Plant niche specialisation and local abundance drive structure and generalisation of plant pollinator spectra

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# Abstract

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Composition of pollinator spectrum is an important component of understanding the pollination effectiveness and ecology of plant species and it is typically predicted to depend on plant’s floral traits. However, most plant species do not possess floral traits that would enforce their specialisation on a particular pollinator group. Species with generalised floral traits are likely to have their pollinator spectrum also influenced by their surroundings.

In present paper, we explore the degree to which composition and generalisation of plant pollinator spectra depends on plant’s niche width (i.e. the diversity of environments it occurs in) and its local dominance (mean cover in community). We achieve this by compiling a database of plant-pollinator spectra from literature and coupling it with data on plant niche width and local dominance based on Czech National Phytosociological Database.

Introduction

The knowledge of plant pollinator spectra is essential for understanding effectiveness of plant pollination ([Escaravage & Wagner 2004](#ref-Escaravage2004), [Gong & Huang 2014](#ref-Gong2014)) as well as the susceptibility of the plant species to declines of pollinator diversity ([Biesmeijer et al. 2006](#ref-Biesmeijer2006), [Van Dyck et al. 2009](#ref-VanDyck2009), [Powney et al. 2019](#ref-Powney2019)). The composition of a plant’s pollinator spectrum has been hypothesised to be connected with plant traits and phylogeny ([Ellis & Ellis-Adam 1993](#ref-ellis1993), [Fenster et al. 2004](#ref-fenster2004)), resulting in the formulation of the so called pollination syndromes (xxx citace xxx). However, the power of floral traits to predict plant’s pollinator spectrum is only limited ([Ollerton et al. 2009](#ref-ollerton2009)), especially for species with floral traits allowing generalised pollinator spectra. Such plant species often make up the majority of plant communities (xxx citace), and other ecological characteristics than floral traits are likely to contribute to the structure of their pollinator spectra. The ecological niche of a plant species influences both its ability to be locally dominant in community as well as to occur in a wide range of environments and thus a wide range of floral contexts. This may have consequences for composition of plant pollinator spectra.X

Being able to achieve local dominance in the community (e.g. such as some clonal species do; xxx citace xxx) allows a plant species to attract more pollinators (e.g [Klinkhamer & de Jong](#ref-klinkhamer1990) ([1990](#ref-klinkhamer1990)); [Hegland et al.](#ref-hegland2009) ([2009](#ref-hegland2009)); [Janovský et al.](#ref-janovský2013) ([2013](#ref-janovský2013))). However, higher local density of flowers also results in a more diverse pollinator assemblage being attracted to such stand ([Hegland & Boeke 2006](#ref-Hegland2006)) including thus both groups that provide effective and less effective pollination of the locally dominant plant species. This is offset by improved pollination effectiveness of locally dominant plant species due to increased proportion of conspecific pollen transfers ([Levin & Anderson 1970](#ref-levin1970), [Straw 1972](#ref-straw1972), [Goulson 1994](#ref-goulson1994)), which especially helps to increase effectiveness of less flower constant pollinators.

Co-flowering species also tend to affect plant pollinator spectra. The more diverse is the surrounding floral context, the more diverse and generalised is the overall plant’s pollinator spectrum (e.g. [Lázaro et al.](#ref-Lazaro2009) ([2009](#ref-Lazaro2009))). Not only the diversity of the floral context, but also the actual species composition of the floral context affect both pollinator density ([Hegland et al. 2009](#ref-hegland2009)) and composition of the pollinator spectra of plant species present in the stand ([Janovský et al. 2013](#ref-janovský2013)). This is corroborated by the rather variable pollinator spectra of plant species studied in several populations across the range of conditions they occur in (e.g. [Thompson](#ref-Thompson1997) ([1997](#ref-Thompson1997));[Brunet & Sweet](#ref-Brunet2006) ([2006](#ref-Brunet2006));[Thompson](#ref-Thompson2001) ([2001](#ref-Thompson2001));[Niemirski & Zych](#ref-Niemirski2011) ([2011](#ref-Niemirski2011))). The extent of variation in plant pollinator spectra can be expected to relate to the extent of variation in floral contexts a plant experiences, i.e. to plant’s niche width as defined by the commonly used measures based on species co-occurrence (e.g. [Pielou](#ref-Pielou1972) ([1972](#ref-Pielou1972)); [Fridley et al.](#ref-Fridley2007) ([2007](#ref-Fridley2007))). Having diverse and generalised pollinator spectra has been also hypothesised to be beneficial for plants encountering variable densities and composition of pollinators ([Waser et al. 1996](#ref-waser1996)), i.e. species more likely having wider niches.

Plant’s niche width and tendency to locally dominate communities can also affect plant’s pollinator spectrum indirectly through responses of individual pollinator functional groups. For example, social hymenopterans (mainly honeybee and bumblebees) concentrate on locally dominant plants ([Ginsberg 1983](#ref-Ginsberg2016), [Tscharntke & Steffan-Dewenter 2000](#ref-Tscharntke2000)) and they are able to locate them in wide surroundings of their nests (e.g. [Osborne et al.](#ref-Osborne1999) ([1999](#ref-Osborne1999));[Steffan-Dewenter & Kuhn](#ref-Steffan-Dewenter2003) ([2003](#ref-Steffan-Dewenter2003));[Westphal et al.](#ref-Westphal2003) ([2003](#ref-Westphal2003))). On the other hand, many bee, butterfly and hoverfly species (but from other pollinator groups as well) show distinct habitat preferences (e.g. Kratochwil (1989), [Sommaggio](#ref-Sommaggio1999) ([1999](#ref-Sommaggio1999)); [Gutierrez et al.](#ref-Gutierrez2001) ([2001](#ref-Gutierrez2001)); [Potts et al.](#ref-Potts2003) ([2003](#ref-Potts2003))), resulting likely in their occurrences only in a fraction of habitats included in the niche of the generalist plant species. This diversity of pollinator species habitat preferences is thus likely to further reinforce the expectation that plant species with wide ecological niches have diverse generalised pollinator spectra.

In the present study, we ask the following questions: 1) How does plant species’ local dominance in community affect its pollinator spectrum?; and 2) How does plant species’ niche width affect its pollinator spectrum? In both cases, we focus on the overall composition of pollinator functional groups, the diversity of pollinator spectra (i.e. the degree of generalisation) as well as specific responses of proportions of individual pollinator functional groups in pollinator spectra. We achieve our goals by compiling a database of pollinator spectra of 259 Central European plant species from literature and relating it to information on species’ niche widths and local dominance in the Czech landscape using a stratified version of a database of vegetation plots.

Methods

*The Floral Visitor Database*

We retrieved the data on pollinator spectra on plant species from the Floral Visitor Database v. 1.1 (hereafter FloViD) compiled as a part of the PLADIAS project aimed at integrating all available data on Central European plant species ([Chytrý et al.](#ref-Chytry2021) ([2021](#ref-Chytry2021)); data available at www.pladias.cz). We restricted the selection of data to entries originating from Central, Northwest and Northern Europe (essentially Europe north of the Alps) and to plant species with at least 25 pollinator individuals recorded. Such selection criteria were passed by 259 Central European plant species corresponding to more than 200 000 recorded pollinator individuals.

The taxonomical resolution of the data used follows the FloViD, i.e. all pollinators recorded were classified into 14 functional groups: **honeybee** – *Apis mellifera*; **bumblebees** *–* *Bombus* spp. incl. *Psithyrus*; **other bees** – anthophilous pollen-collecting taxa from Apoidea other than honeybees and bumblebees; **other Hymenoptera** – hymenopterans other than pollen-collecting Apoidea; **hoverflies** –Syrphidae with body length greater than 5 mm; **muscids** – flies from families Muscidae, Anthomyiidae, Fanniidae, Scathophagidae and Sphaeroceridae greater than 5 mm; **meat flies** – meat flies *s*.*l*., families Sarcophagidae, Calliphoridae and Rhinophoridae; **other Diptera** – Diptera other than other than hoverfies, muscids and meat flies; **nitidulids** – small floricolous beetles with aggregated distribution across flowers from families Nitidulidae, Kateridae, Byturidae and Phalacridae; **other beetles** – beetles other than nitidulids; **butterflies** – all Lepidoptera (including moths and sphingids); **thrips** – all Thysanoptera; **other pollinators** – non-accidental flower visitors outside the orders Diptera, Hymenoptera, Lepidoptera, Coleoptera and Thysanoptera; **not determined** – flower visitors which could not be unambiguously identified to any of the preceding functional groups.

We calculated relative proportions of pollinator functional groups in order to control for different numbers of pollinator individuals recorded for each plant species. Additionally, we calculated Simpson’s Diversity Index (hereafter Simpson diversity) based on the relative proportions of pollinator functional groups in order to obtain a measure of generalisation of plants pollinator spectrum (sensu functional generalisation; [Ollerton et al.](#ref-ollerton2007) ([2007](#ref-ollerton2007))) which takes into account both the number of functional groups pollinating the plant species as well as their evenness (see e.g. [Gong & Huang](#ref-Gong2011) ([2011](#ref-Gong2011)) for similar approach). The higher the Simpson diversity (the closer to 1), the more generalised a plant’s pollinator spectrum is.

*Plant local dominance and niche width*

We used two measures derived from the Czech National Phytosociological Database of vegetation plots (hereafter CNPD; [Chytrý & Rafajová](#ref-Chytry2003) ([2003](#ref-Chytry2003))) to define plant local dominance and niche specialisation. We calculated plant species’ local dominance in communities as the square root of the mean cover of the species in the vegetation plots where it has been present. For that purpose, we used the geographically stratified version of CNPD reflecting the frequency of occurrence of individual vegetation types in the Czech Republic ([Chytrý et al. 2005](#ref-Chytry2005)) and standard translation of Braun-Blanquet cover scale to percentages ([Van Der Maarel 1979](#ref-VanDerMaarel1979)).

We used a measure of niche width based on species co-occurrence following [Fridley et al.](#ref-Fridley2007) ([2007](#ref-Fridley2007)) derived from the geographically stratified CNPD and called Ecological Specialisation Index (ESI; [Zelený & Chytrý](#ref-Zeleny2019) ([2019](#ref-Zeleny2019))). The index can range from 0 to 10 (but typically only from 3-8). High index values indicate species with narrow niches, which typically occur in similar floral neighbourhoods throughout their distribution range. Since ESI was not defined from some of the species included in FloViD, the final number of plant species entering our analysis was 251.

*Data analysis*

In order to assess the influence of plant’s local dominance in communities and its niche width on their plant pollinator spectra, we conducted a two-step analysis. First, we identified the main gradients in composition of plant pollinator spectra by means of phylogenetic principal component analysis (hereafter phylPCA). Second, we regressed the plant species’ positions in the phylPCA ordination space as well as Simpson diversity of pollinator spectra and relative proportions of individual pollinator functional groups against plant local dominance and niche width using the Phylogenetic Generalised Least Squares (hereafter pGLS). For both steps of analysis, we assumed Brownian model of evolution of the continuous response variables and used the maximum likelihood estimate of Pagel’s  to control for the effects of phylogeny ([Freckleton et al. 2002](#ref-Freckleton2002)). We used the DAPHNE phylogenetical tree ([Durka & Michalski 2012](#ref-Durka2012)) with branch lengths computed by standard methods ([Grafen 1989](#ref-Grafen1989), [Swenson 2014](#ref-Swenson)) as the source of information on plant phylogeny.

We used the plant species’ scores on principal components of the phylPCA to describe the species’ position in the ordination space of pollinator spectra. The broken stick rule ([Jackson 1993](#ref-Jackson1993)) indicated that only the first three principal components (hereafter PC1 to PC3) were informative and thus to be used in the subsequent pGLS analyses.

We used the data on all 251 plant species available for pGLS analyses of responses concerning the whole pollinator spectrum (PC1 to PC3 and Simpson diversity), whereas we used only those plants species with the particular pollinator functional group being recorded for the analyses using relative proportions of individual functional groups as response. Functional groups ‘others,’ ‘not determined’ and ‘thrips’ were not used as responses since the first two are not informative and the dataset was not sufficient for ‘thrips’ (recorded only in ca 50 plant species). All relative proportions of pollinator functional groups were square-root transformed prior to analyses in order to meet the assumption of homogeneity of variance of the phylogeny-corrected residuals. In order to test also for unimodal relationships between the predictors and responses, we included quadratic terms besides the linear ones to both predictors.

All analyses were conducted in R statistical environment v. 3.6.1 (R Development Core Team, 2014, available at www.r-project.org). We used the base installation, package phytools 0.6-99 ([Revell 2012](#ref-Revell2012)) and package caper 1.0.1 ([Orme et al.](#ref-Orme2018) ([2018](#ref-Orme2018)); all available at [[http://CRAN.R-project.org](http://CRAN.R-project.org)](http://CRAN.R-project.org/)).

Results

## The structure of plant pollinator spectra

Application of the broken stick rule to the results of phylogenetic PCA identified the first three principal components to be of relevance. The PC1 was mainly determined by a gradient between bumblebees and dipterans+nitidulids dominated plant pollinator spectra (Table 1, Fig. 1A). While plants with pollinator spectra dominated by bumblebees did not vary much along other principal components, pollinator spectra with low proportion of bumblebees were further structured into those dominated either by flies or by hoverflies or by nitidulid beetles (Fig. 1A and B; Appendix xxx, Fig.

*The effects of plant niche width and local dominance on pollinator spectrum composition*

The position of a plant species on the main gradient of pollinator spectra composition (score on PC1) depended unimodally on plant niche width as well as being strongly influenced by plant phylogeny (Table 2). Both niche generalists and niche specialists (but not the intermediate species) were disproportionately represented among the plant species with pollinator dominated by dipterans and/or nitidulids (Fig. 2A; Appendix xxx, Figs. Sxxx).

Among the species with dipteran and/or nitidulid dominated pollinator spectra, the position on PC2 was determined by both their niche width and local dominance, with species with narrow niches and/or locally dominant having pollinator spectra dominated more by muscids (Fig. 2B; Appendix xxx, Figs. Sxxx). There was no detectable signal of plant phylogeny concerning the plant’s position on PC2 and PC3 (Table 2). The overall generalisation of pollinator spectra increased with breadth of their niches (Table 2; Fig. 2C; Appendix xxx, Figs. Sxxx).

*The effects of plant niche width and local dominance on pollinator functional groups*

Out of the pollinator groups studied, only hymenopterans and muscids and hoverflies showed a response to plant niche width or local dominance in community (Table 2,). Bumblebees and other bee proportions showed a response to plant niche width similar to the response of positions on PC1 with decreases in representation close to both extremes of the gradient (Fig. 2E; Appendix xxx, Fig. Sxxx). The proportion of other hymenopterans decreased monotonously with increasing plant niche specailisation (Appendix xxx, Fig. Sxxx). Plant’s average local dominance increased proportion of both honeybee and muscids in its pollinator spectrum (Fig. 2D; Appendix xxx, Fig. Sxxx), whereas it decreased the proportion of hoverflies (Fig. 2F)

​Discussion

The composition of plant pollinator spectra was aligned along the three main gradients. The main gradient was basically determined by whether the plant’s pollinator spectrum was dominated by bumblebees or not and it was unimodally related to plant’s niche width as well as strongly correlated with plant phylogeny. Plants having very wide or very narrow niches had on average the lowest proportion of bumblebees in their pollinator spectra. Among the plants with pollinator spectra not dominated by bumblebees the species with narrower niches and locally dominant species were likely to have their spectra dominated by muscids than by hoverflies and/or nitidulids. The overall degree of generalisation of plant pollinator spectra increased with niche width corroborating existing hypotheses. Of the proportions of individual pollinator functional groups, other bees showed a similar response to plant’s niche width as bumblebees, and proportion of other hymenopterans increased with plant’s niche width. While the proportion of honeybee and muscids in plant’s pollinator spectrum showed the expected positive response to plant’s local dominance, the opposite was true was for hoverflies.

*Plant’s niche width and structure of its pollinator spectrum*

In general, majority of studied plant species possessed a rather generalised pollinator spectrum (Fig. Sxxx; Fig. xxx Simpson), which was in line with the previous studies on the level of a whole flora ([Ellis & Ellis-Adam 1993](#ref-ellis1993), [Herrera 2020](#ref-herrera2020)). The degree of pollinator spectrum generalisation was positively related to plant niche width fitting with the theoretical considerations that plants should have more generalised pollinator spectra when experiencing fluctuating pollinator composition across sites and seasons ([Waser et al. 1996](#ref-waser1996), [Gómez & Zamora 2006](#ref-gómez2006)). However, the effect of plant niche width explains only ca 4 % of variation suggesting that it covers only a fraction of cases of plants having generalised pollinator spectra, possibly corresponding to species with high turnover of pollinator composition among sites ([Thompson 2001](#ref-Thompson2001), [Brunet & Sweet 2006](#ref-Brunet2006)) (+Greya politella Lithophragma). Such species would fit the type E of plants with generalised pollinator spectra as outlined by [Ollerton et al.](#ref-ollerton2007) ([2007](#ref-ollerton2007)).

Interestingly, plant niche width was also unimodally related to position of plant’s pollinator spectrum on the first phylPCA gradient driven by proportion of bumblebees with their porportions being the highest in spectra of plants with niches of intermediate width. The lack of plants with wide niches and bumblebee-dominated spectra could be the result of bumblebees lacking or having low densities in many types agricultural landscapes (which most of the data on pollinator spectra come from; e.g. xxx La Féon et al. 2010; Lye et al. 2009 xxx). The disproportionate declines of bumblebee forage plant frequency in landscape during the last century (e.g. xxx Carvell et al. 2006; Goulson et al. 2005 xxx) may also contribute to the observed pattern, since the calculation of the Ecological Specialisation Index is based on a substantial proportion of the vegetation plot data originating from the last thirty years (xxx Chytrý et Rafajová 2003 xxx). The same reasons probably to other bees as well (Table 2).

On the other hand, the lack of plant species with bumblebee dominated spectra with narrow niches may be an artefact of the overrepresentation of plant species from mountainous habitats (see e.g. Fig. Sxxx), which often possess narrow niches and are often extensively studied (for responses to altitudinal gradients, pollination stochasticity etc.). In mountainous habitats, muscids often constitute a dominant pollinator functional group largely outnumbering bumblebees and hymenopterans in general (e.g. xxx Totland 1993; Benadi et al. 2014; Willis et Burkill 1895 xxx). This is also likely the reason for the effect of plant niche width on position of pollinator spectra on the second gradient of phylPCA (i.e. muscid-dominated pollinator spectra in species with narrower niches).

*The role of plant’s local dominance on plant pollinator spectrum and proportion of individual pollinator groups*

Plant’s local dominance had a far lesser effect on the overall structure and generalistion of plant’s pollinator spectrum than plant’s niche specialisation despite the predictions that it should positively promote generalisation of plant’s pollinator spectrum (xxx Sargent et Ott 2006 xxx). Local dominance played a significant role in species with pollinator spectra with considerable proportions of various dipterans (but not bumblebees; Fig. 1). This could be possibly due to floral rewards constituting only a fraction of muscid diet (especially as compared to most adult hoverflies, which completely rely on nectar and pollen; xxx citace xxx) and muscids utilising them only opportunistically. This seems to be corroborated both by positive response of proportion of muscids to plant’s local dominance and by the fact that even most of the plants with muscid-dominated pollinator spectra and low local dominance constitute a local dominant during their blossom (e.g. *Caltha palustris*, *Anemone nemorosa*, *Bellis perennis*; Fig. Sxxx). This is in line with previous findings that muscids are among the key pollinator functional groups in agricultural landscape (xxx Orford et al. 2015 xxx).

Additional to muscids, honeybees showed the same positive response to plant’s local dominance reflecting their ability to concentrate on an abundant food source (xxx Seeley & Visscher 1988 xxx) combined with large areas they gather resources from (xxx Steffan-Dewenter et Kuhn 2003 xxx). This effect was relatively strong (xxx Table 2 xxx) and relatively weakly related to plant phylogeny supporting the notion that local dominance was a more important driver of the pollinator spectrum than amount of floral rewards available (xxx Goulson 1994; Fowler et al. 2016 xxx).

On the other hand, hoverflies surprisingly responded to plant’s local dominance negatively, i.e. their share in pollinator spectrum decreased in locally dominant plant species. We hypothesise that this may be mainly the result of hoverflies being a very diverse pollinator functional group with no clear shared preferences (xxx Branquart & Hemptinne 2000; Sommagio 1999 xxx). This results in hoverfly lack of ability to concentrate on a locally dominant floral resource and being rather spread among a wide spectrum of plant species (see e.g. xxx Ssymank 2001 xxx for similar evidence) and being outnumbered by more opportunistically behaving groups (e.g. honeybee or muscids) concentrating on dominant resources. The spread of hoverflies among plant species is further corroborated by the highest number of plant species, where hoverflies take part in pollinator spectrum (222 out of 255 plant species as compared to 183 and 189 in similarly abundant bumblebees and muscids respectively).

The patterns across plant phylogeny

While we expected proportions of bumblebees and of butterflies to cluster with plant phylogeny, we found a similar though weaker pattern in muscids, sarcophagids and other dipterans as well. This pattern in butterflies and bumblebees is likely the result of their clear preferences for flowers with distinct morphology, such as long spurs or tubes (xxx citace xxx). On the other hand, the pattern in dipterans (minus syrphids) may have multiple causes. First, they typically have short proboscis (xxx citace Kearns Innouye xxx) and thus they are likely to avoid flowers with long spurs or tubes. Second, our data are proportions in pollinator spectrum and thus the observed pattern may be imposed by other pollinator groups, especially bumblebees, which are both abundant and often tend to strongly dominate spectra of their preferred species (Fig. Sxxx koláče). Third, at least one of our dipteran functional groups, namely sarcophagids seems to show consistent preferences for floral traits (xxx citace Iridy xxx).

Our results are very different from the pattern of clustering of pollinator visits on plant phylogenetic tree from a recent study in several Mediterranean plant communities (xxx Herrera 2020 xxx). We suggest that this discrepancy is due to at least two causes. First, we assessed phylogenetic signal for smaller and ecologically more homogeneous pollinator functional groups (unlike the insect orders used by xxx Herrera 2020 xxx). Second, plant communities tend to be phylogenetically overdispersed (xxx citace Lososová Götzenberger xxx), i.e. there is a lower probability in plant community-centred studies to capture multiple closely related plant species and thus detect a strong degree of clustering across phylogenetical tree (as emasured by Pagel’s ).

Conclusion

In the present article, we showed that not only floral traits but also the seemingly unconnected aspects of plant’s niche – niche specialisation and ability of the plant species to locally dominate communities – may contribute substantially to shaping of plant pollinator spectra. Especially plant’s niche width turned out to affect both composition and degree of generalisation of plant pollinator spectra making it thus another important plant trait possibly predicting plant vulnerability to pollinator declines, similar to plant’s mating system (xxx Biesmeijer et al. 2006 xxx). Plant’s local dominance in community mainly promoted proportion of opportunistic pollinator groups (honeybee, muscids) in plant pollinator spectra. On the other hand, the negative effect of local dominance on proportion of hoverflies in pollinator spectrum highlighted their role of an abundant and ecologically diverse pollinator group spread among an extremely broad range of plant species.

Our results further emphasise that information on plant community structure are necessary for understanding pollination ecology of plant species with relatively generalised pollinator spectra (i.e. the majority of temperate plant species).

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **log(conspecific)** | | | **log(conspecific)** | | | **log(conspecific+1)** | | |
| *Predictors* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* |
| (Intercept) | 3.34 | 2.67 – 4.02 | **<0.001** | 4.82 | 4.14 – 5.51 | **<0.001** | 4.50 | 4.06 – 4.94 | **<0.001** |
| cashm | 0.01 | 0.01 – 0.02 | **<0.001** | 0.01 | 0.00 – 0.01 | **0.004** | -0.00 | -0.01 – -0.00 | **<0.001** |
| cashm^2 | -0.00 | -0.00 – -0.00 | **<0.001** | -0.00 | -0.00 – -0.00 | **0.028** |  |  |  |
| pollinator2 [bombus] |  |  |  | -2.28 | -2.90 – -1.67 | **<0.001** |  |  |  |
| cashm^2 Ã— pollinator2 [bombus] |  |  |  | 0.00 | 0.00 – 0.00 | **0.009** |  |  |  |
| pollinator2 [eristalis\_interrupta] |  |  |  |  |  |  | 0.76 | 0.16 – 1.37 | **0.014** |
| pollinator2 [eristalis\_tenax] |  |  |  |  |  |  | 1.22 | 0.64 – 1.80 | **<0.001** |
| pollinator2 [helophilus] |  |  |  |  |  |  | 0.83 | 0.21 – 1.46 | **0.009** |
| cashm Ã— pollinator2 [eristalis\_interrupta] |  |  |  |  |  |  | -0.00 | -0.00 – -0.00 | **0.005** |
| cashm Ã— pollinator2 [eristalis\_tenax] |  |  |  |  |  |  | -0.00 | -0.00 – -0.00 | **0.003** |
| cashm Ã— pollinator2 [helophilus] |  |  |  |  |  |  | -0.00 | -0.00 – -0.00 | **0.003** |
| Observations | 80 | | | 130 | | | 261 | | |
| R2 / R2 adjusted | 0.195 / 0.174 | | | 0.446 / 0.428 | | | 0.653 / 0.643 | | |

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