Oikos

OIK-03307

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Appendix 1

Volumetric relationship

The size of a gall positively correlated with the number of cavities within a gall (Fig. 5.3, $F_{1,53} = 58.7$, $p < 0.0001$) therefore, gall volume can be used as an indicator of fecundity and, therefore, high-performing mothers.

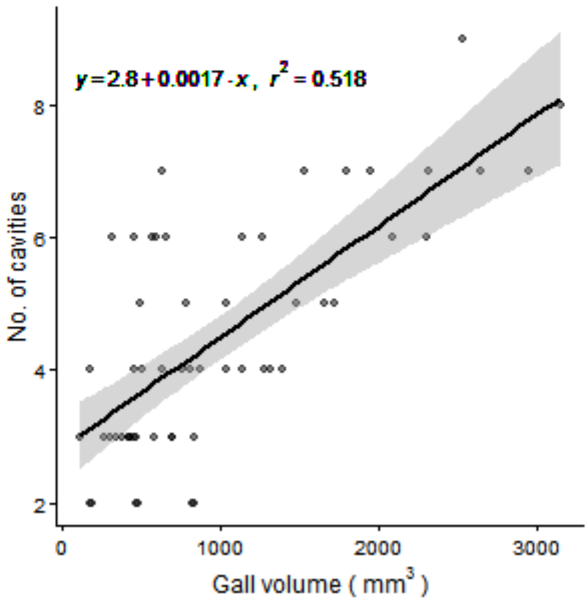

Figure A1. Relationship between gall volume and the number of cavities found in dissected galls. A smoothed mean line (±95% CI) is shown as well as the fitted equation and r^2 from a linear model.

Appendix 2

Initial analysis of all gall count data

Using all gall count data, we initially constructed Poisson GLMMs to assess the effects of tree species richness, canopy cover, tree height and DBH. However, all models were a poor fit to the data to an excess of zero values: of the 353 experimental trees, only 113 hosted galls on the sampled branches. We therefore constructed zero-altered Poisson (ZAP) and zero-inflated Poisson (ZIP) regression models using the *pscl* package in R (Zeileis et al. 2008) to account for the large number of zeros in these data. Both ZIP and ZAP models are two part models where the chance of getting a non-zero result is modelled with a binomial distribution, and then, count data are modelled separately. The main difference between them is in a ZIP model zeroes are included in the count model and in the ZAP they are not. Therefore, we are able to test effects of each predictor variable and also investigate whether the increased information in the count data (with ungalled trees included) altered gall responses.

Table A1. Results from zero-altered (ZAP) and zero-inflated poisson (ZIP) models examining effects of tree species richness, canopy cover, tree height and DBH on gall densities. Both model types report results from the binomial and count parts of the model separately.

	Binomial					Count				
ZAP	Estimate	SE	z	p		Estimate	SE	z	p	
Richness	-0.612	0.148	-4.14	<0.001	***	-0.064	0.056	-1.14	0.254	
Canopy cover	-0.850	0.146	-5.81	<0.001	***	0.043	0.064	0.67	0.503	
Height	0.299	0.130	2.30	0.022	*	0.255	0.063	4.07	<0.001	***
DBH	0.483	0.133	3.64	<0.001	***	0.125	0.054	2.34	0.020	*
ZIP										
Richness	0.594	0.151	3.93	<0.001	***	-0.074	0.055	-1.33	0.184	
Canopy cover	0.891	0.156	5.70	<0.001	***	0.037	0.063	0.58	0.561	
Height	-0.233	0.141	-1.66	0.098	.	0.244	0.063	3.87	<0.001	***
DBH	-0.489	0.145	-3.38	<0.001	***	0.112	0.054	2.08	0.038	*

NB: The binary part of the models exhibits opposite signs as ZAP models predict the probability of a non-zero response and ZIP models predict the probability of excess zeros.

Comparing ZIP and ZAP models, we found that the inclusion of zeros in the count part of ZIP models yielded similar results for all four predictor variables. In addition, results from ZIP/ZAP models are similar to those reported in the main text with gall abundance influenced by tree size, especially tree height, and gall presence affected by all four predictor variables. However, as these models did not allow for the inclusion of random factors, in the main text, we prefer to report results from separate analyses of gall presence and abundance in (generalized) mixed-effects models where 'plot' is specified as a random factor.

Appendix 3

Effects of study area and plot thinning

To determine whether observed effects might be confounded by area or thinning, we examined how the three gall response variables, canopy cover and spruce growth varied between the two study areas (area 1 and 3) and between thinned and unthinned plots.

Table A2. Effects of study area and plot thinning on the three gall responses, canopy cover and spruce growth.

	Study area				Thinning			
	χ^2	DF	p		χ^2	DF	p	
Canopy cover	4.36	1	0.037	*	6.61	1	0.010	*
Tree height	0.69	1	0.405		0.06	1	0.806	
Tree DBH	0.05	1	0.821		0.02	1	0.888	
Gall presence	16.10	1	<0.001	***	1.42	1	0.234	
Gall abundance	17.29	1	<0.001	***	0.00	1	0.958	
Gall volume	0.00	1	0.973		0.00	1	0.995	

Table A3. Results from models testing whether effects of tree species richness, canopy cover and tree growth on pineapple galls differ between the two study areas. Gall presence/absence was modelled with a binomial error structure, gall abundance with a Poisson error structure in GLMMs and gall volume was log transformed to meet assumptions of homogeneity of variance. (DF = 1 in all cases)

*Area**	Richness		Canopy cover		Tree height		Tree DBH	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Gall presence	0.91	0.340	0.02	0.889	1.89	0.169	2.35	0.125
Gall abundance	0.01	0.913	0.24	0.623	0.81	0.367	0.02	0.877
Gall volume	0.96	0.328	2.23	0.135	1.95	0.162	1.3	0.258

Canopy cover was reduced by plot thinning but thinning had no effect on any other variable (Table A2). As galls were more likely to occur and were more abundant in area 3 as compared to area 1, we performed further analysis to test whether effects of study area might interact with any of the other variables. However, as none of the interactions with area were found to be significant (Table A3), all subsequent analyses were performed with data pooled across thinned and unthinned plots and, across both study areas.

Appendix 4

Interactive effects of canopy cover and tree size on pineapple galls

We ran models to determine whether effects of canopy cover were dependent on changes in tree height or DBH finding that negative effects of canopy cover on gall presence and abundance are dependent on spruce tree size.

Table A4. Results from models testing the interactive effects of canopy cover and either tree height or diameter at breast height (DBH) on each gall response.

Canopy cover*	Height			DBH			
	χ^2	DF	p	χ^2	DF	p	
Gall presence	1.66	1	0.198	3.93	1	0.048	*
Gall abundance	0.16	1	0.690	5.95	1	0.015	*
Gall volume	1.01	1	0.315	2.11	1	0.147	

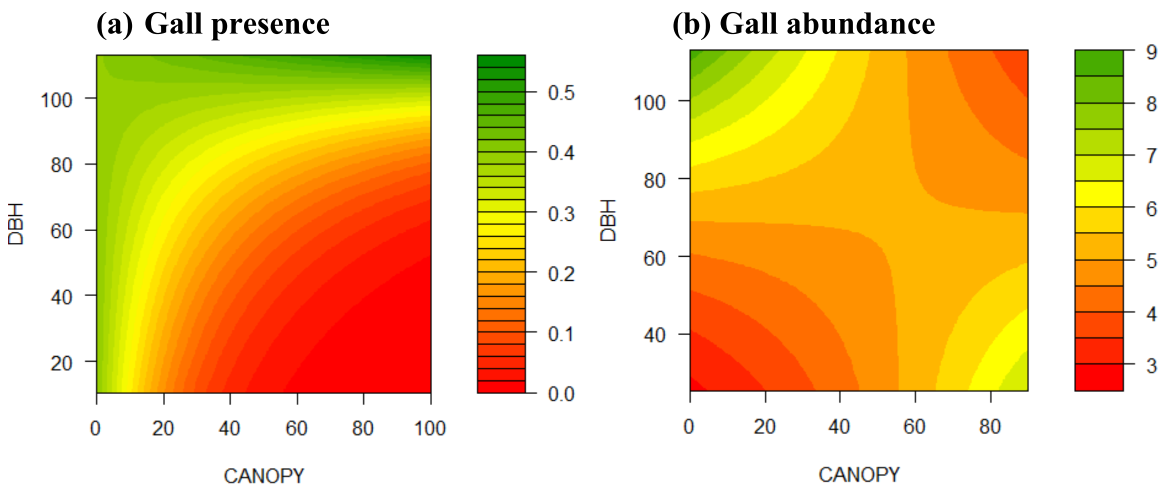

Figure A2. Interactive effects of canopy cover and tree size on (a) gall presence and (b) gall abundance. Colour scale represents the increased predicted proportion of galled trees (a) or increased number of galls per tree (b) along crossed gradients of canopy cover (CANOPY, %) and diameter at breast height (DBH, mm).

Appendix 5

The size of galled 'mother' shoots and ungalled 'neighbour' shoots

Spruce shoots infested with galls were consistently larger than ungalled shoots. Mother shoots averaged 181.8 mm (± 13.7) in length and 4.8 mm (± 0.3) in diameter while neighbouring ungalled shoots were 127.2 mm (± 9.2) long and 3.3 mm (± 0.2) in diameter. The size of galled shoots was positively related to that of neighbouring ungalled shoots (shoot length: $\chi^2 = 40.8$, DF = 1, $p < 0.001$; diameter: $\chi^2 = 46.1$, DF = 1, $p < 0.001$). In addition, as the height of trees increased, both galled and ungalled shoots decreased in size but tree DBH had no effect on shoot size (Table A5). Similarly, neither tree species nor canopy cover had any effect on shoot size (Table A5).

Table A5. Results from models examining the factors influencing the length and diameter of galled 'mother' and ungalled 'neighbour' shoots.

	Mother shoot				Neighbouring shoot			
Shoot length	χ^2	DF	p		χ^2	DF	p	
Tree species richness	2.00	1	0.158		0.24	1	0.624	
Tree height	3.30	1	0.069	.	7.13	1	0.008	**
Tree DBH	1.29	1	0.257		3.50	1	0.061	.
Canopy cover	0.00	1	0.951		0.10	1	0.755	
Shoot diameter								
Tree species richness	1.48	1	0.224		0	1	0.996	
Tree height	5.56	1	0.018	*	5.66	1	0.017	*
Tree DBH	2.80	1	0.094	.	2.58	1	0.108	
Canopy cover	1.19	1	0.276		1.19	1	0.276	