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| **A close up of a logo  Description automatically generated**  **UNIVERSITY OF TORONTO MISSISSAUGA**  **TERM TEST 3**  **BIO360H5, Fall 2022**  **Helene Wagner**  **Duration – 100 min**  **Aids: Non-Programmable Calculator, Crib Sheet (3 sheets, double sided)**  *The University of Toronto Mississauga and you, as a student, share a commitment to academic integrity. You are reminded that you may be charged with an academic offence for possessing any unauthorized aids during the writing of an exam, including but not limited to any electronic devices with storage, such as cell phones, pagers, personal digital assistants (PDAs), iPods, and MP3 players. Unauthorized calculators and notes are also not permitted. Do not have any of these items in your possession in the area of your desk. Please turn the electronics off and put all unauthorized aids with your belongings at the front of the room before the examination begins. If any of these items are kept with you during the writing of your exam, you may be charged with an academic offence. A typical penalty may cause you to fail the course.*  *Please note, you* ***CANNOT*** *petition to* ***re-write*** *an examination once the exam has begun.* |

**TEST QUESTIONS**

1. This exam contains 18 problems with a total of **39 questions on pages 2 - 9**.

2.Pages 11 – 17 contain the description of a case study with three parts.

3. There is additional space for notes on pages 10 and 18.

4. Question point values add to a total of 50 points:

- Matching questions are worth 1 point each (28 points)

- Multiple choice questions are worth 2 points each (22 points).

5. Choose the single best answer for each question.

6. No marks are deducted for incorrect answers, so answer all questions.

7. Transfer all of your answers to the Scantron computer sheet. No answers on the test paper will be marked.

8. You must hand in both your Scantron computer sheet AND your test paper.

9. No questions will be answered during the test.

**SCANTRON computer sheet**

1. Follow the instructions on the sheet.

2. Use PENCIL and erase any changes completely.

3. Bubble your Form (A or B).

4. Write your student number in the boxes and bubble in the numbers in the correct columns.

5. Write your name, date, and course in the upper right in the spaces provided.

6. Do NOT write anything along the top or side of the Scantron sheet.

7. For each question bubble your answer during the time allowed.

**REFER TO CASE STUDY**

**Study Design**

Familiarize yourself with the topic (page 11), then refer to the case study description on pages 12 - 13 to answer the questions in this section.

**Topic: Study design**

*2 marks* **1 Multiple choice:** What type of study was this? Select one answer and enter it under question 1 of the Scantron form.

(A) Laboratory experiment.

(B) Field experiment.

(C) Cohort study.

(D) Case-control study.

(E) Cross-sectional study.

*2 marks* **2 Multiple choice:** Genetic differences between maternal plants are a potential confounding variable. How did the researchers account for it in the study design? Select one answer and enter it under question 2 of the Scantron form.

(A) Control.

(B) Blocking.

(C) Stratification.

(D) Blinding.

*2 marks* **3 Multiple choice:** What was the level of replication in this study as it was planned? Select one answer and enter it under question 3 of the Scantron form.

(A) 3.

(B) 6.

(C) 12.

(D) 72.

*2 marks* **4 Multiple choice:** If we compared larvae raised on outbred plants from maternal family B1 to larvae raised on inbred plants from the same maternal family, will this result in paired data? Select one answer and enter it under question 4 of the Scantron form.

(A) Yes, because the sample size is the same for each breeding type.

(B) Yes, because the plants are from the same maternal plant family.

(C) No, because the inbred and outbred plants are not the same.

(D) No, because each larva is observed for only one breeding type.

**Topic: Categorical Data Analysis**

In Box 1 (quoted from Portmann et al. 2015), the researchers described in detail how many individuals were lost due to different reasons. Compare their account to the table of valid sample sizes in Fig. 3.

**Box 1: a) For the assessment of flight capacity in adult moths (Part 2):**"The number of adults available for the flight metabolism assay was significantly reduced because 9 pupae died, 3 adults eclosed with deformed wings, 3 more damaged their wings trying to escape confinement and 1 adult died prematurely. Moths with deformed or damaged wings were excluded from subsequent flight assays."

**b) For the molecular-level study (Part 3):**   
"RNA isolations for five inbred fed individuals failed, and the reactions were not repeated because the muscle tissue samples had degraded after freeze-thawing."

*Note: "eclosed" refers to the emergence of adult moths from pupae.*

**Matching:** Refer to Box 1 and Fig. 3. For each of the statements listed below, indicate whether it is true (A) or false (B). Use questions 5 – 8 on the Scantron form, one question per statement.

*1 mark* **5** The loss of valid samples from "Larvae" to "Adults" is consistent with Box 1a.

*1 mark* **6** The loss of valid samples from "Adults" to "Molecular" is consistent with Box 1b.

*1 mark* **7** The study design, as it was planned originally, was balanced.

*1 mark* **8** The study design, based on valid sample sizes for adult moths, is balanced.

*2 marks* **9 Multiple choice:** Use the information in Fig. 3 to calculate the odds ratio for the loss of inbred-fed individuals, from larvae to adults, compared to outbred-fed individuals. What is the correct value of the odds ratio? Select one answer and enter it under question 9 of the Scantron form.

(A) 0.4.

(B) 0.67.

(C) 1.5.

(D) 2.5.

**Matching:** Refer to the previous example. For each of the statements listed below, indicate whether it is true (A) or false (B). Use questions 10 – 13 on the Scantron form, one question per statement.

*1 mark* **10** The hazard ratio may be calculated and interpreted for these data.

*1 mark* **11** For these data, the odds ratio will provide a good approximation of the hazard ratio.

*1 mark* **12** The mortality data suggest that outbred plants may be higher quality host plants.

*1 mark* **13** Differences in mortality rates between groups could introduce bias.

**Part 1: Growth Differences**

Refer to pages 14 - 15 to answer the questions in this section. On average, the larvae reared on inbred plants grew faster. This difference translated to the adult stage, where inbred-fed moths had a larger body mass, on average, than outbred-fed moths. Inbred-fed moths also had higher flight muscle mass, on average. Can this difference in flight muscle mass be explained by the difference in body mass alone?

**Topic: Regression Models**

**Matching:** Refer to Fig. 4 and the description of three regression models, A - D, in the table below. Note that the axis does not start at 0. For each of the data (sub)sets listed below, indicate the corresponding model (A, B, C or D). Use questions 14 – 17 on the Scantron form, one question per statement.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Model | Intercept | Slope | P-value for slope | R2 |
| Model A | 0.274 | 0.060 | 0.099 | 0.070 |
| Model B | 0.249 | 0.101 | 0.227 | 0.085 |
| Model C | 0.180 | 0.108 | 0.017 | 0.264 |
| Model D | 0.318 | 0.030 | 0.409 | 0.019 |

*1 mark* **14** Female adult moths.

*1 mark* **15** Male adult moths.

*1 mark* **16** All adult moths (not considering whether they are male or female).

*1 mark* **17** All adult moths, but excluding the two points labeled "P1" and "P2".

**Topic: Influential Points**

**Matching:** Refer to Fig. 4 and the summary statistics in Fig. 5. Consider the two data points labeled "P1" (a male moth) and "P2" (a female moth) in Fig. 4, and their respective regression models (blue line for point P1, red line for point P2). For each of the statements listed below, indicate whether it is true (A) or false (B). Use questions 18 – 21 on the Scantron form, one question per statement.

*1 mark* **18** Point P1 has a larger predicted value than point P2.

*1 mark* **19** Point P2 has a larger squared residual than point P2.

*1 mark* **20** If point P1 was excluded, the *R*2 of the corresponding model would increase.

*1 mark* **21** If point P1 was excluded, the slope of the corresponding model would increase.

**Topic: Residual Analysis**

The researchers fitted a multiple regression model that combines the effects of two predictors, moth body mass and gender, on thorax mass (response). Box 2 shows how they described the regression results in the published paper. They did not comment on residual analysis, hence your instructor re-analyzed the data in R to check the residuals.

**Box 2: "**Thorax mass (which correlates closely with flight muscle mass [...]) varied with body mass (*P* = 0.006) and gender (*P* = 0.01), but did not show independent effects of plant breeding type or maternal family ([...] *P* = 0.009, *R*2 = 0.23), suggesting that larval diet had no significant effects on flight muscle mass outside of the effects on overall body size."

*Notes: "P" refers to a p-value, with separate p-values shown for the two predictors included in the final model (body mass and gender). The R2 value refers to the combined effect of the two predictors. Plant breeding type and maternal family were not included in the final model.*

*2 marks* **22 Multiple choice:** Refer to Box 2 and the residual plots in Fig. 6. What is the appropriate interpretation of these regression results? Select one answer and enter it under question 22 of the Scantron form.

(A) Both predictors were statistically significant, and their joint effect was large enough to be practically relevant.

(B) Both predictors were statistically significant, but their joint effect was too small to be practically relevant.

(C) The predictors were not statistically significant, but there may be a considerable risk of a type II error, more data are needed to be sure.

(D) The predictors were not statistically significant, and there was no indication that an important effect may have been missed.

(E) The model should not be interpreted, it is not valid because at least one condition has been violated.

**Matching:** Refer to Figures 6 and 7. Your instructor fitted a new, more complex model. Compare the residual plot of the new model (Fig. 7) with the residual plot of the model reported by the researchers (Fig. 6). For each of the statements listed below, indicate whether it is true (A) or false (B). Use questions 23 – 26 on the Scantron form, one question per statement.

*1 mark* **23** The model in Fig. 7 fits better in terms of the normality of the residuals.

*1 mark* **24** The model in Fig. 7 fits better in terms of the thickening of the plot.

*1 mark* **25** The model in Fig. 6 fits better in terms of the relationship being linear.

*1 mark* **26** The model in Fig. 6 fits better in terms of influential points.

**Part 2: Flight Capacity**

Refer to page 16 to answer the questions in this section. When they analyzed the data on flight capacity, the researchers found that those moths who, as larvae, had been reared on plants from maternal family B1 had a low flight capacity. This suggested that this plant family provided a low quality diet for *M. sexta* larvae, no matter whether they were inbred-fed or outbred-fed. The researchers worried that this might create bias in their data, hence they reported the results with and without the moths reared on plants from the B1 maternal family. Box 3 quotes the figure caption from the published paper, the corresponding figure is shown in Fig. 8.

**Box 3:** "Peak flight metabolic rate in relation to adult body mass during 5 mins of flight. Open circles and dashed lines represent moths reared on inbred horsenettle plants; solid markers and lines show moths reared on outbred plants. Plot in panel A includes all 3 maternal plant families (inbred: *R*2 = 0.50, *P* < 0.0001, *N* = 24; outbred: *R*2 = 0.12, *P* = 0.19, *N* = 16). Family B1, which produced moths with uniformly low metabolic rates [...], is excluded in panel B (inbred: *R*2 = 0.32, *P* = 0.02, *N* = 16; outbred: *R*2 = 0.08, *P* = 0.39, *N* = 12)."

**Topic: Regression Interpretation**

**Matching:** Refer to Box 3 and Fig. 8. How did excluding those moths reared on plants from the B1 maternal family affect the regression results for inbred-fed moths? For each of the statements listed below, indicate whether it is true (A) or false (B). Use questions 27 – 30 on the Scantron form, one question per statement.

*1 mark* **27** Dropping B1 increased the intercept for inbred-fed moths.

*1 mark* **28** Dropping B1 increased the slope for inbred-fed moths.

*1 mark* **29** Dropping B1 increased the effect size for inbred-fed moths.

*1 mark* **30** Dropping B1 increased the p-value for inbred-fed moths.

*2 marks* **31 Multiple choice:** Refer to Box 3 and Fig. 8. Assume that all assumptions and conditions were met. What is the most appropriate biological interpretation of these results? Select the best answer and enter it under question 31 of the Scantron form.

(A) Flight capacity (Peak metabolic rate) significantly increased with adult body mass, both for inbred-fed moths and for outbred-fed moths.

(B) Flight capacity (Peak metabolic rate) significantly increased with adult body mass for inbred-fed moths but not for outbred-fed moths.

(C) Neither inbred-fed not outbred-fed moths showed a significant increase of flight capacity (Peak metabolic rate) with adult body mass.

(D) The overall conclusion of the statistical hypothesis tests depended on whether or not the moths raised on plants from the B1 family were excluded.

**Part 3: Molecular Basis**

Refer to pages 16 - 17 to answer the questions in this section. The quality of the larval diet may affect flight capacity at a molecular level. The researchers found that differences in flight capacity of adult moths correlated with the relative abundance of troponin t isoform E (*Tnt E*) in the flight muscle.

**Topic: Hypothesis Testing**

*2 marks* **32 Multiple choice:** Refer to Fig. 9. Which test would be most appropriate to compare the response variable *ArcSinTntE* between **male moths** that as larvae were reared on inbred (*M\_s*) or outbred (*M\_x*) plants? Select the best answer and enter it under question 32 of the Scantron form.

(A) Wilcoxon rank sum test.

(B) Sign test.

(C) A *t*-test assuming unequal variances (two-sample *t*-test as taught in this course).

(D) A pooled *t*-test assuming equal variances (equivalent to ANOVA with two groups).

We learned that different statistical tests are variations on a common theme. Follow the instructions below to perform a one-sided Wilcoxon rank sum test to test whether among the adult male moths that, as larvae, were raised on plants from maternal families B3 or B4, the median *ArcSinTntE* value is lower for the inbred-fed group (s) than for outbred-fed group (x). The data are shown in Fig. 10.

1. Rank the values of the response variable from the smallest to the largest.
2. For the smaller group (here: s), calculate the sum of the ranks. This will be your test statistic.
3. Compare the test statistic to the critical value for the Wilcoxon test. For the given sample sizes (s: n = 4, x: n = 6), the critical value for a one-sided test, with alternative "less" and significance level alpha = 0.05, is 14.
4. If the test statistic is as small or smaller than the critical value, then the p-value will be smaller than alpha.
5. If the test statistic is larger than the critical value, the p-value will be larger than alpha.

*2 marks* **33 Multiple choice:** After performing the Wilcoxon rank sum test as described above, what can you say about the p-value of this test? Select the best answer and enter it under question 33 of the Scantron form.

(A) The p-value will likely be much smaller than 0.05.

(B) The p-value will likely be smaller than 0.05, but not by much.

(C) The p-value will likely be larger than 0.05, but not by much.

(D) The p-value will likely be much larger than 0.05.

**Topic: Bonferroni Correction**

The researchers quantified the relative amounts of six different Tnt isoforms (A - E) in the flight muscle sample from each adult moth. They performed a separate ANOVA analysis for each isoform, for a total of six ANOVA models. Each model included two predictors, breeding type and moth gender. They only found a significant effect of breeding type for isoform E. Box 4 quotes how the researchers reported these results.

**Box 4:** "The relative abundance of isoform E was 25.8% lower in inbred fed moths (ANOVA *P* = 0.011, *R*2 = 0.23 breeding type *P* = 0.049; gender *P* = 0.008; Table 1), but no independent significant differences in relative abundances were found for the other 5 Tnt isoforms [...]."

*Notes: "P" refers to a p-value, with separate p-values shown for the overall F-test and for the two predictors breeding type and gender. The R2 value (= eta squared) refers to the combined effect of the two predictors on the response variable ArcSinTntE.*

*2 marks* **34 Multiple choice:** A reviewer for the journal might have requested that the researchers use a Bonferroni correction to account for the number of tests performed on these Tnt data. Refer to Box 4 and apply a Bonferroni correction (with *k* = 6) to the statistical results reported for isoform E. How would the Bonferroni correction affect the interpretation of the hypothesis tests? Select the best answer and enter it under question 34 of the Scantron form.

(A) The effect of breeding type would be significant, but the effect of gender would not be statistically significant.

(B) The effect of gender would be significant, but the effect of breeding type would not be statistically significant.

(C) Both the effect of breeding type and the effect of gender would be statistically significant.

(D) Neither the effect of breeding type nor the effect of gender would be statistically significant.

**Topic: One-way ANOVA**

As we have not yet learned how to perform ANOVA with two predictors, your instructor re-analyzed the data using a one-way ANOVA with the four groups shown in Fig. 9, where each group represents a combination of gender and breeding type. The R output is shown in Fig. 11.

*2 marks* **35 Multiple choice:** Refer to Fig. 9. Are the assumptions and conditions for performing an ANOVA on these data met? Select the best answer and enter it under question 35 of the Scantron form.

(A) Yes, there is no major issue with the data.

(B) No, because the equal means assumption is not met.

(C) No, because the equal variances assumption is not met.

(D) No, because the data are not independent, they are paired.

**Matching:** Refer to the R output in Fig. 11. Assume that all assumptions and conditions for this ANOVA have been met. For each of the statements listed below, indicate whether it is true (A) or false (B). Use questions 36 – 39 on the Scantron form, one question per statement.

*1 mark* **36** Based on the data analyzed, the design was balanced.

*1 mark* **37** The null hypothesis that all means are the same should be rejected.

*1 mark* **38** Overall, the effect size was medium.

*1 mark* **39** None of the pairwise comparisons was statistically significant.

*Total marks = 50*

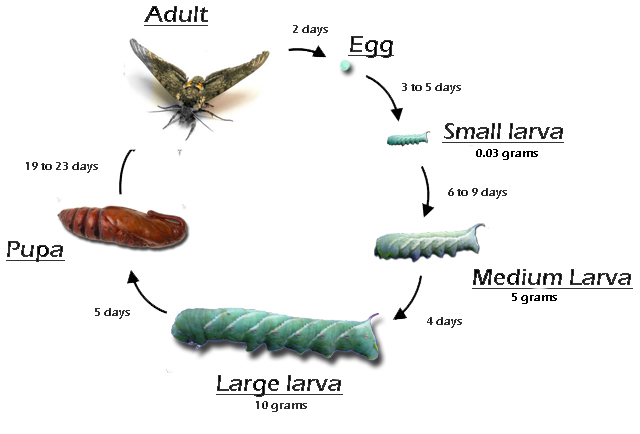
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**Case study: Plant Inbreeding Increases Insect Flight Capacity**

"You are what you eat" - in the case of the tobacco hornworm (*Manduca sexta*), researchers studied whether small differences in the quality of the host plants, on which the larvae (caterpillars) were reared, affect the flight capacity of adult moths.

Earlier research found that inbreeding reduces the ability of the Carolina horsenettle plant (*Solanum carolinense*) to defend itself against herbivores and pathogens, and that tobacco hornworm caterpillars prefer to feed on inbred plants compared to outbred plants.

Portman et al. (2017) found that caterpillars that ate inbred plants grew faster and developed into larger pupae compared to caterpillars that ate outbred plants. These differences translated to the adult moth stage: moths that fed on inbred plants as caterpillars exhibited improved flight muscle metabolic function, i.e., they had a better flight capacity. At the molecular level, the differences in flight capacity correlated with changes to the amino acid composition of a key regulatory protein in the flight muscles, troponin t (*Tnt*).

 A green caterpillar on a plant

Description automatically generated with medium confidence

***Fig. 1****: Life cycle of the tobacco hornworm moth (Manduca sexta; left), and a Manduca sexta larva feeding on a tomato plant (right).*

**Note:** The description, analyses and results presented here may differ from the original paper.

**Reference:**

* Portman, S.L., Kariyat, R.R., Johnston, M.A., Stephenson, A.G. and Marden, J.H. (2015), Cascading effects of host plant inbreeding on the larval growth, muscle molecular composition, and flight capacity of an adult herbivorous insect. Funct Ecol, 29: 328-337.   
  https://doi-org.myaccess.library.utoronto.ca/10.1111/1365-2435.12358.
* Image sources (Fig.1): *https://www.rainbowmealworms.net/hornworms, https://commons.wikimedia.org/wiki/File:Tobacco\_Hornworm\_Manduca\_Sexta.jpg*

Fig. 2 details the study design and the planned sample sizes (see figure caption). Fig 3 lists the valid sample sizes for different parts of the study. The table on the next page describes the data analyzed in this case study. On the following pages, the statistical results are presented separately for Parts 1 - 3 of the case study.

A picture containing diagram

Description automatically generated

***Fig. 2****: Study design involving inbred and outbred offspring from three Carolina horsenettle plants (Solanum carolinense). F1 refers to the first offspring generation. Two offspring were grown from each of three maternal plants: one inbred (ovule fertilized with self-pollen), and one outbred (ovule fertilized with outcrossed pollen). The offspring from the same maternal plant are referred to as a maternal family. Each offspring (F1 plant) was clonally propagated, using horizontal root segments (runners), to grow twelve genetically identical plants per F1 plant that were placed in a cage (one cage per F1 plant). A total of 72 tobacco hornworm larvae (Manduca sexta) were randomly assigned to the 6 cages (12 larvae per cage) and grown to adult moths (see Fig.1).*

Table

Description automatically generated

***Fig. 3****: Valid sample size for different parts of the study, separately for inbred-fed (S) and outbred-fed (X) tobacco hornworms (M. sexta) that were raised on plants from three different maternal families (B1, B3, B4). Valid sample size refers to the number of individuals with non-missing values. Overall, valid sample size decreased from larvae to pupae, adult moths, and the molecular analysis of the flight muscle of adult moths, as individuals were lost for various reasons.*

|  |  |
| --- | --- |
| Who: | * Tobacco hornworm moths (*M. sexta*) that developed from larvae (caterpillars) reared on Carolina horsenettle plants (*S. carolinense*). Twelve larvae were randomly assigned to each of six cages, for a total of 72 larvae (see Fig. 2). |
| What: | * **Maternal family** (B1, B3, B4): plant family on which the larvae were reared. Each family ID refers to plant offspring from the same maternal plant. * **Breeding type** (s, x): the quality of the host plant on which the larvae were reared. Plants were either inbred (s: grown from a self-pollinated seed) or outbred (x: grown from an outcrossed seed). * **Gender** (M, F): biological sex of the adult moth (M: male, F: female). * **Body mass** (*BodyMassg*): total body mass of adult moths was measured in grams (*g*). * **Thorax mass** (*ThoraxMassg*): thorax mass is known to correlate closely with flight muscle mass. Thorax mass of adult moths was measured in grams (*g*). Flight muscles are metabolically costly to build and maintain, especially in the presence of toxins. Hence the nutritional quality of the host plant may affect the development and performance of the flight muscles in adult moths. * **Peak metabolic rate** (mL CO2 hour-1): peak metabolic rate during 5 min flight in a 10 L glass jar. * **Arcsine relative abundance *Tnt E*** *(ArcSinTntE)*: RNA was isolated from the flight muscle to characterize the amino acid composition of troponin t (*Tnt*), a flight muscle protein that regulates muscle contraction. Specifically, the relative abundance of *Tnt E* was measured as the proportion of all *Tnt* amino acids (which included the isoforms *A, B, C, D, E, F*) that were of isoform *E*. |
| Why | * **Part 1:** to test whether a larger body size correlated with a higher flight muscle mass (thorax mass) in adult moths. * **Part 2:** to test whether adult moths that, as larvae, were reared on inbred plants had a higher flight capacity than those reared on outbred plants. * **Part 3**: to test whether at the molecular level, differences in flight capacity correlated with the relative abundance of troponin t isoform E (*Tnt E*). |

**Part 1: Growth Differences**

Chart, scatter chart

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***Fig. 4****: Scatterplot of thorax mass and body mass of adult moths, separately for males (blue triangles) and females (red circles). Lines indicate linear regression models fitted separately for males (blue line) and females (red line). The labels "P1" and "P2" indicate two observations that may be influential points – these points were included in the analysis.*

Table

Description automatically generated with medium confidence

***Fig. 5****: Summary statistics of the two variables shown in Fig. 4, BodyMassg and ThoraxMassg, separately for female (F) and male moths (M).*

Chart, diagram, scatter chart

Description automatically generated

***Fig. 6****: Residual plots for the regression model reported by the researchers in Box 2.*

Chart, diagram, scatter chart

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***Fig. 7****: Residual plots for an alternative, more complex regression model than the one reported in Box 2.*

**Part 2: Flight Capacity**

Chart, scatter chart

Description automatically generated

***Fig 8****: Original figure from Portmann et al. (2015) showing the relationship between flight capacity (Peak flight metabolic rate) and the body mass, separately for moths that as larvae were reared on inbred or outbred plants. See Box 3 for the figure caption from the published paper.*

**Part 3: Molecular Basis**

Chart, box and whisker chart

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***Fig 9****: Boxplot of the variable ArcSinTntE for female (F) and male (M) adult moths that, as larvae, were raised either on inbred plants (s) or on outbred plants (x). Valid sample size for each group is reported in Fig. 11.*

Table

Description automatically generated

***Fig 10****: Observed values of the response variable ArcSinTntE for male moths reared on plants from maternal families B3 or B4. Values are sorted from the smallest to the largest value. Breeding type indicates whether larvae were fed on inbred (s) or outbred plants (x).*

Anova Table (Type II tests)

Response: ArcSinTntE

Sum Sq Df F value Pr(>F)

Group 0.018008 3 3.755 0.02004 \*

Residuals 0.052752 33

---

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

eta.sq eta.sq.part

Group 0.2544897 0.2544897

mean sd data:n data:NA

F\_s 0.10231905 0.04274185 13 1

F\_x 0.11797043 0.03807348 8 0

M\_s 0.05172358 0.01646651 7 4

M\_x 0.09383047 0.04880494 9 0

Tukey multiple comparisons of means

95% family-wise confidence level

$Group

diff lwr upr p adj

F\_x-F\_s 0.015651381 -0.03294606 0.0642488179 0.8196232

M\_s-F\_s -0.050595476 -0.10129626 0.0001053101 0.0506391

M\_x-F\_s -0.008488579 -0.05538490 0.0384077447 0.9608674

M\_s-F\_x -0.066246857 -0.12221901 -0.0102747045 0.0152269

M\_x-F\_x -0.024139960 -0.07669067 0.0284107518 0.6049227

M\_x-M\_s 0.042106897 -0.01239481 0.0966086038 0.1774912

***Fig 11****: R output and summary statistics for a one-way ANOVA comparing the mean of the response variable ArcSinTntE between male (M) and female moths (F) that, as larvae, were reared either on inbred plants (s) or on outbred plants (x).*

*Space for your notes:*