

**Supplementary Material for:**

**Title:** Wind drives temporal variation in pollinator visitation in a fragmented tropical forest

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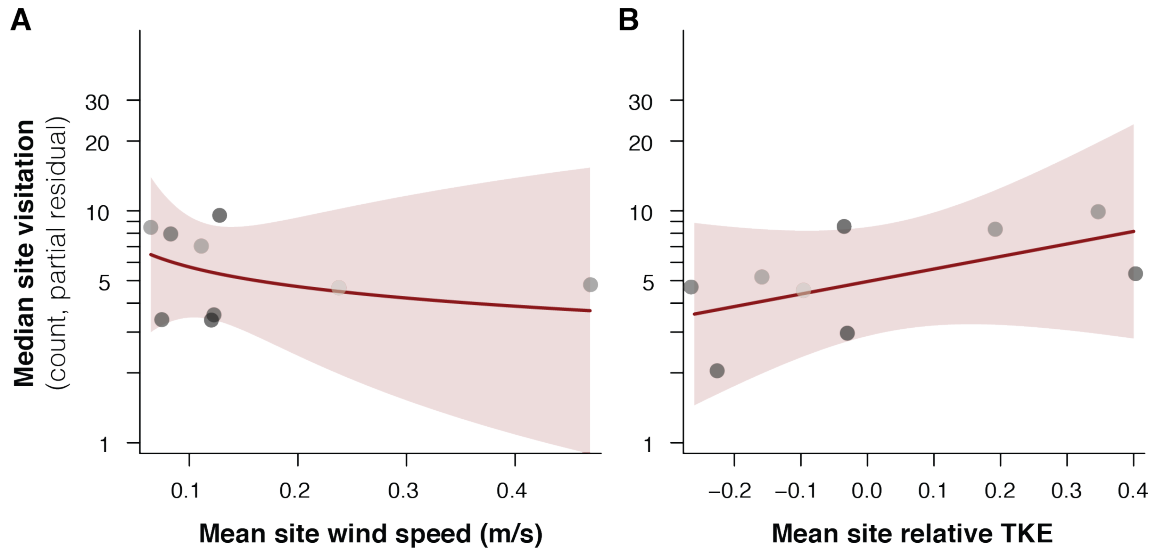
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**Fig S1.** Wind and visitation across sites. Marginal effect plot of mean site wind speed (A) and mean site turbulence (relative TKE, B) on median visitation across sites. Solid markers show partial residuals for individual collections. In both panels, solid red line and shaded regions show the estimated relationship and  $\pm$  SE, and filled markers show partial residuals, from a single generalized linear model (GLM), including fixed effects for wind speed, relative turbulence, and forest cover within 200m (GLM with quasi-poisson error, log-link; Wind speed:  $df = 8$ ,  $t = -0.73$ ,  $p = 0.49$ ; Relative TKE:  $df = 8$ ,  $t = 1.28$ ,  $p = 0.26$ ). GLM was implemented using the ‘nlme’ (1) package in R (2). Shade in all panels indicates amount of forested area (equivalent to site colors in Fig 1).

Table S1. Collection site metadata. Wind speed, turbulence, visitation, and forest cover metrics shown for each of nine collection sites (shown in Fig 1A).

Site	Mean wind speed (m/s)			Mean turbulence (relative TKE)			Male orchid bee visitation (count)			Forest cover (%)				
	Min	Median	Max	Min	Median	Max	Min	Median	Max	100m buffer	200m buffer	300m buffer	400m buffer	500m buffer
1	0.0285	0.0685	0.138	-0.933	-0.0881	0.388	1	2	8	81.1	81.3	81.3	79.1	76.9
2	0.0456	0.12	0.177	-0.623	-0.226	0.447	0	6	14	69.4	78.5	84.4	83.8	79.9
3	0.061	0.494	0.73	0.166	0.336	0.549	0	3	5	12.8	15.9	18.2	24	31.3
4	0.129	0.231	0.415	-0.564	-0.165	0.431	1	6	11	100	100	100	95.5	90.2
5	0.0347	0.0805	0.145	-0.613	-0.338	0.28	2	7.5	23	100	100	100	96.6	92.3
6	0.0414	0.133	0.233	-0.546	-0.157	0.816	4	6	8	44.5	54.4	59.5	56.6	58.5
7	0.0436	0.128	0.178	-0.293	-0.116	0.421	1	4	6	100	99.8	97.5	89.2	81.6
8	0.0621	0.132	0.213	0.0989	0.355	0.858	0	3	6	19.3	38	41.5	45.8	55.9
9	0.0206	0.0757	0.0897	-0.146	0.179	0.548	2	14	16	100	94.6	94.5	93.9	94

Table S2. Collection metadata. Data shown for each 20-min collection of orchid bee visitation and wind metrics. “cin” and “meth” denote collections made with cineole and methyl salicylate, respectively.

Site	Date	Collection start time	Scent	Count	Mean wind speed (m/s)	Mean turbulence (relative TKE)
1	10/1/14	10h57	cin	1	0.0608	-0.0789
1	10/7/14	9h02	cin	1	0.0285	0.388
1	10/13/14	8h27	cin	8	0.0785	-0.821
1	10/23/14	8h28	cin	7	0.105	-0.0973
1	10/27/14	10h10	cin	2	0.06	-0.333
1	11/6/14	8h18	cin	2	0.0762	-0.933
1	11/15/14	10h57	cin	1	0.0512	0.109
1	11/18/14	8h30	cin	2	0.138	-0.0392
2	10/3/14	10h48	cin	6	0.11	-0.156
2	10/8/14	8h36	cin	5	0.147	0.447
2	10/12/14	10h18	cin	8	0.0476	-0.00758
2	10/15/14	9h53	cin	4	0.127	-0.226
2	10/19/14	9h08	cin	8	0.177	-0.623
2	10/23/14	11h19	cin	14	0.0919	0.295
2	10/26/14	8h40	cin	0	0.0456	-0.355
2	10/28/14	8h06	cin	3	0.133	-0.354
2	11/2/14	9h16	cin	9	0.12	-0.447
3	10/6/14	8h07	meth	3	0.442	0.166
3	10/14/14	8h03	cin	0	0.061	0.336
3	11/16/14	10h44	cin	3	0.619	0.549
3	11/17/14	9h02	cin	5	0.73	0.331
3	11/18/14	11h28	cin	3	0.494	0.351
4	10/1/14	8h51	meth	10	0.129	0.257
4	10/7/14	11h14	cin	1	0.294	-0.165
4	10/12/14	8h22	cin	9	0.257	-0.342
4	10/15/14	9h01	cin	3	0.151	-0.564
4	10/23/14	9h20	cin	2	0.296	-0.339
4	10/29/14	8h13	cin	5	0.177	-0.551
4	11/4/14	10h08	cin	11	0.231	0.431
4	11/6/14	9h09	cin	7	0.191	0.232
4	11/13/14	10h03	cin	6	0.415	0.176
5	10/1/14	9h54	cin	23	0.145	-0.613
5	10/7/14	9h46	cin	12	0.11	0.28
5	10/13/14	9h17	cin	2	0.0828	-0.522

5	10/21/14	9h06	cin	12	0.055	0.179
5	10/27/14	9h19	cin	7	0.0782	-0.46
5	11/4/14	8h21	cin	8	0.0858	-0.194
5	11/13/14	8h19	cin	5	0.0347	-0.572
5	11/15/14	10h10	cin	6	0.0723	-0.216
6	10/7/14	10h26	cin	7	0.122	0.217
6	10/21/14	8h26	cin	6	0.158	-0.339
6	10/27/14	8h38	cin	5	0.16	-0.237
6	11/4/14	9h05	cin	8	0.0414	0.816
6	11/13/14	9h01	cin	6	0.233	-0.546
6	11/15/14	9h24	cin	8	0.133	-0.157
6	11/18/14	9h21	cin	4	0.0476	0.000656
7	10/6/14	10h10	cin	1	0.0903	0.147
7	10/9/14	9h28	cin	4	0.13	0.421
7	10/14/14	9h11	cin	4	0.135	-0.293
7	10/19/14	10h09	cin	4	0.125	-0.214
7	10/22/14	9h08	cin	2	0.0436	0.106
7	10/26/14	11h27	cin	6	0.178	-0.129
7	10/28/14	10h22	cin	4	0.138	-0.175
7	11/2/14	8h14	cin	3	0.124	-0.103
8	10/2/14	9h00	meth	3	0.0706	0.355
8	10/4/14	10h43	cin	6	0.0733	0.784
8	10/9/14	8h10	cin	2	0.132	0.297
8	10/19/14	8h07	cin	1	0.144	0.125
8	10/28/14	9h11	cin	6	0.0621	0.858
8	11/3/14	10h20	cin	4	0.213	0.489
8	11/6/14	10h23	cin	1	0.14	0.263
8	11/16/14	8h23	cin	0	0.124	0.357
8	11/17/14	10h35	cin	6	0.145	0.0989
9	10/3/14	9h36	cin	16	0.0757	0.179
9	10/8/14	9h39	cin	14	0.0897	0.548
9	10/15/14	8h12	cin	2	0.0206	-0.146
9	10/23/14	10h13	cin	14	0.0441	0.493
9	10/29/14	9h09	cin	13	0.0855	-0.0768
9	11/3/14	8h37	cin	14	0.0568	0.229
9	11/17/14	12h02	cin	11	0.0796	0.118

**Table S3.** Species composition table. Species are listed in descending order of abundance across all collections.

Species	# Cineole	# Methyl salicylate	Total	%
<i>Euglossa championi</i>	115	7	122	27.1
<i>Euglossa cybelia</i>	70	0	70	15.6
<i>Euglossa maculilabris</i>	42	0	42	9.3
<i>Euglossa flammea</i>	39	0	39	8.7
<i>Euglossa mixta</i>	30	6	36	8
<i>Euglossa dodsoni</i>	30	0	30	6.7
<i>Euglossa tridentata</i>	18	0	18	4
<i>Euglossa asarophora</i>	17	0	17	3.8
<i>Euglossa hansonii</i>	7	7	14	3.1
<i>Euglossa deceptrix</i>	11	0	11	2.4
<i>Euglossa gorgonensis</i>	10	1	11	2.4
<i>Euglossa sapphirina</i>	8	0	8	1.8
<i>Euglossa bursigera</i>	6	0	6	1.3
<i>Eulaema speciosa</i>	6	0	6	1.3
<i>Euglossa erythrochlora</i>	0	4	4	0.9
<i>Euglossa imperialis</i>	3	0	3	0.7
<i>Eulaema nigrita</i>	3	0	3	0.7
<i>Euglossa despecta</i>	2	0	2	0.44
<i>Euglossa heterosticta</i>	2	0	2	0.4
<i>Euglossa purpurea</i>	2	0	2	0.4
<i>Euglossa variabilis</i>	2	0	2	0.4
<i>Euglossa allosticta</i>	1	0	1	0.2
<i>Eulaema bombiformis</i>	0	1	1	0.2

## Supplementary Text

### ***Assessing effects of wind direction and local landscape structure***

It is possible that wind direction could have strong effects on visitation that interact with local landscape structure. In particular, increased forest cover downwind from the scent bait would be predicted to increase visitation if male orchid bees are typically located in forested sites. To explore the potential effects of wind direction and its interaction with local landscape structure, we estimated the mean direction of wind flow for each 20-min collection period, and then calculated the % of forested area in this downwind direction (this metric thus varied within each site over sampling periods, according to the predominant wind direction). We then included this metric (“downwind % forested”) as an additional fixed effect in the glmm model described in the main text. We found no significant effects of downwind forested area on visitation in these extended models (Poisson glmm,  $z = 0.81$ ,  $df = 63$ ,  $p = 0.42$ ), even after exclusion of completely forested sites (Poisson glmm,  $z = -0.24$ ,  $df = 63$ ,  $p = 0.81$ ). (However, we did find evidence for a significant effect of downwind % forested if static forest cover (i.e., % forested with 200 m) was excluded as a fixed effect, Poisson glmm,  $z = 0.49$ ,  $df = 64$ ,  $p = 0.02$ ).

These results do not provide direct support for an effect of wind direction separate from effects of local landscape cover. It is likely, however, that such an effect exists in the real-world (assuming orchid bees are primarily located in forested areas), because spatial patterns of wind dispersion will determine which areas scents will diffuse to and potentially attract bees. We thus interpret the lack of direct support for this additional hypothesis as likely resulting from either (a) insufficient sample sizes for detecting the effects of wind direction, vs speed and static landscape characteristics, or (b) wind direction providing too simplified of a metric to accurately capture scent diffusion patterns. Wind-driven scent dispersal in these environments will of course be complex, 3-dimensional, and have strong interactions with landscape structure. It is thus possible that wind direction is only weakly, if at all, correlated with real-world spatial patterns of scent diffusion. These results highlight the potential importance of more detailed odor dispersion models in complex, fragmented landscapes.

### Supplementary Material References

(1) Pinheiro J, Bates D, DebRoy S, Sarkar D, R Core Team (2019). *nlme: Linear and Nonlinear Mixed Effects Models*. R package version 3.1-142, <https://CRAN.R-project.org/package=nlme>

(2) R Core Team (2018). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>.