	seasonal
103	Malpighiaceae	*Byrsonima guilleminiana*	plant	6	0	6	0.00	1.00	seasonal	9	0	9	0.00	1.00	seasonal
104	Malpighiaceae	*Byrsonima intermedia*	plant	6	6	0	1.00	0.00	seasonal	12	12	0	1.00	0.00	seasonal
136	Melastomataceae	*Miconia fallax*	plant	6	0	6	0.00	1.00	seasonal	9	0	9	0.00	1.00	seasonal
33	Burseraceae	*Protium ovatum*	plant	5	1	5	0.20	1.00	seasonal	5	1	4	0.20	0.80	seasonal
76	Asteraceae	*Baccharis retusa*	plant	5	0	5	0.00	1.00	seasonal	15	0	15	0.00	1.00	seasonal
93	Araliaceae	*Didymopanax macrocarpus*	plant	5	0	5	0.00	1.00	seasonal	16	0	16	0.00	1.00	seasonal
123	Dilleneaceae	*Davilla elliptica*	plant	5	2	5	0.40	1.00	seasonal	7	3	4	0.43	0.57	aseasonal
168	Asteraceae	*Viguiera robusta*	plant	5	0	5	0.00	1.00	seasonal	10	0	10	0.00	1.00	seasonal
20	Lythraceae	*Diplusodon villosus*	plant	4	3	4	0.75	1.00	seasonal	4	3	1	0.75	0.25	aseasonal
28	Malvaceae	*Pseudobombax longiflorum*	plant	4	0	4	0.00	1.00	seasonal	11	0	11	0.00	1.00	seasonal
38	Bignoniaceae	*Memora pedunculata*	plant	4	4	0	1.00	0.00	seasonal	5	5	0	1.00	0.00	seasonal
57	Poaceae	*Echinolaena inflexa*	plant	4	2	4	0.50	1.00	seasonal	5	3	2	0.60	0.40	aseasonal
58	Rubiaceae	*Borreria capitata*	plant	4	0	4	0.00	1.00	seasonal	4	0	4	0.00	1.00	seasonal
83	Fabaceae	*Stryphnodendron adstringens*	plant	4	0	4	0.00	1.00	seasonal	6	0	6	0.00	1.00	seasonal
92	Gentianaceae	*Deianira chiquitana*	plant	4	0	4	0.00	1.00	seasonal	4	0	4	0.00	1.00	seasonal
96	Malvaceae	*Pavonia grandiflora*	plant	4	4	0	1.00	0.00	seasonal	5	5	0	1.00	0.00	seasonal
106	Malpighiaceae	*Byrsonima rotunda*	plant	4	2	4	0.50	1.00	seasonal	4	2	2	0.50	0.50	aseasonal

Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
111	Rutaceae	*Spiranthera odoratissima*	plant	4	3	4	0.75	1.00	seasonal	5	4	1	0.80	0.20	seasonal
139	Malvaceae	*Eriotheca pubescens*	plant	4	0	4	0.00	1.00	seasonal	15	0	15	0.00	1.00	seasonal
154	Asteraceae	*Lessingianthus durus*	plant	4	0	4	0.00	1.00	seasonal	6	0	6	0.00	1.00	seasonal
161	Rubiaceae	*Declieuxia fruticosa*	plant	4	4	0	1.00	0.00	seasonal	4	4	0	1.00	0.00	seasonal
11	Convolvulaceae	*Ipomoea campestris*	plant	3	3	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
27	Vochysiaceae	*Vochysia thyrsoidea*	plant	3	3	0	1.00	0.00	seasonal	4	4	0	1.00	0.00	seasonal
36	Malpighiaceae	*Pterandra pyroidea*	plant	3	0	3	0.00	1.00	seasonal	3	0	3	0.00	1.00	seasonal
39	Asteraceae	*Mikania officinalis*	plant	3	3	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
41	Fabaceae	*Bauhinia pulchella*	plant	3	3	3	1.00	1.00	seasonal	7	5	2	0.71	0.29	aseasonal
48	Myrtaceae	*Blepharocalyx salicifolius*	plant	3	3	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
50	Asteraceae	*Aspilia foliacea*	plant	3	3	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
65	Acanthaceae	*Ruellia incompta*	plant	3	0	3	0.00	1.00	seasonal	4	0	4	0.00	1.00	seasonal
69	Lamiaceae	*Hyptis desertorum*	plant	3	0	3	0.00	1.00	seasonal	4	0	4	0.00	1.00	seasonal
70	Rubiaceae	*Canavalia dictyota*	plant	3	0	3	0.00	1.00	seasonal	3	0	3	0.00	1.00	seasonal
71	Asteraceae	*Elephantopus biflorus*	plant	3	0	3	0.00	1.00	seasonal	5	0	5	0.00	1.00	seasonal
77	Rubiaceae	*Borreria verbenoides*	plant	3	2	3	0.67	1.00	seasonal	4	2	2	0.50	0.50	aseasonal
90	Bignoniaceae	*Phryganocydia corymbosa*	plant	3	3	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
97	Erythroxylaceae	*Erythroxylum suberosum*	plant	3	0	3	0.00	1.00	seasonal	7	0	7	0.00	1.00	seasonal
100	Fabaceae	*Eriosema glabrum*	plant	3	3	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal

Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
114	Asteraceae	*Calea quadrifolia*	plant	3	3	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
129	Fabaceae	*Calliandra dysantha*	plant	3	0	3	0.00	1.00	seasonal	11	0	11	0.00	1.00	seasonal
134	Fabaceae	*Canavalia dictyota*	plant	3	0	3	0.00	1.00	seasonal	5	0	5	0.00	1.00	seasonal
146	Bignoniaceae	*Jacaranda caroba*	plant	3	0	3	0.00	1.00	seasonal	7	0	7	0.00	1.00	seasonal
149	Iridaceae	*Trimezia* sp.	plant	3	3	0	1.00	0.00	seasonal	4	4	0	1.00	0.00	seasonal
151	Loranthaceae	*Psittacanthus robustus*	plant	3	3	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
157	Velloziaceae	*Vellozia squamata*	plant	3	3	0	1.00	0.00	seasonal	8	8	0	1.00	0.00	seasonal
163	Fabaceae	*Chamaecrista conferta*	plant	3	0	3	0.00	1.00	seasonal	6	0	6	0.00	1.00	seasonal
172	Malvaceae	*Waltheria americana*	plant	3	3	0	1.00	0.00	seasonal	4	4	0	1.00	0.00	seasonal
3	Bignoniaceae	*Anemopaegma glaucum*	plant	2	2	0	1.00	0.00	seasonal	4	4	0	1.00	0.00	seasonal
10	Cyperaceae	*Rhynchospora elatior*	plant	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
13	Fabaceae	*Stylosanthes capitata*	plant	2	1	2	0.50	1.00	seasonal	7	6	1	0.86	0.14	seasonal
15	Malpighiaceae	*Banisteriopsis schizoptera*	plant	2	0	2	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
18	Connaraceae	*Connarus suberosus*	plant	2	0	2	0.00	1.00	seasonal	3	0	3	0.00	1.00	seasonal
24	Convolvulaceae	*Ipomoea procumbens*	plant	2	1	2	0.50	1.00	seasonal	2	1	1	0.50	0.50	aseasonal
42	Fabaceae	*Mimosa sensitiva*	plant	2	0	2	0.00	1.00	seasonal	3	0	3	0.00	1.00	seasonal
46	Fabaceae	*Acosmium dasycarpum*	plant	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
55	Convolvulaceae	*Ipomoea squamisepala*	plant	2	1	2	0.50	1.00	seasonal	2	1	1	0.50	0.50	aseasonal
61	Lythraceae	*Lafoensia pacari*	plant	2	0	2	0.00	1.00	seasonal	3	0	3	0.00	1.00	seasonal

Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
66	Asteraceae	*Lepidaploa remotiflora*	plant	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
72	Rubiaceae	*Sabicea brasiliensis*	plant	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
73	Oxalidaceae	*Oxalis cordata*	plant	2	0	2	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
84	Bignoniaceae	*Jacaranda ulei*	plant	2	2	2	1.00	1.00	seasonal	3	2	1	0.67	0.33	aseasonal
85	Fabaceae	*Crotalaria nitens*	plant	2	2	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
94	Asteraceae	*Baccharis varians*	plant	2	0	2	0.00	1.00	seasonal	4	0	4	0.00	1.00	seasonal
98	Malpighiaceae	*Banisteriopsis megaphylla*	plant	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
102	Bignoniaceae	*Zeyhera digitalis*	plant	2	1	2	0.50	1.00	seasonal	2	1	1	0.50	0.50	aseasonal
108	Fabaceae	*Dalbergia miscolobium*	plant	2	2	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
110	Malpighiaceae	*Banisteriopsis anisandra*	plant	2	0	2	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
112	Lamiaceae	*Hyptis sexatilis*	plant	2	0	2	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
141	Fabaceae	*Tephrosia candida*	plant	2	0	2	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
153	Fabaceae	*Mimosa setosa*	plant	2	2	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
170	Fabaceae	*Clitoria fairchildiana*	plant	2	2	0	1.00	0.00	seasonal	3	3	0	1.00	0.00	seasonal
182	Asteraceae	*Dimerostemma* sp.	plant	2	2	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
1	Anacardiaceae	*Anacardium humile*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
5	Fabaceae	*Andira vermifuga*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
7	Fabaceae	*Dimorphandra mollis*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
12	Cochlospermaceae	*Cochlospermum regium*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal

Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
19	Malpighiaceae	*Banisteriopsis stellaris*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
22	Malvaceae	*Peltaea macedoi*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
23	Myrtaceae	*Eugenia lutescens*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
25	Asteraceae	*Eriosema glabrum*	plant	1	1	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
26	Clusiaceae	*Kielmeyera abdita*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
32	Clusiaceae	*Kielmeyera coriacea*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
34	Fabaceae	*Galactia neesii*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
37	Loganiaceae	*Antonia ovata*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
43	Asteraceae	*Lessingianthus bardanoides*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
45	Orchidaceae	*Galeandra* sp.	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
47	Fabaceae	*Eriosema defoliatum*	plant	1	0	1	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
53	Asteraceae	*Aspilia setosa*	plant	1	1	0	1.00	0.00	seasonal	2	2	0	1.00	0.00	seasonal
54	Verbenaceae	*Lippia lupulina*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
62	Melastomataceae	*Miconia ferruginata*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
63	Melastomataceae	*Miconia burchelli*	plant	1	0	1	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
64	Convolvulaceae	*Ipomoea tubulata*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
68	Fabaceae	*Crotalaria flavicoma*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
89	Lythraceae	*Cuphea spermacoce*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
105	Passifloraceae	*Turnera oblongifolia*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal

Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
109	Passifloraceae	*Piriqueta sidifolia*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
115	Fabaceae	*Eriosema prorepens*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
116	Asteraceae	*Ichthyothere latifolia*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
122	Melastomataceae	*Tibouchina candolleana*	plant	1	0	1	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
126	Fabaceae	*Mimosa glaucescens*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
127	Melastomataceae	*Rhynchanthera grandiflora*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
130	Asteraceae	*Lessingianthus compactiflorus*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
131	Aquifoliaceae	*Ilex conocarpa*	plant	1	0	1	0.00	1.00	seasonal	2	0	2	0.00	1.00	seasonal
132	Myrtaceae	*Campomanesia pubescens*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
135	Caryocaraceae	*Caryocar brasiliense*	plant	1	1	0	1.00	0.00	seasonal	5	5	0	1.00	0.00	seasonal
137	Fabaceae	*Pterodon emarginatus*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
142	Fabaceae	*Chamaecrista* sp.	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
143	Rubiaceae	*Tocoyena formosa*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
144	Malpighiaceae	*Banisteriopsis gardneriana*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
145	Fabaceae	*Enterolobium gummiferum*	plant	1	0	1	0.00	1.00	seasonal	4	0	4	0.00	1.00	seasonal
148	Vochysiaceae	*Qualea grandiflora*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
159	Cochlospermaceae	*Desmodium platycarpum*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal
164	Apocynaceae	*Mandevilla novocapitalis*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
166	Malpighiaceae	*Banisteriopsis laevifolia*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal

Node	Family	Species	TL	Degree						Interaction frequency					
				Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality	Cum.	Rainy	Dry	% Rainy	% Dry	Seasonality
167	Loranthaceae	*Phthirusa ovata*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
176	Myrtaceae	*Porsderonia* sp.	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
179	Malvaceae	*Melochia villosa*	plant	1	1	0	1.00	0.00	seasonal	1	1	0	1.00	0.00	seasonal
180	Passifloraceae	*Turnera longiflora*	plant	1	0	1	0.00	1.00	seasonal	1	0	1	0.00	1.00	seasonal

Table S3. Network statistics of Cerrado plant-pollinator communities.

Degree distribution characteristics across seasons for the two communities quantified by fitting three alternative models: exponential, power-law, and truncated power law. The Akaike Information Criteria (AIC) values are shown for each fit. In all but one case, the truncated power law is the best fitting distribution. *P*= plants; *A*= animals.

	IBGE			BBG		
	Cumulative	**Rainy**	**Dry**	**Cumulative**	**Rainy**	**Dry**
Mean P degree	4.7	4.8	2.5	5.4	4.4	4.9
Maximum P degree	22	19	12	48	36	45
Exponential fit	-63.2	-58.2	-40.6	-68.1	-49.1	-55.8
Power-law fit	-45.4	-38.6	-32.6	-73.0	-58.2	-53.5
Truncated power-law fit	-91.6	-76.3	-57.5	-116.2	-75.8	-82.2
Mean A degree	3.9	3.5	2.3	4.5	3.0	3.6
Maximum A degree	29	20	14	51	24	32
Exponential fit	-63.5	-58.6	-27.5	-65.7	-49.6	-45.7
Power-law fit	-47.7	-36.3	-45.6	-70.5	-55.6	-46.3
Truncated power-law fit	-79.6	-70.3	-40.6	-129.7	-101.5	-63.6

Table S4. Results of robustness analyses for the Cerrado communities studied. The Area Under the Curve (AUC) values are shown for each curve (mean of 100 random removal sequences) followed by the proportion of nodes or continued A or resource service remaining after removal, and the values obtained for the 95% Confidence Intervals in parentheses. Pairs of dry and rainy season network robustness AUC values that are significantly different (95% CI's of robustness curves do not overlap) are also flagged by an asterisk.

	IBGE			BBG		
	Cum.	**Rainy**	**Dry**	**Cum.**	**Rainy**	**Dry**
Robustness to loss of pollinator species after plant removal						
High to low degree	0.48 (0.47±0.01)	0.49* (0.51±0.01)	0.43* (0.41±0.01)	0.43 (0.4±0.01)	0.41 (0.39±0.01)	0.41 (0.38±0.01)
Low to high degree	0.76 (0.82±0.01)	0.76* (0.83±0.01)	0.67* (0.72±0.01)	0.78 (0.83±0.01)	0.75 (0.8±0.01)	0.78 (0.82±0.01)
Random	0.67 (0.75±0.01)	0.67* (0.75±0.01)	0.57* (0.62±0.02)	0.68 (0.76±0.01)	0.64 (0.69±0.02)	0.65 (0.72±0.02)
Robustness to loss of services from plant to pollinator after plant removal						
High to low weighted degree	0.38 (0.33±0.01)	0.39* (0.35±0.01)	0.35* (0.30±0.01)	0.37 (0.31±0.001)	0.36 (0.31±0.001)	0.37 (0.31±0.01)
Low to high weighted degree	0.55 (0.56±0.01)	0.55 (0.58±0.01)	0.57 (0.60±0.01)	0.56 (0.58±0.01)	0.55 (0.58±0.01)	0.56 (0.57±0.01)
Random	0.49 (0.50±0.01)	0.49 (0.50±0.01)	0.48 (0.49±0.01)	0.5 (0.50±0.01)	0.49 (0.50±0.01)	0.49 (0.49±0.01)
Robustness to loss of plant species after pollinator removal						
High to low degree	0.50 (0.53±0.01)	0.56* (0.61±0.01)	0.44* (0.44±0.01)	0.46 (0.44±0.01)	0.5* (0.50±0.01)	0.47* (0.46±0.01)

	IBGE			BBG		
	Cum.	**Rainy**	**Dry**	**Cum.**	**Rainy**	**Dry**
Low to high degree	0.84 (0.88±0.01)	0.80* (0.85±0.01)	0.74* (0.81±0.02)	0.81 (0.86±0.01)	0.77* (0.83±0.01)	0.8* (0.86±0.01)
Random	0.70 (0.77±0.01)	0.71* (0.79±0.01)	0.63* (0.72±0.02)	0.71 (0.79±0.01)	0.68 (0.75±0.01)	0.69 (0.77±0.01)
Robustness to loss of services from pollinator to plant after pollinator removal						
High to low weighted degree	0.20 (0.13±0.001)	0.27* (0.19±0.001)	0.16* (0.1±0.001)	0.21 (0.12±0.001)	0.26* (0.17±0.001)	0.21* (0.12±0.001)
Low to high weighted degree	0.62 (0.63±0.01)	0.58* (0.60±0.01)	0.67* (0.70±0.02)	0.58 (0.60±0.01)	0.57* (0.58±0.01)	0.60* (0.62±0.01)
Random	0.49 (0.48±0.02)	0.48* (0.49±0.01)	0.51* (0.55±0.04)	0.50 (0.51±0.02)	0.49 (0.49±0.02)	0.49 (0.5±0.02)

Supplementary Figures

Figure S1. Interaction frequency, rainfall, temperature and relative humidity recorded at IBGE from November 2008 to October 2009. Interaction frequency indicates the proportional number of bees sampled on flowers. Climatic data source: IBGE meteorological station**.**

Figure S2. Interaction frequency, rainfall, temperature and relative humidity recorded at BBG from May 1996 to April 1997. Interaction frequency indicates the proportional number of bees sampled on flowers. Climatic data source: IBGE meteorological station.

Figure S3. Rarefaction analyses of sampling effort for capturing interactions recorded during the dry season in IBGE.

Figure S4. Rarefaction analyses of sampling effort for capturing interactions recorded during the wet season in IBGE.

Figure S5. Rarefaction analyses of sampling effort for capturing interactions recorded during the dry season in BBG.

Figure S6. Rarefaction analyses of sampling effort for capturing interactions recorded during the wet season in BBG.

Figure S1

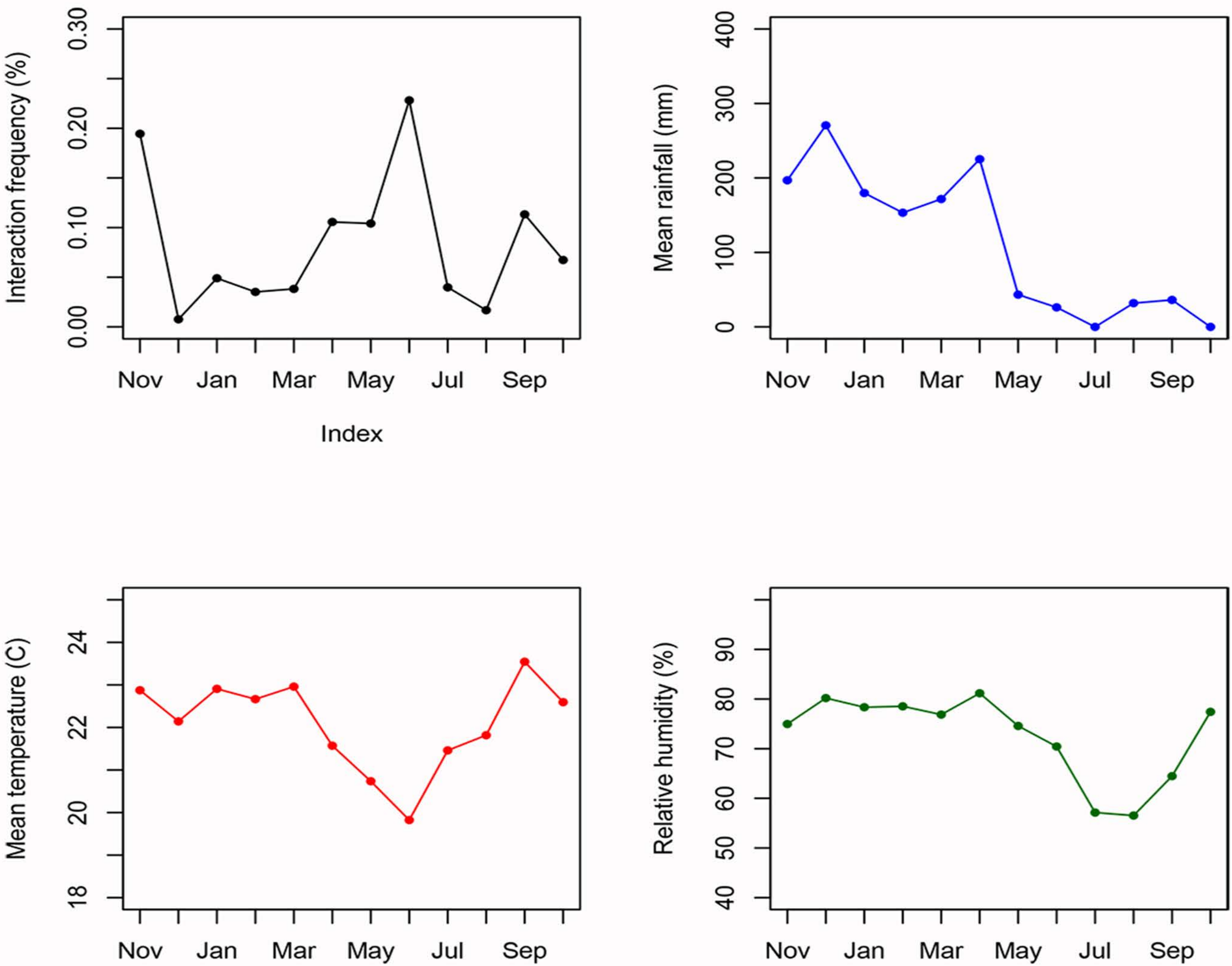

Interaction frequency (%)
0.00
0.10
0.20
0.30
Nov
Jan
Mar
May
Jul
Sep
Index
Mean rainfall (mm)
0
100
200
300
400
Mean temperature (C)
18
20
22
24
Relative humidity (%)
40
50
60
70
80
90

Figure S2

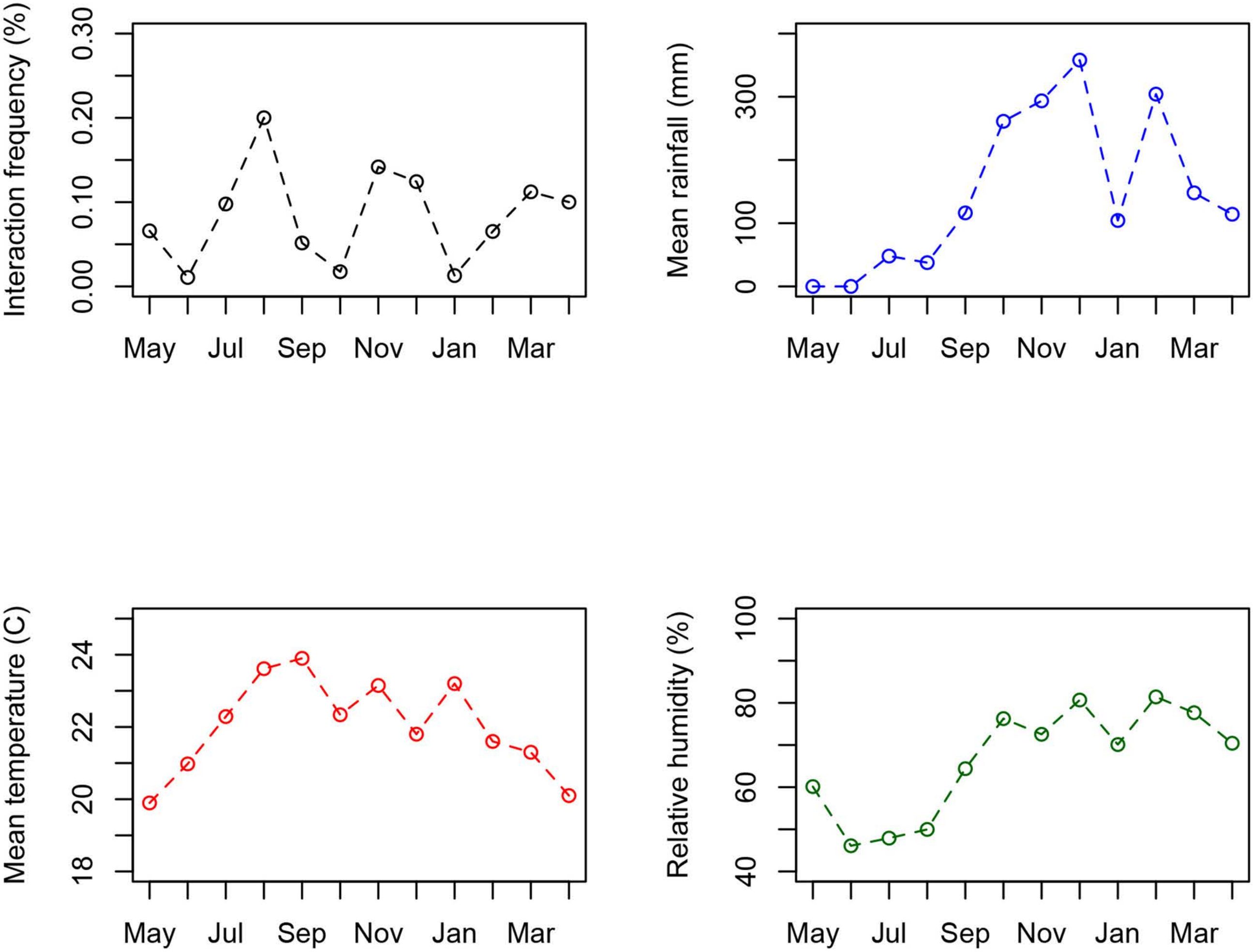

Interaction frequency (%)
0.00
0.10
0.20
0.30
Mean rainfall (mm)
0
100
300
Mean temperature (C)
18
20
22
24
Relative humidity (%)
40
60
80
100
May
Jul
Sep
Nov
Jan
Mar

Figure S3.

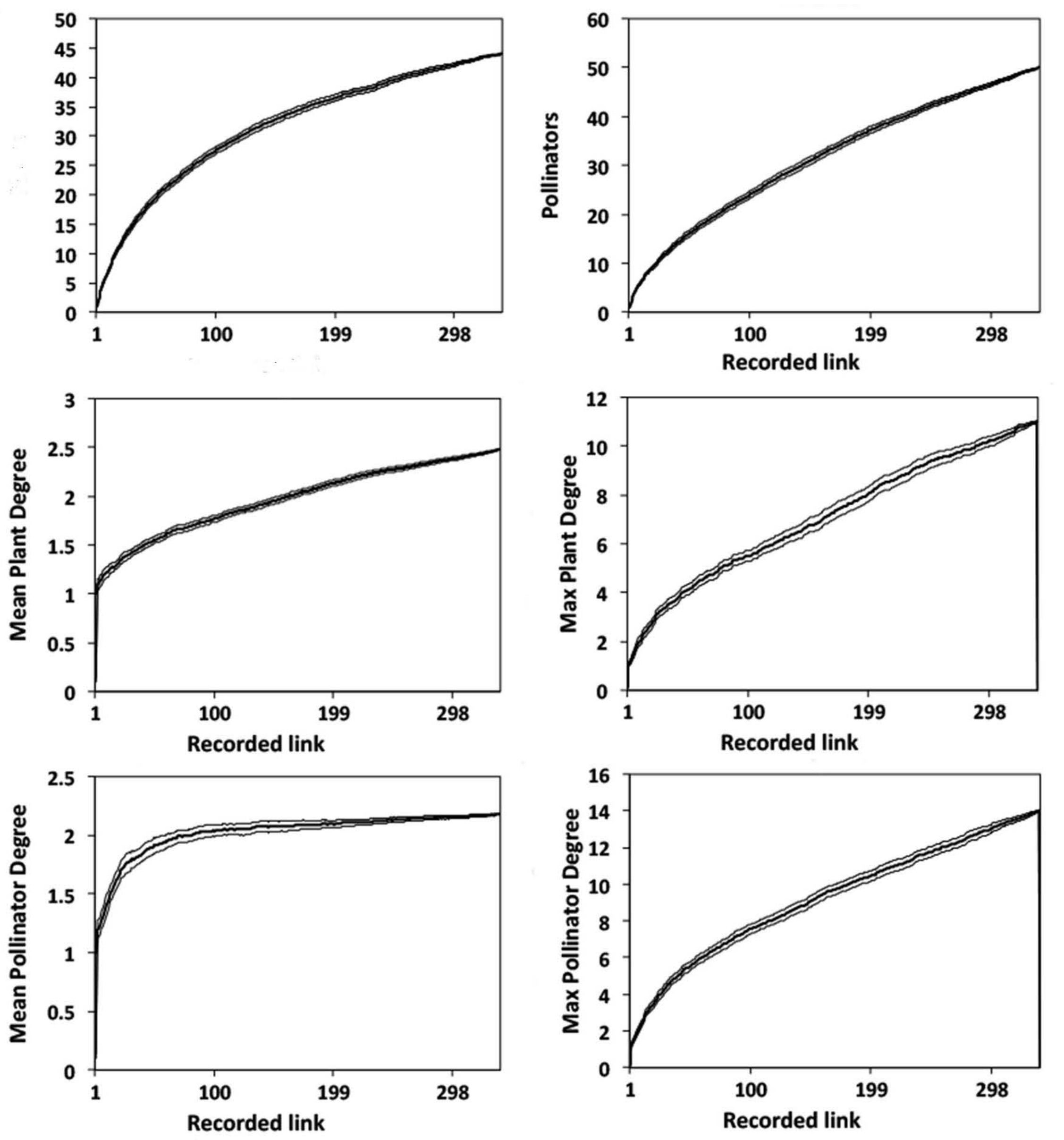

50
45
40
35
30
25
20
15
10
5
0
1
100
199
298
60
50
40
30
20
10
0
Pollinators
Recorded link
3
2.5
2
1.5
1
0.5
Mean Plant Degree
12
10
8
6
4
2
Max Plant Degree
2.5
Mean Pollinator Degree
16
14
Max Pollinator Degree

Figure S4.

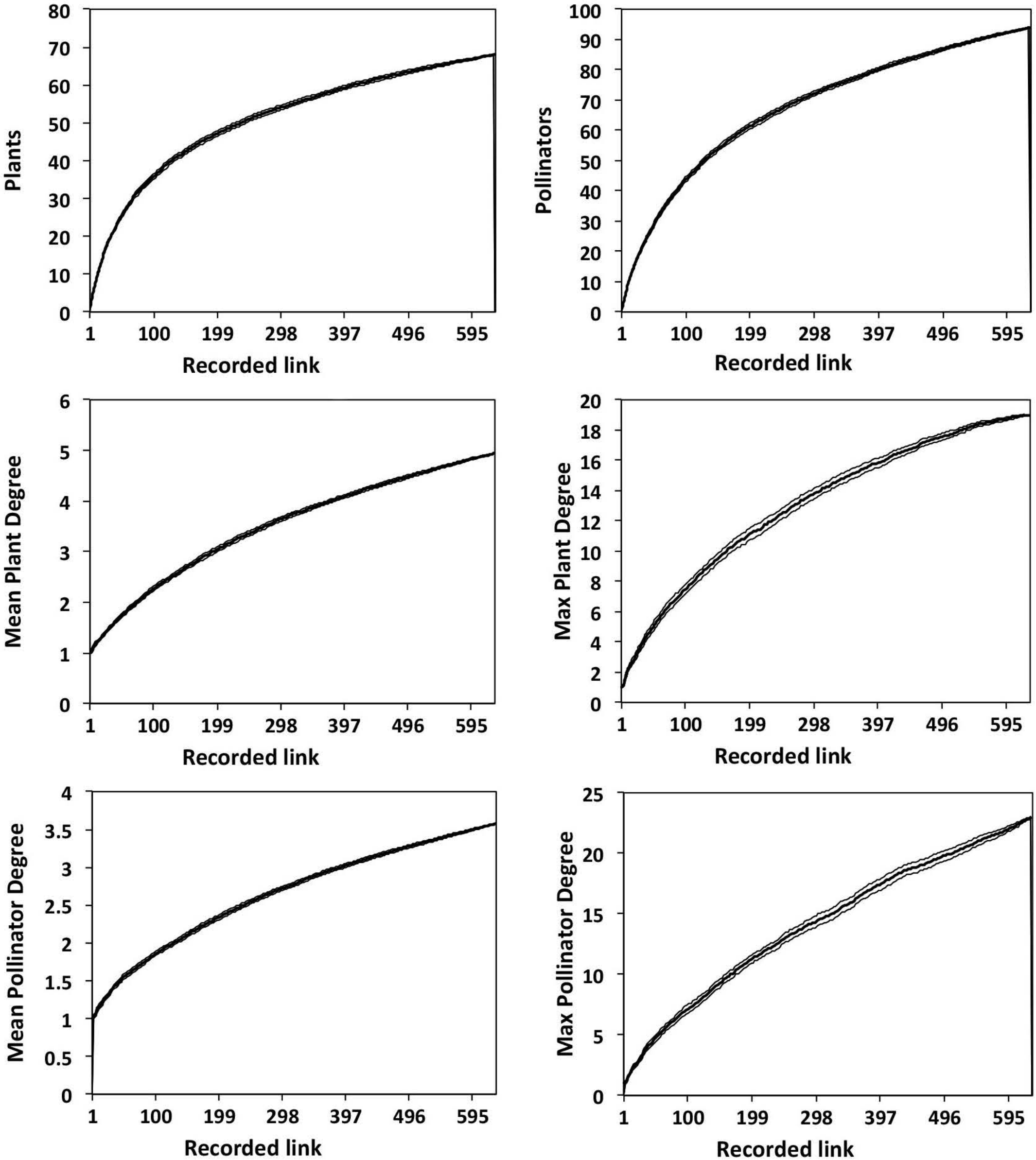

Plants
Recorded link
Pollinators
Recorded link
Mean Plant Degree
Recorded link
Max Plant Degree
Recorded link
Mean Pollinator Degree
Recorded link
Max Pollinator Degree
Recorded link

Figure S5.

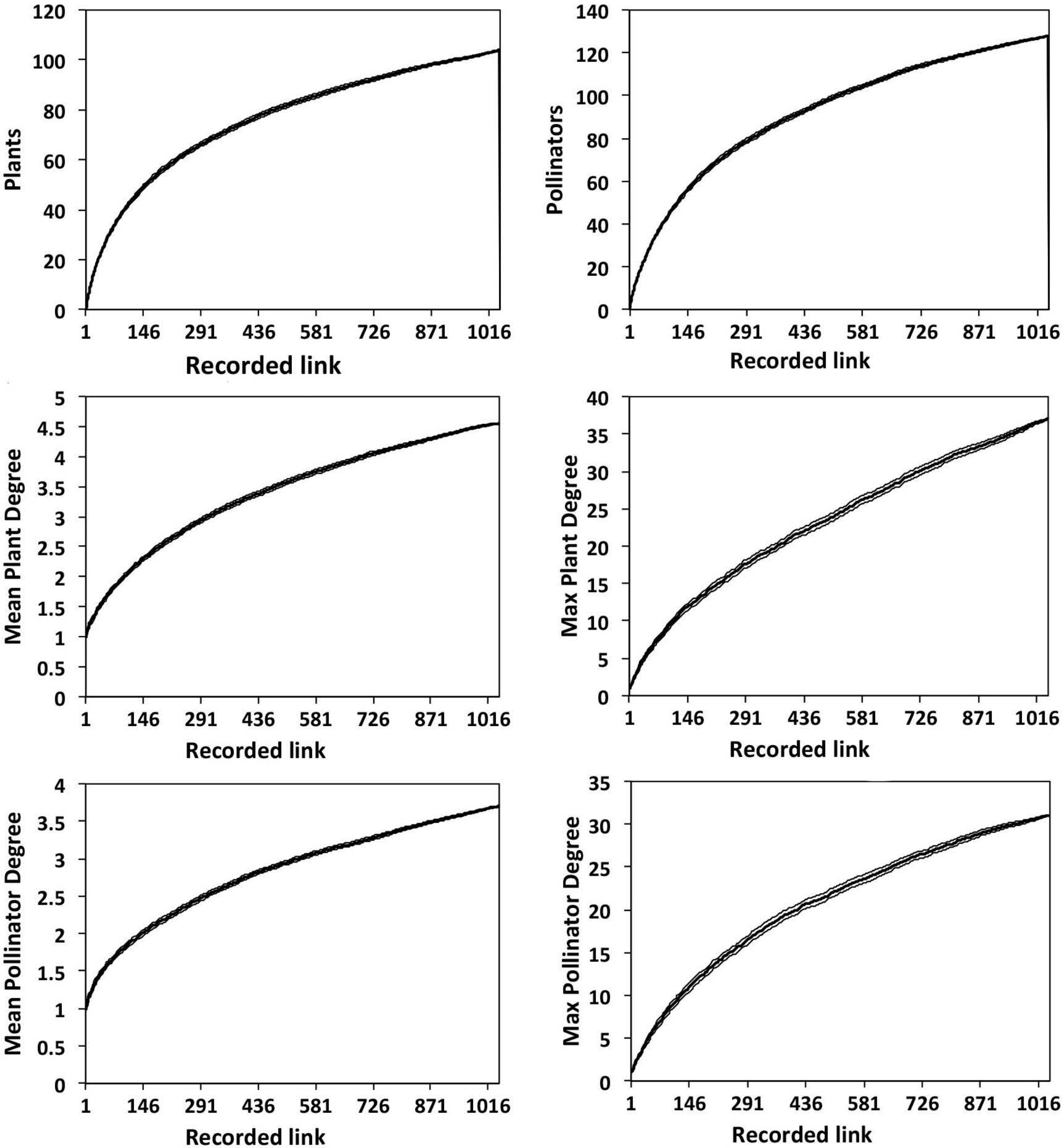
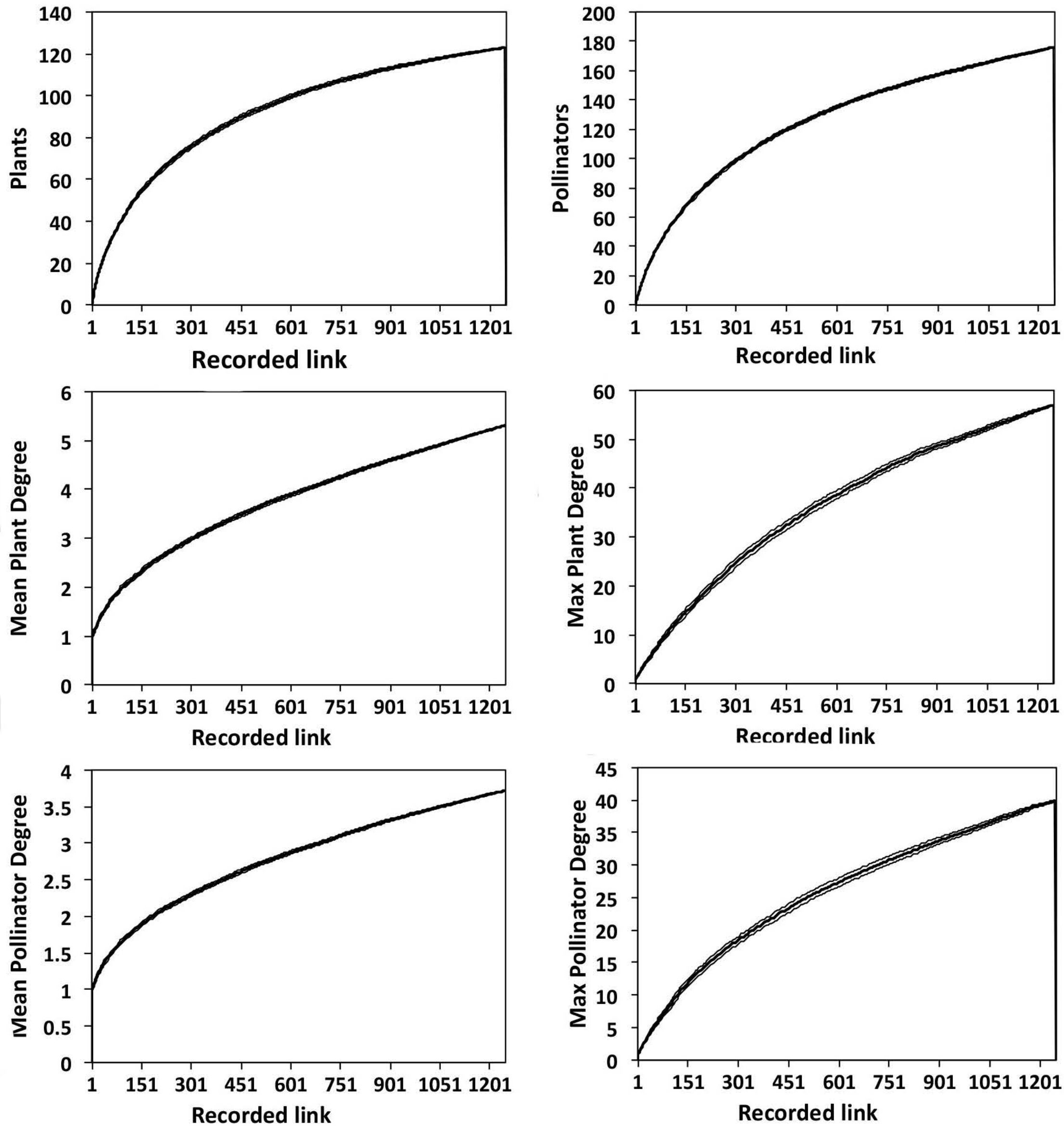

120
100
80
60
40
20
0
Plants
1
146
291
436
581
726
871
1016
Recorded link
140
120
100
80
60
40
20
0
Pollinators
Recorded link
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Mean Plant Degree
Recorded link
40
35
30
25
20
15
10
5
0
Max Plant Degree
Recorded link
4
3.5
3
2.5
2
1.5
1
0.5
0
Mean Pollinator Degree
Recorded link
35
30
25
20
15
10
5
0
Max Pollinator Degree
Recorded link

Figure S6


Plants
Recorded link
Pollinators
Recorded link
Mean Plant Degree
Recorded link
Max Plant Degree
Recorded link
Mean Pollinator Degree
Recorded link
Max Pollinator Degree
Recorded link