# Group 4

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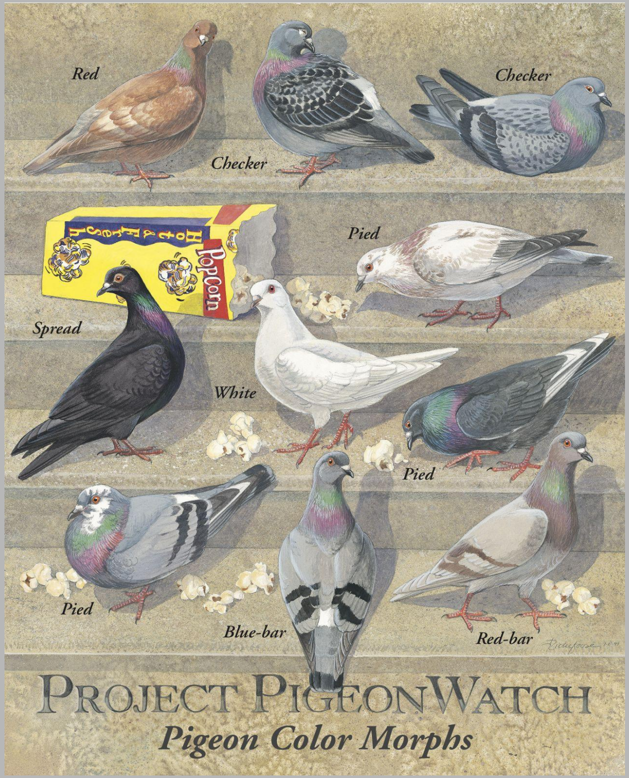
# Introduction: Why Study Pigeons?

- Wild pigeons have one specific morph called "Blue-bar" coloration.
- Feral pigeons were domesticated thousands of years ago to have many color morphs.
- Since then, feral pigeons have adapted to every kind of environment.
- Feral pigeons are unique because they have retained their variety of morphs.

# Literature Review: Possible Reasons Why Pigeons Retain Diverse Morphologies

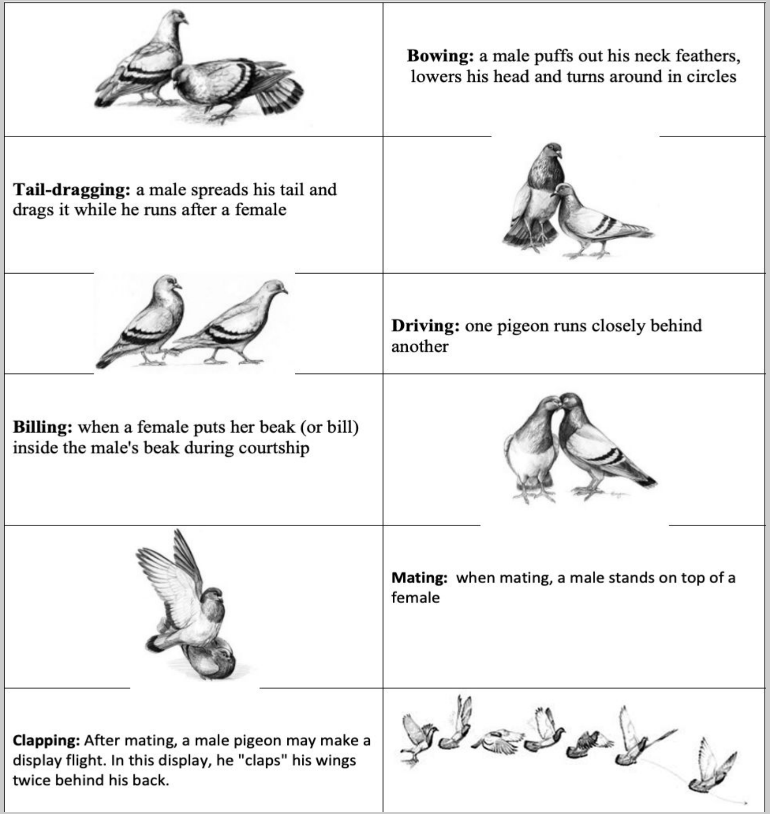
- Colorations are heritable and weakly influenced by environmental conditions beyond wild habitats. Melanin-based colors of pigeons are influenced by life-history traits, i.e. differently colored individuals may have different fitness in alternative environments. (Derelle et al., 2013)

- Certain morphs have better immune system functions--melanin-based (e.g. ashy-red and dark) colorations are significantly correlated with lower blood-parasite intensity than non-melanin-based ones like “blue-bars”. (Jacquin, Lisa, et al., 2011)

- Changes in plumage morph frequencies are associated with sexual selection. (Haag-Wackernagel et al., 2006).

# Hypothesis

- Why have feral pigeons retained their morphs despite natural selection?
- Our hypothesis: sexual selection determines why all pigeons are not “blue-bars”.
- Pigeons preferentially mate with those with the same coloration.



# Data and Methods

- Data was collected by students from the years 2000-2018
- Wide variety of sites, including beaches, parks, shopping centers, schools, and more
- Data was collected through on-site observation
- The total number of birds in the area was determined
- Color morphs among the birds were counted
- Courting behavior was noted, as well as the color morphs that engaged in the courting
- From 2000-2018,  6102 birds were counted total
- Of these 6102, 5976 had a known color morph
- In total, 610 courtships were recorded


# Data

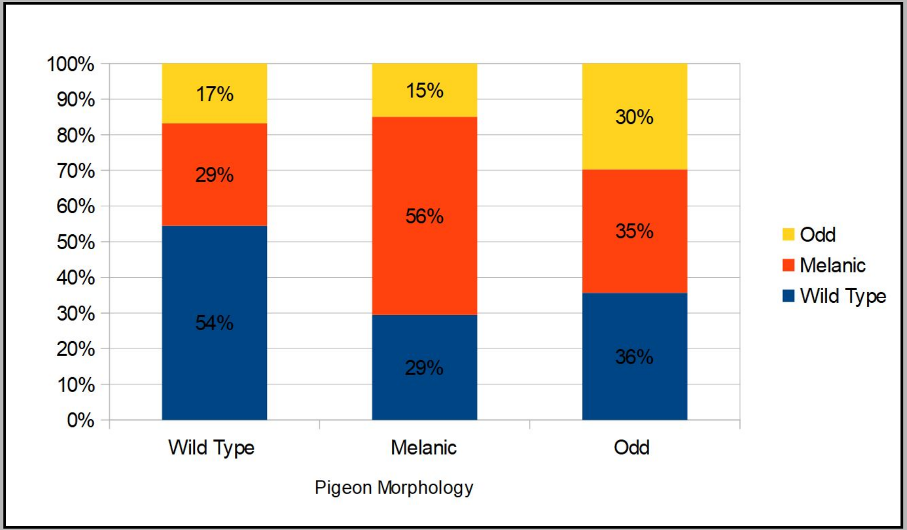



Figure 1

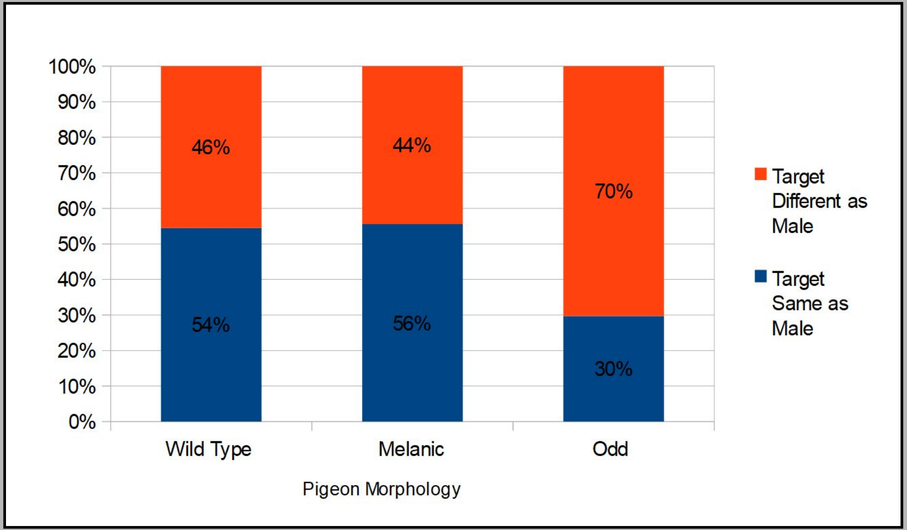



Figure 2

# Statistical Analysis

$X^2$ — **Enter data and *alpha* in yellow cells only** — **Outputs in blue cells**

| VAR 1 | VAR 2: a | b | c | * |
|---|---|---|---|---|
| Obs | 152 | 80 | 47 | 279 |
| Exp | *118.349* | *109.319* | *51.332* | |
| | d | e | f | |
| Obs | 61 | 115 | 31 | 207 |
| Exp | *87.807* | *81.107* | *38.085* | |
| | g | h | i | |
| Obs | 36 | 35 | 30 | 101 |
| Exp | *42.843* | *39.574* | *18.583* | |
| * | 249 | 230 | 108 | 587 |

| Cell | O | O sq. | E | O sq./E |
|---|---|---|---|---|
| a | 152 | 23104 | 118.349 | 195.219 |
| b | 80 | 6400 | 109.319 | 58.544 |
| c | 47 | 2209 | 51.332 | 43.033 |
| d | 61 | 3721 | 87.807 | 42.377 |
| e | 115 | 13225 | 81.107 | 163.056 |
| f | 31 | 961 | 38.085 | 25.233 |
| g | 36 | 1296 | 42.843 | 30.250 |
| h | 35 | 1225 | 39.574 | 30.955 |
| i | 30 | 900 | 18.583 | 48.432 |
| | | | | 637.099 |

| | |
|---|---|
| $X^2_{calc}$ | 50.099 |
| *alpha* | 0.05 |
| df | 4 |
| $X^2_{crit}$ | 9.488 |
| prob | 0.000 |
| k (min r or c) | 3 |
| **(effect size measure) Cramér's V** | **0.207** |
| (effect size measure) φc or w | 0.292 |
| Noncentrality (λ) | 25.049 |
| Estimated power (1-β) | 1.000 |
| **Corrected power (Rodrigue)** | **0.999** |

| | |
|---|---|
| Percentage of expected counts < 5 | 0.00 % |
| (if > 20%, collapse data rows) | |
| Number of expected counts ≤ 1 | 0 |
| (if there are any, collapse rows) | |

*β/α*: ratio of Type II to Type I error probability 1645320.242

Table 1

$X^2$ — **Enter data and *alpha* in yellow cells only** — **Outputs in blue cells**

| VAR 1 | VAR 2: a | b | * |
|---|---|---|---|
| Obs | 152 | 127 | 279 |
| Exp | *141.164* | *137.836* | |
| | c | d | |
| Obs | 115 | 92 | 207 |
| Exp | *104.734* | *102.266* | |
| | e | f | |
| Obs | 30 | 71 | 101 |
| Exp | *51.102* | *49.898* | |
| * | 297 | 290 | 587 |

| Cell | O | O sq. | E | O sq./E |
|---|---|---|---|---|
| a | 152 | 23104 | 141.164 | 163.668 |
| b | 127 | 16129 | 137.836 | 117.015 |
| c | 115 | 13225 | 104.734 | 126.272 |
| d | 92 | 8464 | 102.266 | 82.765 |
| e | 30 | 900 | 51.102 | 17.612 |
| f | 71 | 5041 | 49.898 | 101.027 |
| | | | | 608.359 |

| | |
|---|---|
| $X^2_{calc}$ | 21.359 |
| *alpha* | 0.05 |
| df | 2 |
| $X^2_{crit}$ | 5.991 |
| prob | 0.00002 |
| k (min r or c) | 2 |
| **(effect size measure) Cramér's V** | **0.191** |
| (effect size measure) φc or w | 0.191 |
| Noncentrality (λ) | 21.359 |
| Estimated power (1-β) | 0.992 |
| **Corrected power (Rodrigue)** | **0.990** |

| | |
|---|---|
| Percentage of expected counts < 5 | 0.00 % |
| (if > 20%, collapse data rows) | |
| Number of expected counts ≤ 1 | 0 |
| (if there are any, collapse rows) | |

*β/α*: ratio of Type II to Type I error probability 416.795

Table 2

# Conclusion

- Reject both the null hypothesis with certainty
- Both tests had significant results, however, our effect size shows we need more data.
- Performed Chi-Squared Test of Independence

| | Test 1 | Test 2 |
|---|---|---|
| $X^2$ calculated | 50.099 | 21.359 |
| p-value | 0.000 | 0.00002 |
| Effect size | 0.207 | 0.191 |
| power | 0.999 | 0.990 |

# References


A. Daniel Haag-Wackernagel, Philipp Heeb & Andreas Leiss (2006) Phenotype-dependent selection of juvenile urban Feral Pigeons *Columba livia*, Bird Study, 53:2, 163-170, DOI: 10.1080/00063650609461429.

B. Derelle, R., Kondrashov, F.A., Arkhipov, V.Y. *et al.* Color differences among feral pigeons (*Columba livia*) are not attributable to sequence variation in the coding region of the melanocortin-1 receptor gene (MC1R). *BMC Res Notes* 6, 310 (2013). https://doi.org/10.1186/1756-0500-6-310.

C. Jacquin, Lisa, et al. “Melanin-Based Coloration Is Related to Parasite Intensity and Cellular Immune Response in an Urban Free Living Bird: the Feral Pigeon Columba Livia.” *Journal of Avian Biology*, vol. 42, no. 1, 2011, pp. 11–15., www.jstor.org/stable/23018072. Accessed 2 Dec. 2020.

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