**Lab 8**

We will continue using the extrafloral nectary (EFN) example. 22 total points.

**Research question:** Do foliar and floral EFNs differ in sugar calorie content?

Sugar calorie content is the “Sugar” variable in the EFN dataset

1. What is the mixed model specification to answer this research question (2 pts)?

m1<-lmer(Sugar~EFNtype + (1|Plant), data=EFN)

1. Why do we include “Plant” as a random effect (2 pts)?

Due to the uneven sampling and the fact that the sampled plants are unique form each other that effect is not directly quantified in our study and thus cannot be a fixed effect, but could still have significant impact on our results (still confused about this)

1. Graphical user interface, application

   Description automatically generatedUse check\_model() to check model assumptions. Include the figure output (2pts). What is your assessment of model assumptions (2 pts)?

The residuals are not very linear but there might be an even distribution above and below. Also the underlying distribution does not seem to be normal but follows the general trend. Assumptions can be met.

1. Use summary() and Anova() to assess the model-fitting and hypothesis testing results. Include the output below (4 pts). How much variance is explained by the random effect? (2 pts)

405.4 is the estimated variance due to the random effect. What this means is that a lot of the effect of plant ID is accounted for by our model.

Linear mixed model fit by REML. t-tests use Satterthwaite's method [lmerModLmerTest]

Formula: Sugar ~ EFNtype + (1 | Plant)

Data: EFN

REML criterion at convergence: 260

Scaled residuals:

Min 1Q Median 3Q Max

-1.55267 -0.50897 0.00453 0.60134 1.08541

Random effects:

Groups Name Variance Std.Dev.

Plant (Intercept) 405.4 20.13

Residual 237.5 15.41

Number of obs: 30, groups: Plant, 19

Fixed effects:

Estimate Std. Error df t value Pr(>|t|)

(Intercept) 36.220 6.863 26.041 5.278 1.61e-05 \*\*\*

EFNtypeFoliar -24.159 7.080 18.821 -3.412 0.00295 \*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:

(Intr)

EFNtypeFolr -0.595

> Anova(m1)

Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Sugar

Chisq Df Pr(>Chisq)

EFNtype 11.642 1 0.0006448 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

1. Write the results sentence(s) for the analyses conducted in #4. Make sure to include the direction of the effect and effect size, as well as any appropriate statistics. (4 pts)

The production of sugar content differed significantly between foliar and floral nectories (X2= 11.62, df = 1, P = 0.0006448). Across samples, floral nectaries (x̄ = 36.22 calories) had higher mean calorie content that that of extra floral nectaries (EFN) (x̄ = 12.061 calories).

1. Write the analysis methods section for this analysis. Make sure you mention the packages and functions used, as well as how the fixed and random effects are specified in your model. (4 pts)

Foliar and floral extrafloral nectaries (EFN) were analyzed for nectar calories content using a linear mixed model with EFN type as a fixed effect and plant as a random effect (function lmer() in the lme4 package, Bates et al. 2015). An analysis of deviance using Type II Wald chisquare tests was also performed (function Anova() in the car package, Weisberg S 2019).

Bonus points (2 pts): For the study that you analyzed last week, write the model specification for their analysis in lmer() syntax. Briefly describe it verbally as well.