

Supplementary Material S2. Dispersion and zero-inflation in cones distribution

Cone production are count data (e.g. Poisson distribution), but often characterized by overdispersion (e.g. an excess of variability) and zero-inflation (e.g. an excess of zeros) [19]. To test the dispersion and zero-inflation of cone production, we fitted GLMM with a Poisson link function, including clone, year and their interaction as random effects, with the package glmmTMB [40]. Package DHARMA [41] use simulated residuals to test the models residuals for dispersion and zero inflation (the functions testDispersion and testZeroInflation). Additionally, we tested zero-inflation also with the function check_zeroinflation of the package performance [42], which evaluate the model over-/underfitting by the amount of observed and predicted zeros: if the first is larger than the later, this is an indication of zero-inflation in the data, as that the current model underfit zeros. Must be noted that in comparison with the dispersion tests or information criteria metrics, simulation is a recommended testing approach [43].

The results suggested no overdispersion in the fitted GLMM, but zero-inflation in data.

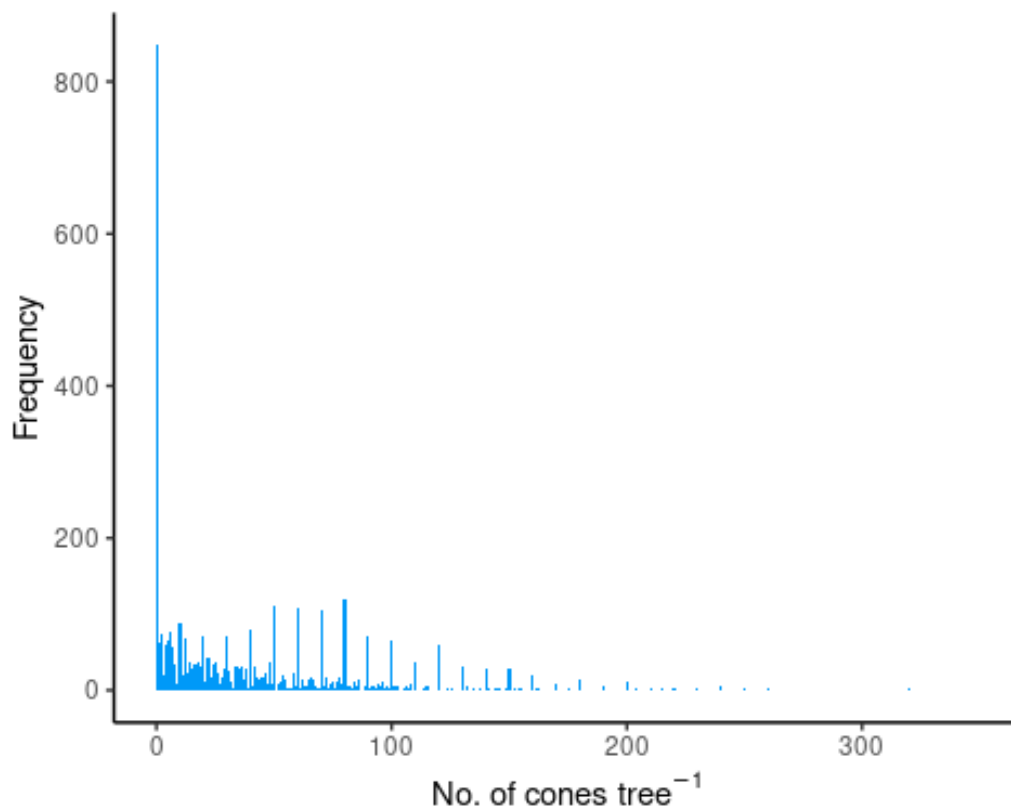


Figure S2.1: Histogram of cones, pooled data. Histogram binwidth = 1.

```
# Packages used
library(glmTMB) # fitting the models
library(DHARMA) # dispersion/zero-inflation tests
library(performance) # zero-inflation

# Fitting the model
p <- glmTMB(Cones ~ (1|Clone) + (1|Year) + (1|Clone:Year), data, family =
poisson)
# Scaled residuals by simulating from the fitted model
simulationOutput <- simulateResiduals(p, n = 1000)
# Testing dispersion
testD <- testDispersion(simulationOutput)
```

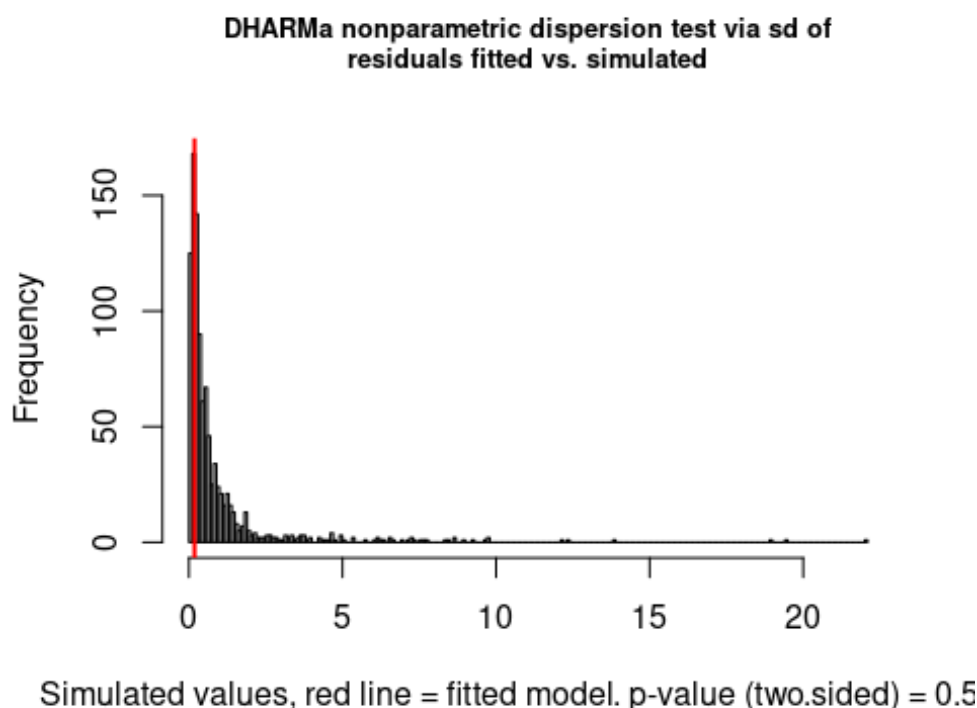


Figure S2.2: Dispersion test

```
# Testing zero-inflation with the package DHARMA
testZI <- testZeroInflation(simulationOutput)
```

**DHARMA zero-inflation test via comparison to
expected zeros with simulation under H0 = fitted
model**

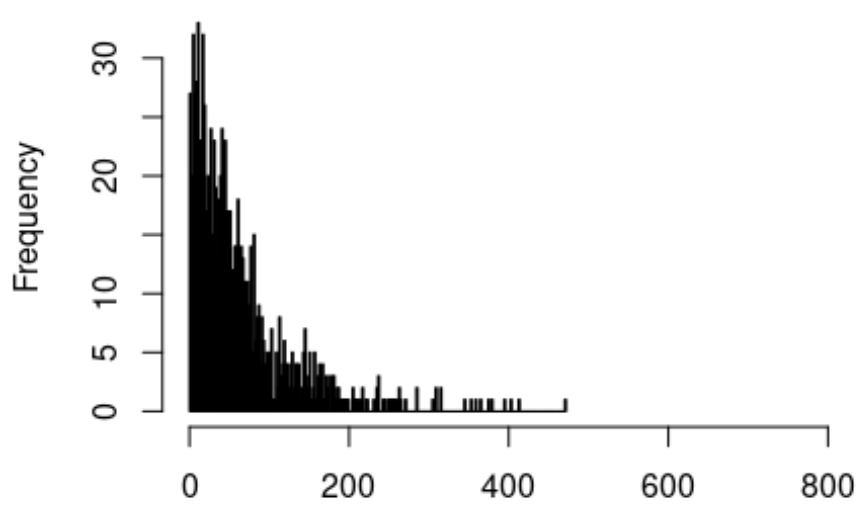


Figure S2. 3: Zero-inflation test

```
# Testing zero-inflation with the package performance  
check_zeroinflation(p)  
  
# Check for zero-inflation  
  
  Observed zeros: 848  
 Predicted zeros: 45  
    Ratio: 0.05
```

References

19. Martin, T.G.; Wintle, B.A.; Rhodes, J.R.; Kuhnert, P.M.; Field, S.A.; Low-Choy, S.J.; Tyre, A.J.; Possingham, H.P. Zero Tolerance Ecology: Improving Ecological Inference by Modelling the Source of Zero Observations: Modelling Excess Zeros in Ecology. *Ecol. Lett.* **2005**, *8*, 1235–1246. <https://doi.org/10.1111/j.1461-0248.2005.00826.x>.
40. Brooks, M.E.; Kristensen, K.; van Benthem, K.J.; Magnusson, A.; Berg, C.W.; Nielsen, A.; Skaug, H.J.; Mächler, M.; Bolker, B.M. glmmTMB Balances Speed and Flexibility Among Packages for Zero-inflated Generalized Linear Mixed Modeling. *R J.* **2017**, *9*, 378–400. <https://doi.org/10.32614/RJ-2017-066>.
41. Hartig, F. DHARMA: Residual Diagnostics for Hierarchical (Multi-Level/Mixed) Regression Models. R package version 0.4.6: **2022**. Available online: <http://florianhartig.github.io/DHARMA/>. Accessed 22/07/2022.
42. Lüdtke, D.; Ben-Shachar, M.S.; Patil, I.; Waggoner, P.; Makowski, D. performance: An R Package for Assessment, Comparison and Testing of Statistical Models. *J. Open Source Softw.* **2021**, *6*, 3139. <https://doi.org/10.21105/joss.03139>.
43. Campbell, H. The Consequences of Checking for Zero-inflation and Overdispersion in the Analysis of Count Data. *Methods Ecol. Evol.* **2021**, *12*, 665–680. <https://doi.org/10.1111/2041-210X.13559>.