

Supplementary Material 2

# Inter-sexual differences in behaviour and resource use of specialist *Phengaris teleius* butterflies

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## 1. Butterfly Tracking Study

### 1.1. Average Flight Time

**Table S1.** Average time spent on flying recorded during the butterfly tracking study. Original model contained three explanatory variables: sex (females and males), locality (Selevenj and Ludaš) and mowing regime (mown and unmown meadow).

Parameter estimates	Estimate ± SE	Z value	P value
Intercept	2.307 ± 0.150	15.352	< <b>0.001</b>
Sex (male)	0.577 ± 0.194	2.979	<b>0.003</b>
Estimates of response	Rate ± SE		
Females	10.0 ± 1.5		
Males	17.9 ± 2.2		
Contrasts	Ratio ± SE	Z ratio	P value
Females / Males	0.561 ± 0.109	-2.979	<b>0.003</b>

Statistically significant *P* values are shown in bold. Variance of the individual variation (random effect) was  $0.636 \pm 0.798$  based on 330 observations of 65 individuals. Poisson mixed model was fitted using *lme4*, while estimates of response and contrasts are calculated in *emmeans* package in R. AIC of the model was 4844.5. Other supported models include the sex + locality (AIC = 4844.8) and sex \* locality (AIC = 4845.0).

### 1.2. Average Interaction Time

**Table S2.** Average time spent on interactions during the butterfly tracking study. Original model contained two explanatory variables: sex (females and males) and locality (Selevenj and Ludaš).

Parameter estimates	Estimate ± SE	Z value	P value
Intercept	2.252 ± 0.224	10.036	< <b>0.001</b>
Sex (male)	-0.780 ± 0.284	-2.743	<b>0.006</b>
Estimates of response	Rate ± SE		
Females	9.51 ± 2.14		
Males	4.36 ± 0.77		
Contrasts	Ratio ± SE	Z ratio	P value
Females / Males	2.18 ± 0.62	2.734	<b>0.006</b>

Statistically significant *P* values are shown in bold. Variance of the individual variation (random effect) was  $0.765 \pm 0.875$  based on 100 observations of 46 individuals. Poisson mixed model was fitted using *lme4*, while estimates of response and contrasts are calculated in *emmeans* package in R. AIC of the best model was 992.4 without support for more complex models.

**Table S3.** Average time spent on interactions during the butterfly tracking study. Original model included significant variables from Table S2 and an additional variable to differentiate interspecific (different species) and intraspecific (same species) interactions.

<b>Parameter estimates</b>	<b>Estimate <math>\pm</math> SE</b>	<b>Z vlaue</b>	<b>P value</b>
Intercept	0.582 $\pm$ 0.309	1.887	0.059
Interaction (intraspecific)	1.303 $\pm$ 0.285	4.577	<b>&lt; 0.001</b>
<b>Estimates of response</b>	<b>Rate <math>\pm</math> SE</b>		
Interspecific interactions	1.79 $\pm$ 0.55		
Intraspecific interactions	6.59 $\pm$ 1.12		
<b>Contrast</b>	<b>Ratio <math>\pm</math> SE</b>	<b>Z ratio</b>	<b>P value</b>
Interspecific interactions / Intraspecific interactions	0.272 $\pm$ 0.077	-4.577	<b>&lt; 0.001</b>

Statistically significant *P* values are shown in bold. Variance of the individual variation (random effect) was 0.960  $\pm$  0.980 based on 76 observations of 39 individuals. Poisson mixed model was fitted using *lme4*, while estimates of response and contrasts are calculated in *emmeans* package in R. AIC value for the model was 678.7.

**Table S4.** Comparison of average interspecific interaction times for individuals of the same sexes in contrast to individuals of different sexes.

<b>Parameter estimates</b>	<b>Estimate <math>\pm</math> SE</b>	<b>Z vlaue</b>	<b>P value</b>
Intercept	2.401 $\pm$ 0.202	11.859	<b>&lt; 0.001</b>
Same sex	-1.109 $\pm$ 0.198	-5.594	<b>&lt; 0.001</b>
<b>Estimates</b>	<b>Rate <math>\pm</math> SE</b>		
Different sex	11.03 $\pm$ 2.23		
Same sex	3.64 $\pm$ 0.78		
<b>Contrast</b>	<b>Ratio <math>\pm</math> SE</b>	<b>Z ratio</b>	<b>P value</b>
Different sex / Same sex	3.03 $\pm$ 0.60	5.594	<b>&lt; 0.001</b>

Statistically significant *P* values are shown in bold. Variance of the individual variation (random effect) was 0.944  $\pm$  0.972 based on 58 observations of 32 individuals. Poisson mixed model was fitted using *lme4*, while estimates of response and contrasts are calculated in *emmeans* package in R. AIC value for the model was 562.2.

### 1.3. Average Feeding Time

**Table S5.** Average time that *Phengaris teleius* butterflies spent on feeding during the tracking study. Original model contained three explanatory variables: plant (*Sanguisorba officinalis* and other Asteraceae plants), sex (females and males) and locality (Selevenj and Ludaš).

Parameter estimates	Estimate	Z value	P value
Intercept	2.904 ± 0.195	14.922	< <b>0.001</b>
Plant (Asteraceae)	1.466 ± 0.245	5.978	< <b>0.001</b>
Sex (male)	-0.382 ± 0.285	-1.338	0.181
Interaction term (Asteraceae × male)	-0.448 ± 0.226	-1.981	0.055

  

Estimates of response	Rate ± SE
Females on <i>S. officinalis</i>	18.2 ± 3.55
Females on Asteraceae plants	79.0 ± 21.14
Males on <i>S. officinalis</i>	12.5 ± 2.61
Males on Asteraceae plants	31.4 ± 6.59

  

Contrasts	Ratio ± SE	Z ratio	P value
Females on <i>S. officinalis</i> / Female on Asteraceae	0.231 ± 0.056	-5.978	< <b>0.001</b>
Females on <i>S. officinalis</i> / Males on <i>S. officinalis</i>	1.465 ± 0.418	1.338	0.538
Females on <i>S. officinalis</i> / Males on Asteraceae	0.581 ± 0.166	-1.906	0.226
Females on Asteraceae / Males on <i>S. officinalis</i>	6.346 ± 2.163	5.421	< <b>0.001</b>
Females on Asteraceae / Males on Asteraceae	2.516 ± 0.860	2.698	<b>0.035</b>
Males on <i>S. officinalis</i> / Males on Asteraceae	0.396 ± 0.054	-6.809	< <b>0.001</b>

Statistically significant *P* values are shown in bold. Variance of the individual variation (random effect) was 0.739 ± 0.859 based on 116 observation of 42 individuals. Poisson mixed model was fitted using *lme4*, while estimates of response and contrasts are calculated in *emmeans* package in R. AIC of the best model was 1661.8. Other supported models included plant \* locality + sex (AIC = 1663.4), plant + sex (AIC = 1663.6) and plant \* sex + locality (AIC = 1663.8).

#### 1.4. Average Resting Time

**Table S6.** Average time spent on resting during the tracking study. Original model contained two explanatory variables: sex (females and males) and locality (Selevenj and Ludaš).

Parameter estimates	Estimate $\pm$ SE	Z value	P value
Intercept	1.819 $\pm$ 0.435	4.196	< <b>0.001</b>
Sex (male)	-0.648 $\pm$ 0.680	-0.952	0.341
Locality (Selevenj)	-0.129 $\pm$ 0.513	-0.252	0.801
Interaction term (male $\times$ Selevenj)	1.482 $\pm$ 0.822	1.802	0.072
Estimates of response	Rate $\pm$ SE		
Females at Ludaš Lake	6.16 $\pm$ 2.67		
Females at Selevenj Sand	5.42 $\pm$ 1.49		
Males at Ludaš Lake	3.23 $\pm$ 1.69		
Males at Selevenj Sand	12.47 $\pm$ 4.63		
Contrasts	Ratio $\pm$ SE	Z ratio	P value
Females at Ludaš / Females at Selevenj	1.138 $\pm$ 0.584	0.252	0.994
Females at Ludaš / Males at Ludaš	1.911 $\pm$ 1.300	0.952	0.777
Females at Ludaš / Males at Selevenj	0.494 $\pm$ 0.282	-1.235	0.605
Females at Selevenj / Males at Ludaš	1.679 $\pm$ 0.995	0.875	0.818
Females at Selevenj / Males at Selevenj	0.434 $\pm$ 0.201	-1.804	0.271
Males at Ludaš / Males at Selevenj	0.259 $\pm$ 0.166	-2.104	0.152

Statistically significant *P* values are shown in bold. Variance of the individual variation (random effect) was  $1.192 \pm 1.092$  based on 111 observations of 38 individuals. Poisson mixed model was fitted using *lme4*, while estimates of response and contrasts are calculated in *emmeans* package in R. AIC of the selected model and model that included locality as a sole predictor was 1485.5. Other supported model include sex (AIC = 1485.8) and sex + locality (AIC = 1486.6).

## 2. Mark Release Recapture Study

### 2.1. Intersexual Differences in Plant Preferences

**Table S7.** Intersexual differences in feeding plants of *Phengaris teleius* grouped in three classes based on phylogeny and sample size.

Parameter estimates	Estimate $\pm$ SE	Z value	P value
Asteraceae	0.308 $\pm$ 0.219	1.404	0.160
Other plants	0.693 $\pm$ 0.327	2.118	<b>0.034</b>
<i>Sanguisorba officinalis</i>	-0.383 $\pm$ 0.117	-3.265	<b>0.001</b>
Estimates of response	Probability $\pm$ SE		
Asteraceae	0.576 $\pm$ 0.054		
Other plants	0.667 $\pm$ 0.073		
<i>Sanguisorba officinalis</i>	0.405 $\pm$ 0.028		
Contrasts	Odds ratio $\pm$ SE	Z ratio	P value
Asteraceae / Other plants	0.681 $\pm$ 0.268	-0.976	0.592
Asteraceae / <i>Sanguisorba officinalis</i>	1.997 $\pm$ 0.497	2.778	<b>0.015</b>
Other plants / <i>Sanguisorba officinalis</i>	2.934 $\pm$ 1.020	3.096	<b>0.006</b>

Statistically significant *P* values are shown in bold. GLM binomial model was fitted using R base function, while estimates of response and contrasts are calculated in *emmeans* package.

**Table S8.** Intersexual differences in resting plants of *Phengaris teleius* grouped in four classes based on phylogeny and sample size.

Coefficients	Estimate	Z value	P value
Asteraceae	0.257 $\pm$ 0.139	1.854	0.064
Other plants	0.069 $\pm$ 0.166	4.150	0.678
Poales	0.376 $\pm$ 0.121	3.121	<b>0.002</b>
<i>Sanguisorba officinalis</i>	-0.411 $\pm$ 0.086	-4.796	<b>&lt; 0.001</b>
Estimates	Probability estimate		
Asteraceae	0.564 $\pm$ 0.034		
Other plants	0.517 $\pm$ 0.041		
Poales	0.593 $\pm$ 0.029		
<i>Sanguisorba officinalis</i>	0.399 $\pm$ 0.021		
Contrasts	Odds ration	Z ratio	P value
Asteraceae / Other plants	1.207 $\pm$ 0.261	8.700	0.821
Asteraceae / Poales	0.888 $\pm$ 0.163	-6.470	0.917
Asteraceae / <i>Sanguisorba officinalis</i>	1.952 $\pm$ 0.318	4.098	<b>&lt; 0.001</b>
Other plants / Poales	0.735 $\pm$ 0.151	-1.497	0.439
Other plants / <i>Sanguisorba officinalis</i>	1.617 $\pm$ 0.302	2.568	<b>0.050</b>
Poales / <i>Sanguisorba officinalis</i>	2.198 $\pm$ 0.325	5.323	<b>&lt; 0.001</b>

Statistically significant *P* values are shown in bold. GLM binomial model was fitted using R base function, while estimates of response and contrasts are calculated in *emmeans* package.

### 3. Overview of the Plant Usage

**Table S9.** The list of plant species and other objects used by *Phengaris teleius* butterflies for feeding and resting, with percentages of their use shown.

Plant/object	Mark-release-recapture				Butterfly tracking study			
	Females		Males		Females		Males	
	Feed (%)	Rest (%)	Feed (%)	Rest (%)	Feed (%)	Rest (%)	Feed (%)	Rest (%)
<i>Sanguisorba officinalis</i>	77.83	53.90	61.31	36.78	90.11	70.43	43.66	40.48
<i>Serratula tinctoria</i>	14.78	7.95	18.59	11.00	8.79	11.30	43.66	52.38
<i>Epilobium</i> sp.	3.39	0.48	3.52	2.30				
<i>Knautia integrifolia</i>	0.43		4.02	0.33				
<i>Centaurea jacea</i>	0.43	4.61	2.51	6.08		3.48	12.68	
<i>Stenactis annua</i>	0.43	0.79	2.51	0.66				
<i>Viccia cracca</i>	0.43	0.16	2.01	0.16				
<i>Trifolium pratensis</i>			1.51	0.16				
Fabaceae	0.43		0.50					
<i>Campanula glomerata</i>	0.43		0.50					
<i>Achillea asplenifolia</i>		0.64	1.01	1.31	1.10			4.76
<i>Plantago maritima</i>	0.43	1.91	0.50	2.46		2.61		
<i>Plantago lanceolata</i>			0.50					
<i>Stachis palustris</i>			0.50					
<i>Lathyrus tuberosus</i>			0.50					
Snail shell	0.43	1.59		3.28				
<i>Lotus corniculatus</i>								
Poaceae		8.43		13.63		5.22		2.38
<i>Mollinia</i> sp.		7.15		10.67				
<i>Festuca ovina</i>								
<i>Phragmites communis</i>		1.27		1.15				
<i>Carex</i> sp.		0.16		0.16		0.87		
<i>Genista tinctoria</i>		0.16		0.33				
<i>Galium verum</i>		3.18		3.12				
<i>Equisetum</i> sp.		2.07		1.64		0.87		
<i>Holoschoenus vulgaris</i>		1.27		1.15				
<i>Silene vulgaris</i>		0.64		0.49				
<i>Ononis spinosa</i>		1.75		0.66		0.87		
<i>Linum perenne/austriacum</i>		0.16						
<i>Cirsium canum</i>				0.16				
<i>Prunella officinalis</i>				0.33				
Other Compositae		0.32						
<i>Cichorium intybus</i>		0.32				2.61		
<i>Salvia</i> sp.		0.16						
Apiaceae		0.16		0.33				
<i>Lepidium cartilagineum</i>								
<i>Medicago sativa</i>								
Dry plant organs		0.64		0.81		1.74		
<i>Sanguisorba officinalis</i> leaf		0.16		0.33				