How gender affects the relationship between body length and wing area in Tephritis conura flies

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Introduction:

The study aims to investigate the relationship between body length, wing area and gender in Tephritis conura flies (Figure 1). The R code used for this analysis is publicly available here.

Figure 1: Tephritis conura

The dataset used in this study consists of measurements taken from Tephritis conura flies collected in northern Europe.

The dataset includes the following variables:

- **Patry**: Denotes whether an individual is from a sympatric or allopatric population.
- **Hostplant**: Indicates whether the individual is a specialist in C. heterophyllum or C. oleraceum.
- **Sex**: Specifies the sex of the individual.
- **Body Length**: Measurements of body length in millimeters.
- **Ovipositor Length**: Measurements of ovipositor length in millimeters.
- **Wing length**: Measurements of wing length in millimeters.
- **Wing width**: Measurements of wing width in millimeters.
- **Wing area**: The product of wing length and wing width, providing an estimation of wing area.
- **Melanized area**: Area of the wing that is melanized, measured with an automated script.
- **Melanized ratio**: The ratio of dark to white area of the wing, measured with an automated script.
- **Baltic**: Specifies whether the population of the individual is East or West of the Baltic Sea.

Analysis

To begin the analysis, a correlation scatter plot with accompanying histograms was generated to inspect potential correlations between variables and assess their distribution for normality.

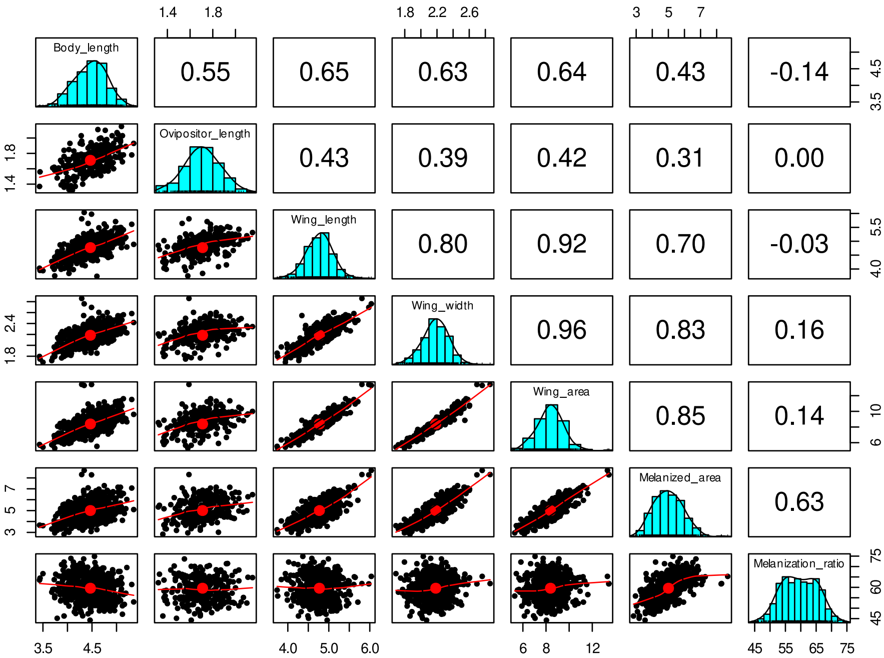

Figure 2: Correlation scatter plots and predictors histograms

In Figure 2, a pronounced positive correlation is depicted among wing length, wing width, and wing area. This correlation is anticipated as all these measures are associated with the same anatomical feature. All variables demonstrate a normal distribution, except for the melanization ratio, which exhibits a bimodal distribution.

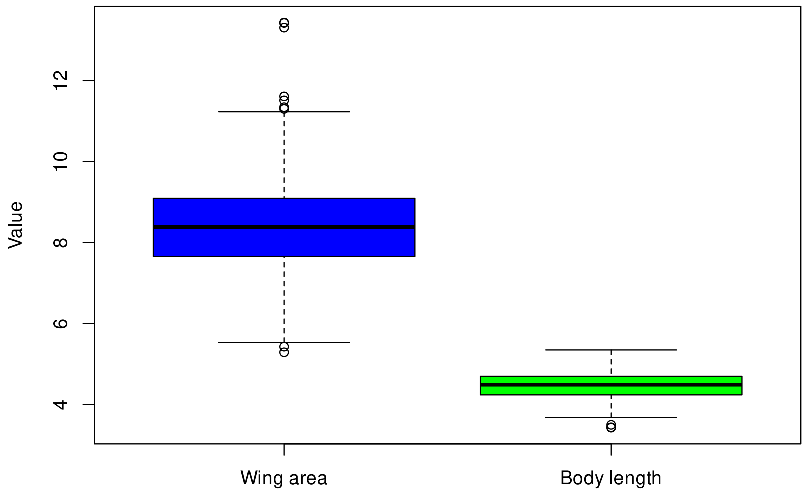

Figure 3: Box plots of wing area and body length

As the primary objective of this study is to explore the impact of sex on the linear relationship between body length and wing area, Figure 3 presents a box plot depicting the distribution of these two variables. Notably, outliers are observed in both body length and wing area, with some prominent outliers in the wing area. Despite the presence of outliers, they have been retained in the dataset as their influence on the results is deemed negligible.

Linear Model and ANCOVA

The following analysis of covariance (ANCOVA) linear model was used:

```
lm(Wing_area ~ -1 + Sex + Body_length_diff : Sex, data = data)
```

The model have very good statistical support with a R^2 of 0.99, Table 1 show the intercept and slope for both sexes.

Table 1: Intercepts and slopes of the female and male regression lines

Regression lines parameters

Sex	Intercept	Slope
Female	8.64	2.37
Male	8.11	1.96

Figure 4 shows the regression lines of the sexes highlighted with the same color as the individuals, the intercepts found by the model are the average wing areas for the two groups mean body length.

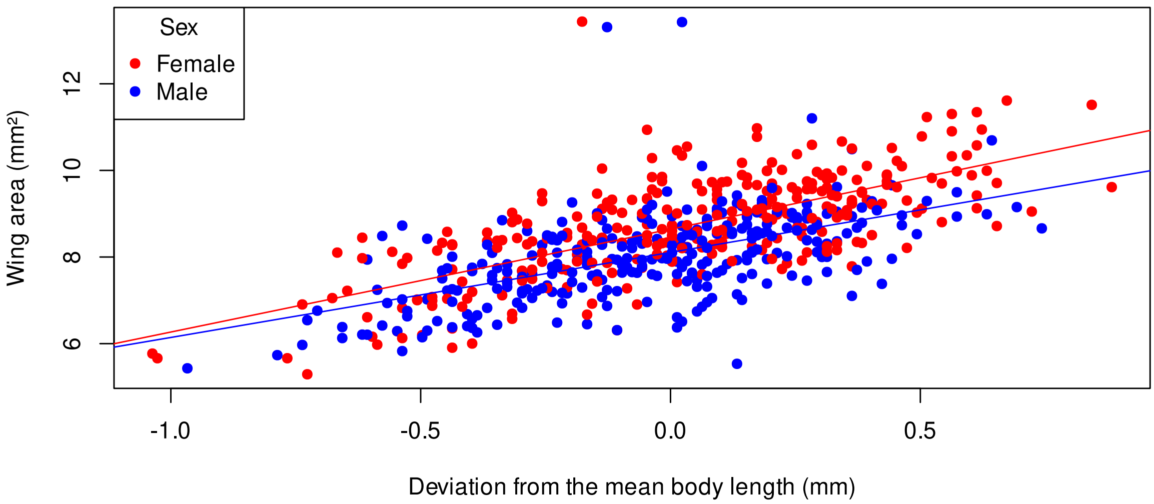

Figure 4: Ancova linear model

Results

As shown in Table 2, there are significant differences between sexes.

Table 2: Minimums, means and maximum of males, females and both for body length and wing area

Mins, means and maxes

Variable	Group	Min	Mean	Max
Body lenth	Global	3.68	4.47	5.35
	Female	-	4.51	-
	Male	-	4.42	-
Wing area	Global	5.53	8.39	11.2
	Female	-	8.75	-
	Male	-	8.02	-

The average difference in body size and wing area between females and males are respectively 0.09 mm and 0.73 mm^2. For a male an increase of 0.5 mm in body length corresponds to an increase in wing area of 0.98 mm^2 while for females the increase in wing area is 1.19 mm^2. This corresponds to a 21% bigger increase for the females.

Conclusion

The model provides a well-fitted representation of the relationship between wing area and the interaction between body length and sex in Tephritis conura flies. The coefficients highlight distinct intercepts for females and males, emphasizing the influence of both sex and body length difference on wing area. The interaction terms underscore the differential impact of body length on wing area between females and males.