

Bird Sex

Dr. Ethan Linck
Office: 305 Lewis Hall

Bird sexes

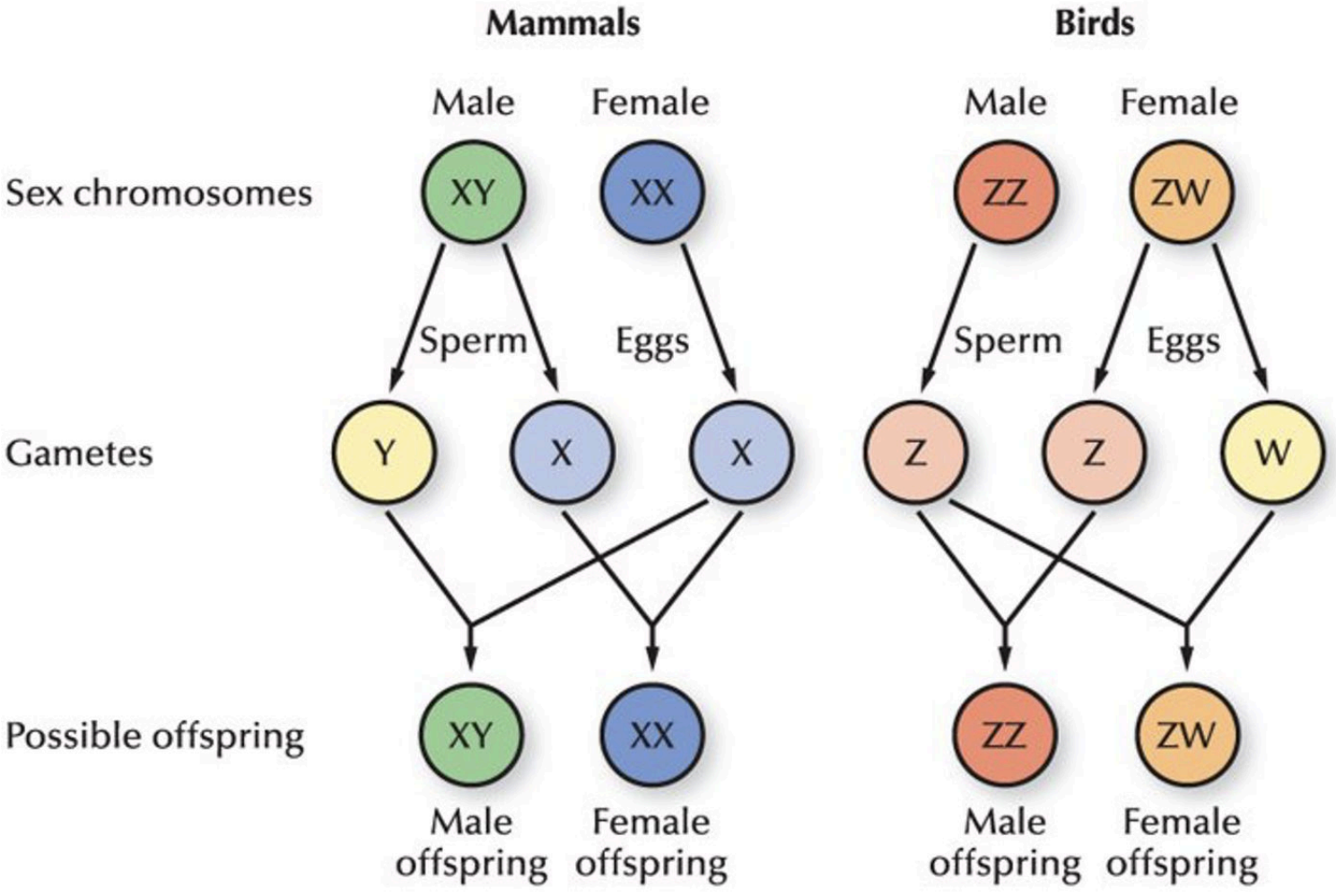
- Two sexes: M/F (c.f. hermaphrodites, clonal reproduction, animals with 4-7 mating types)
- Sex is determined at fertilization, permanent (c.f. some fish, frogs, reptiles)
- Roles and phenotypes determined by gene activity, hormones, **chromosomes**



(*Paradisaea apoda*)

ZW sex determination

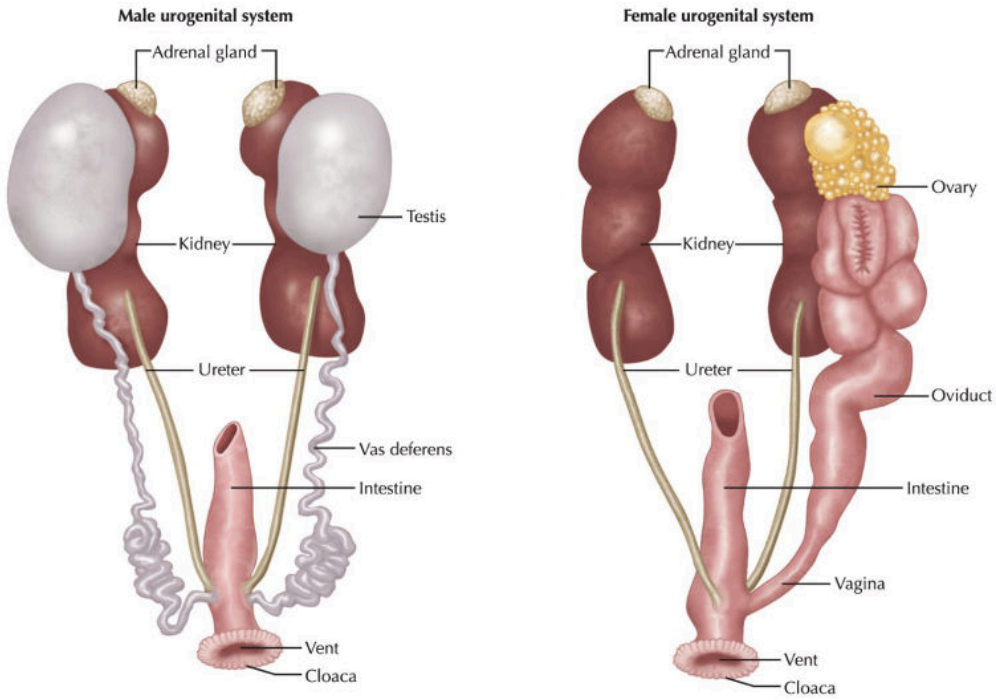
- Females are the **heterogametic** sex



(Gill et al. 2019)

Bird reproductive organs

- Most female birds only have one ovary, on the left side (excluding kiwis, raptors)
- More germ cells on left side in male birds leads to large L testis
- Produce **testosterone** and **estrogen** (both sexes have both; ratio matters)



(Gill et al. 2019)

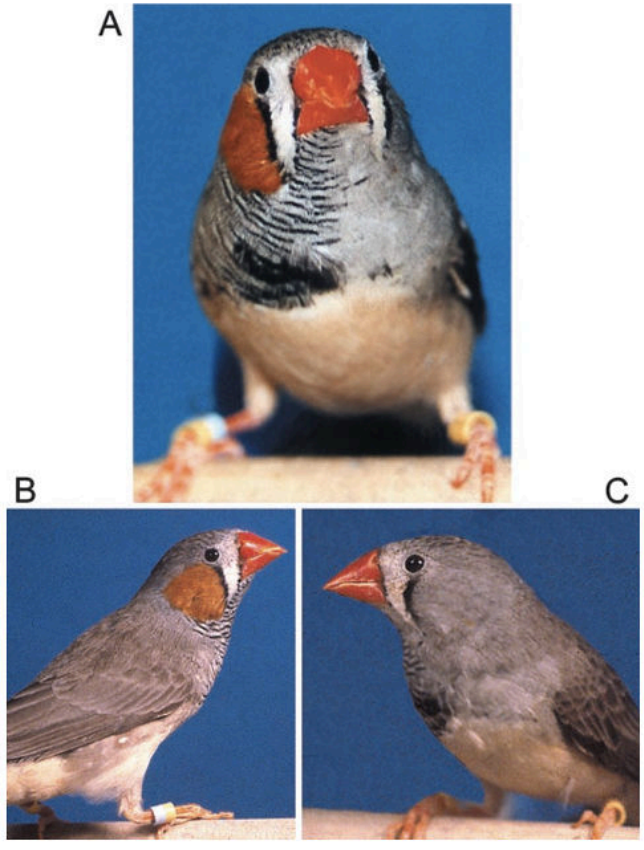
Sexual dimorphism is not ubiquitous



(*Empidonax difficilis*)

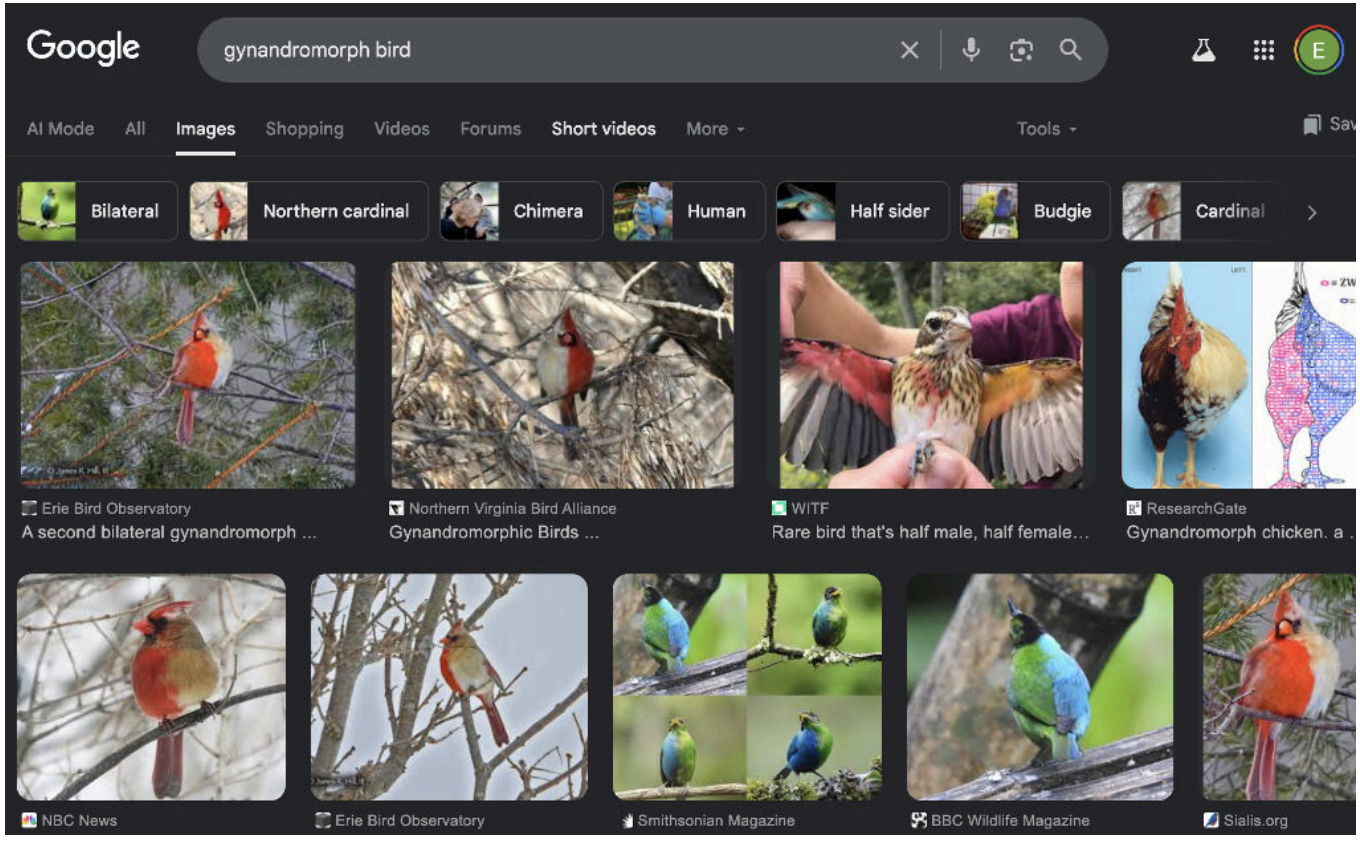
Sexual differences are not absolute

- Failure during first mitotic division of fertilized ovum leads to **bilateral gynandromorphs** with one testis / one ovum, M/F halves



(Agate et al. 2003)

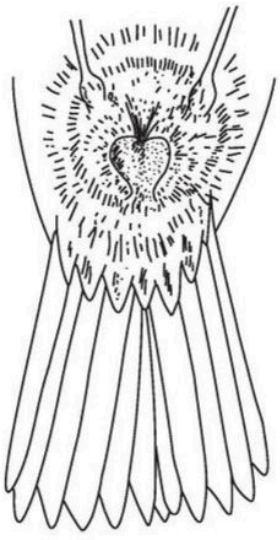
Bilateral gynandromorphs are not uncommon

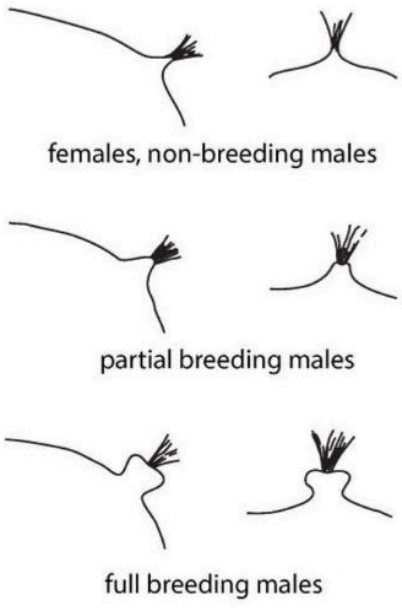


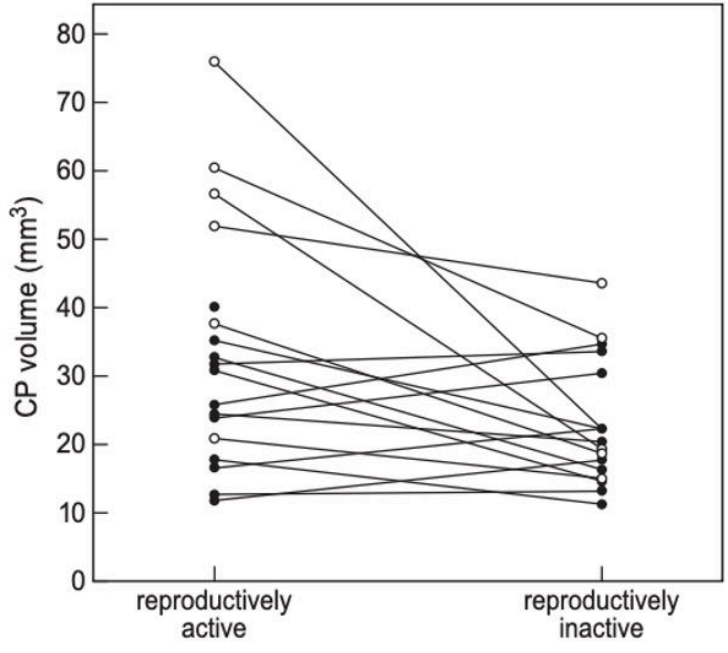
https://www.discoverwildlife.com/news/bilateral-gynandromorphy-in-green-honeycreeper

Copulation via cloacal contact

- accumulating sperm produces **cloacal protrubrence** in some passerines; can indicate reproductive status







(Pyle 1997; Schut et al. 2012)

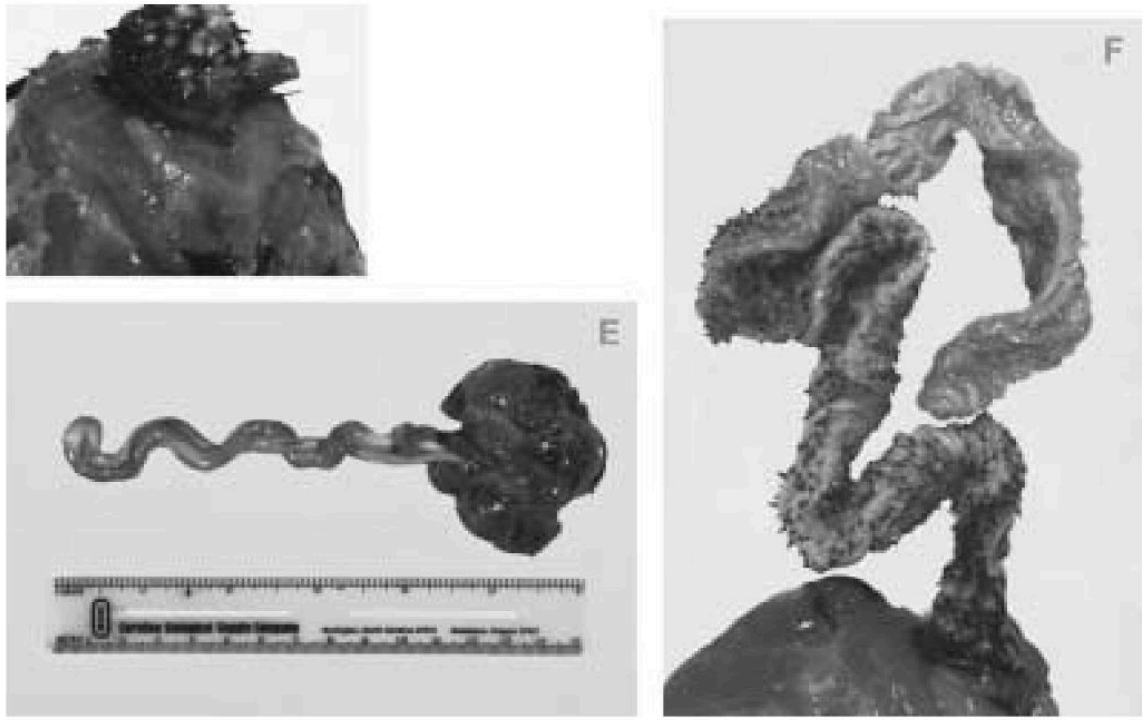
Ratites and waterfowl retain a penis

- Universal in reptiles and mammals, lost in all other birds
- Erections from lymphatic fluids, not blood pressure
- Retained within body until explosive activation

The Auk 117(3):820–825, 2000

The 20-cm Spiny Penis of the Argentine Lake Duck (*Oxyura vittata*)

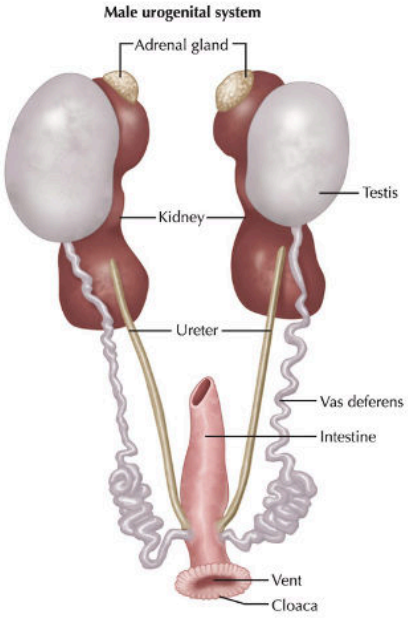
KEVIN G. MCCRACKEN[1]
School of Forestry, Wildlife, and Fisheries, Louisiana State University, Baton Rouge, Louisiana 70803, USA

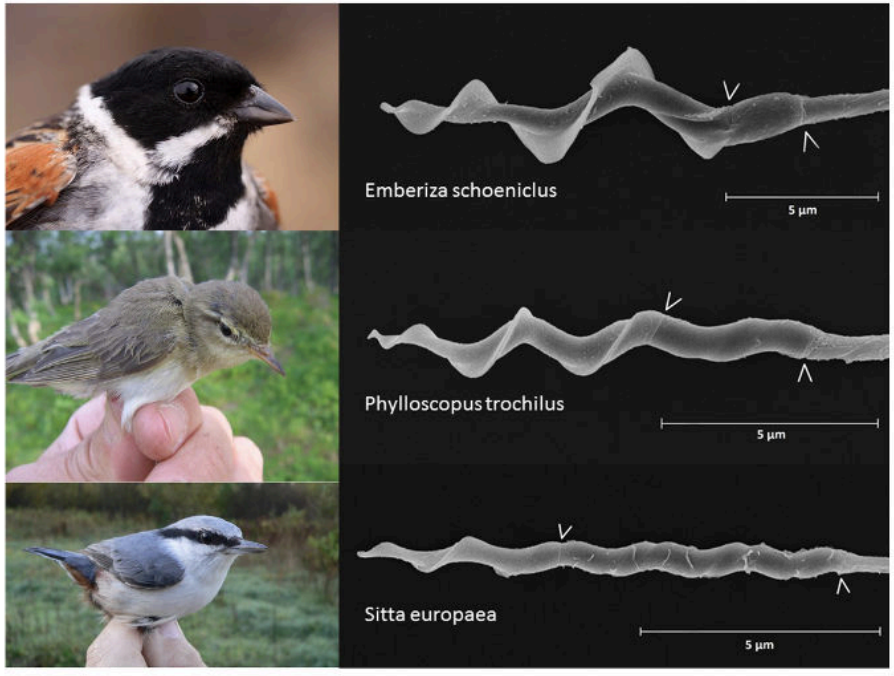


(McCracken et al. 2003)

Sperm production

- Sperm produced at night during cooler temperatures
- Stored at distal end of vas deferens (4 degrees C cooler than body)
- Sperm morphology and size vary widely across birds—even within passerines

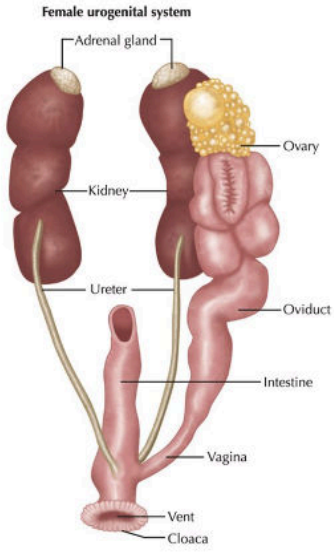




(Gill et al. 2019; NHM U. Oslo)

Ova maturation

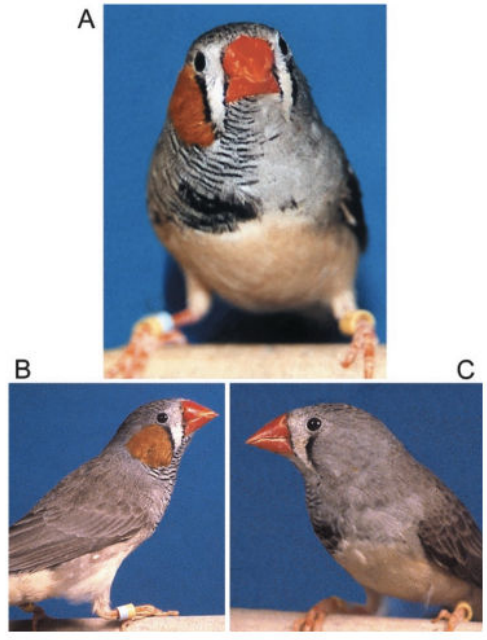
- Oocytes present at hatching
- Ova by two months of age
- Add yolk in week prior to ovulation
- **L**: dissected female House Sparrow that had previously laid 4 eggs; a fifth is visible in the oviduct, plus two more forming yolk





(Gill et al. 2019; photo courtesy Jay Rotella)

Which of the following is false?

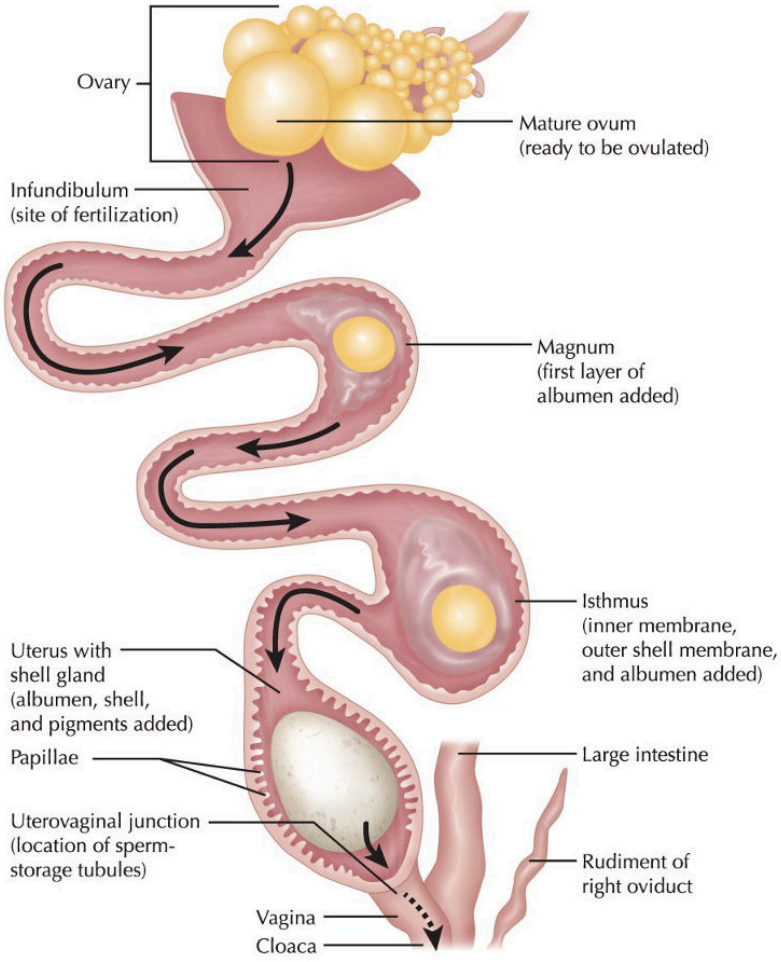


(Agate et al. 2003)

a) males have ZZ chromosomes
b) kiwis have paired ovaries
c) females have a cloaca
d) not all birds are sexually dimorphic
e) the right male testis is largest

Ovulation

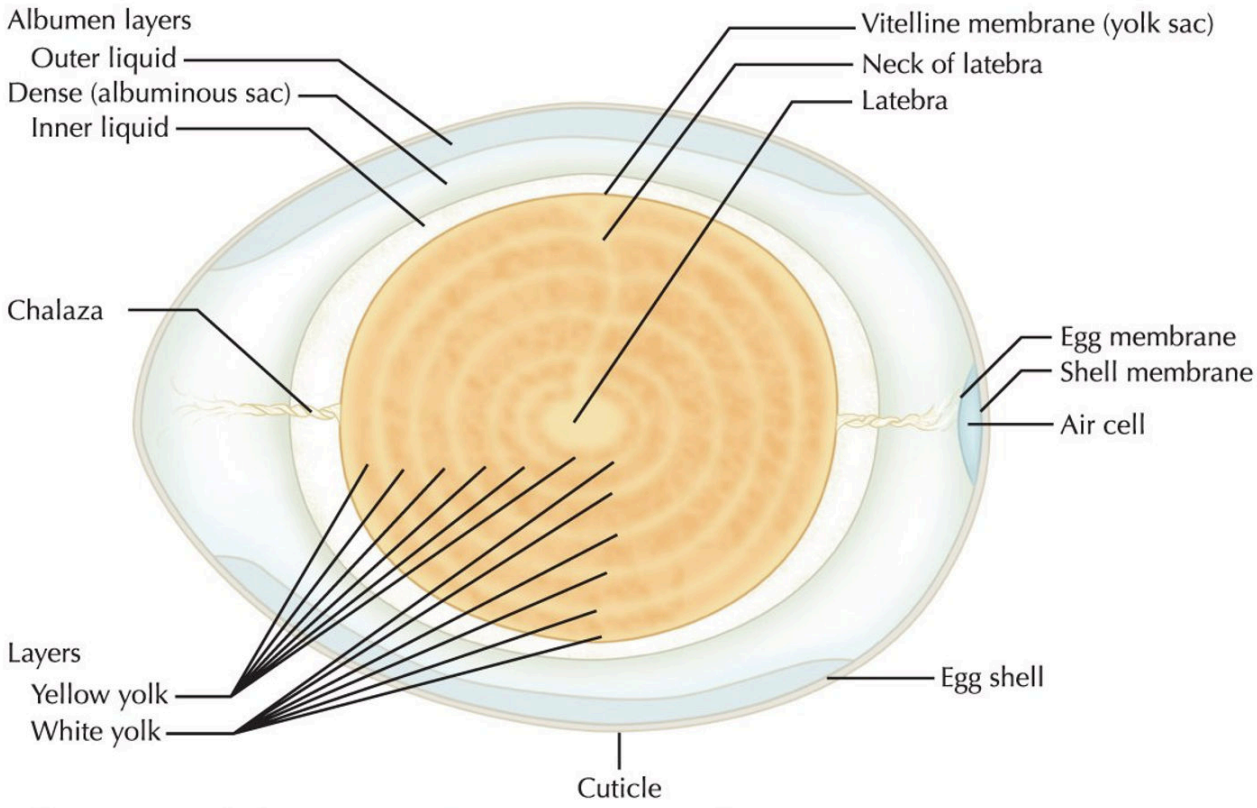
- Egg moves through oviduct in ~24 hours (albumen, 3-4 hours; egg membranes, 1 hour; shell, 20 hours)



(Gill et al. 2019)

Egg anatomy

- yellow yolk deposited at night, white during the day
- **carotenoids** determine yolk color
- yolk for food (21-36% lipids, 16-22% proteins)
- albumen for H_20 (90%), protein (10%), shock absorption
- shell for protection ($CaCO_3$), gas exchange



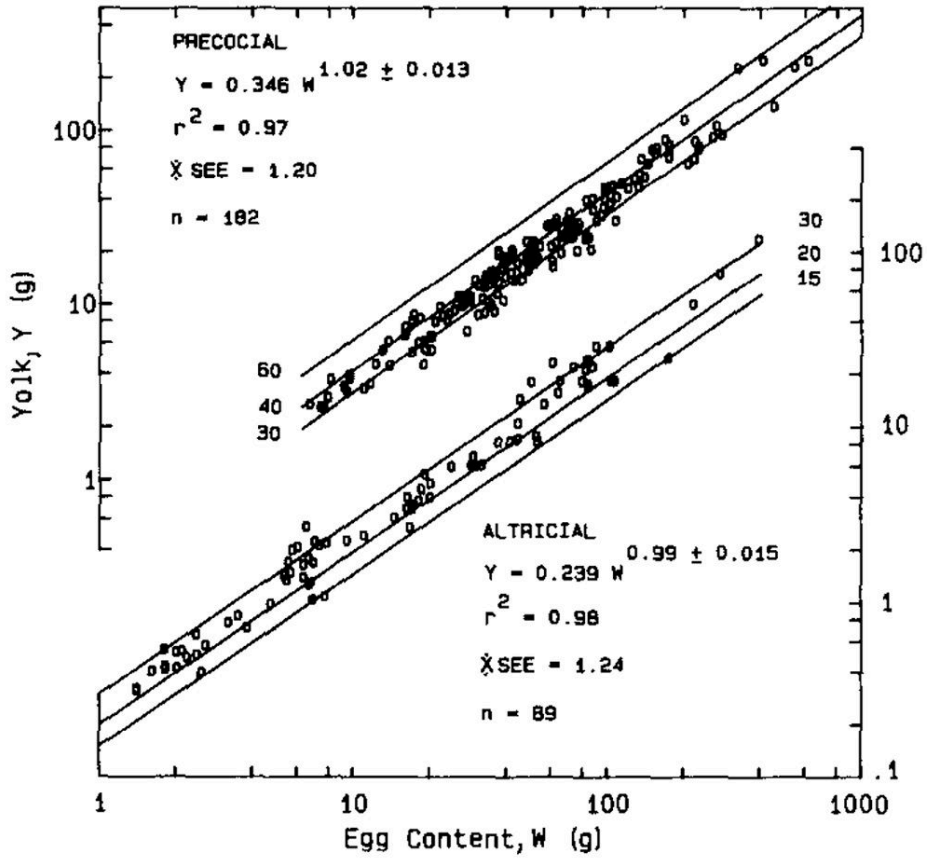
(Gill et al. 2019)

Yolk investment varies with maturity at birth

- **precocial**: capable of moving and feeding itself soon after hatching
- **altricial**: hatched helpless; requiring significant parental care



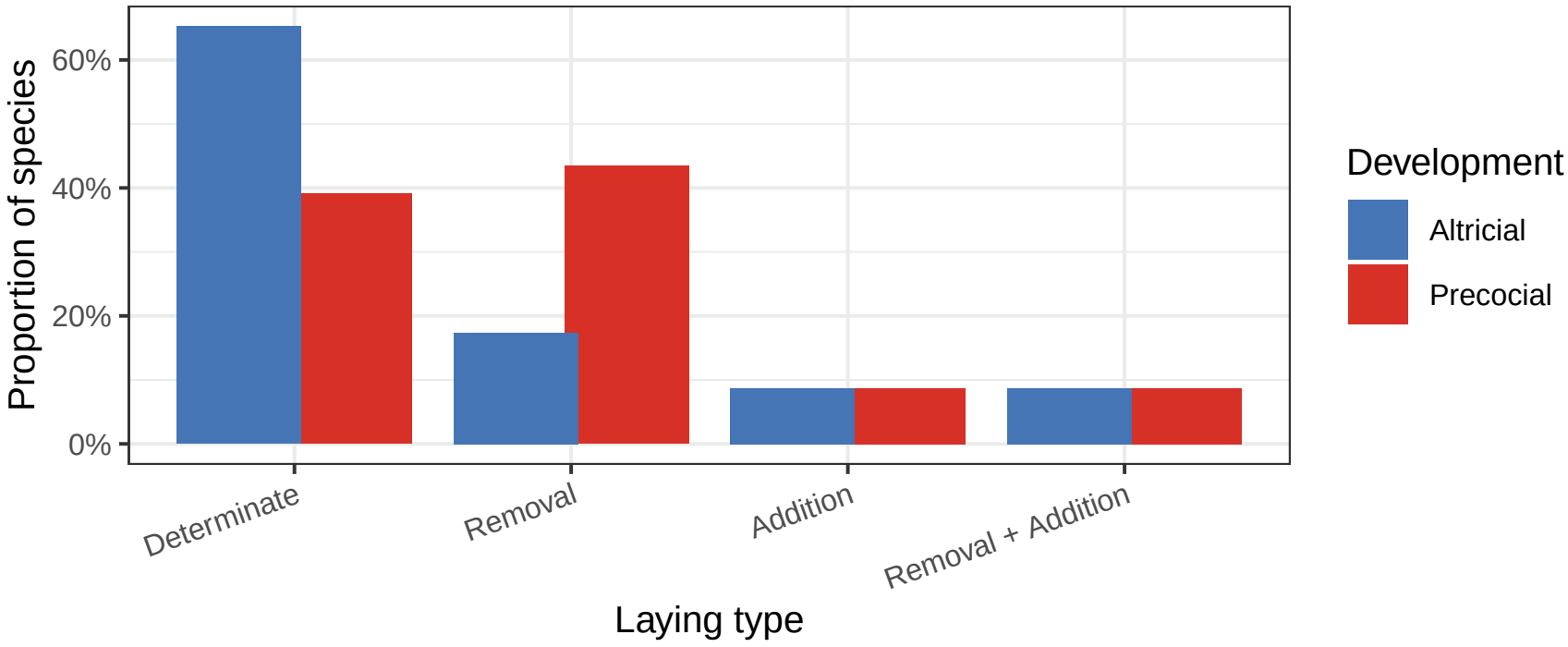




(Sotherland & Rahn 1987)

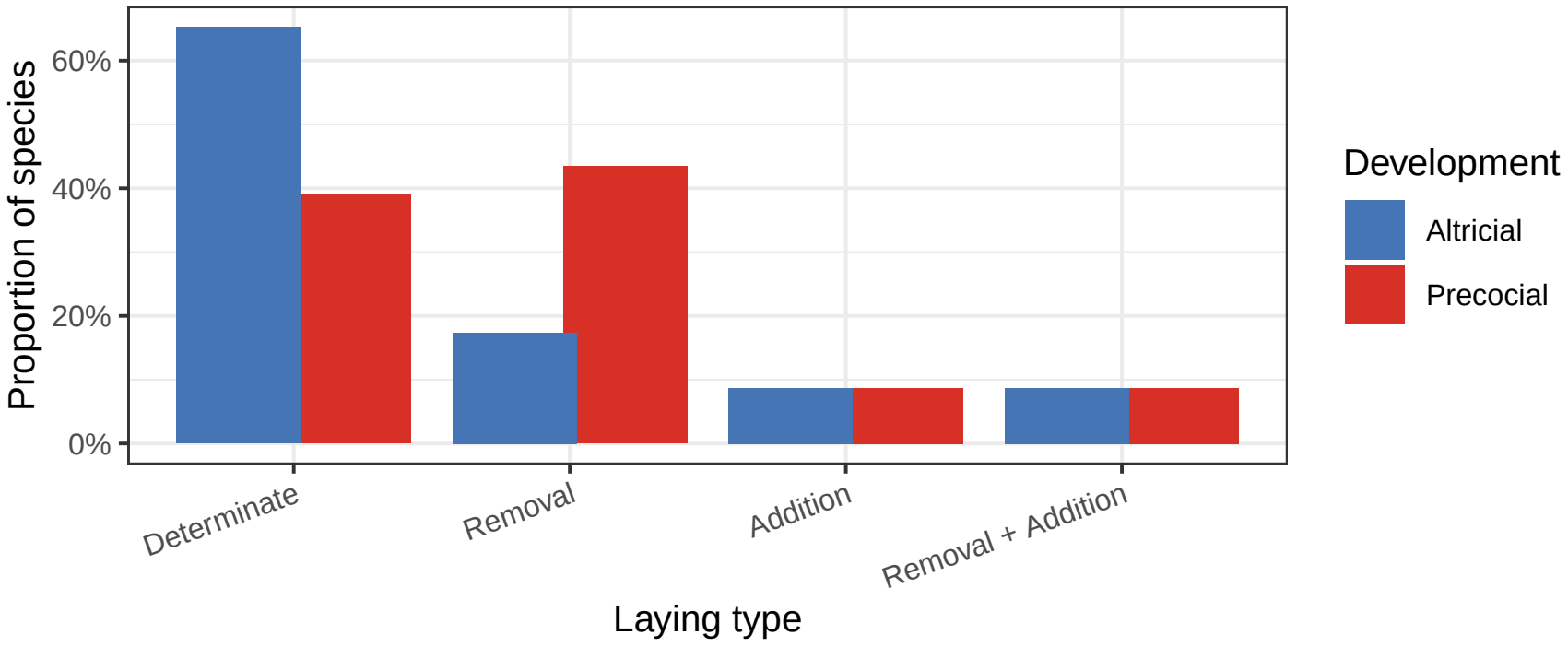
Egg production

- Usually 1 egg per day max
- **Determinate layers**: lay a fixed total of eggs per nesting attempt
- **Indeterminate layers**: try for a set number of eggs in nest



("addition" and "removal" indicate eggs were added or taken away to show indeterminancy; data from Kennedy 1991)

Why might more precocial species be indeterminate layers?



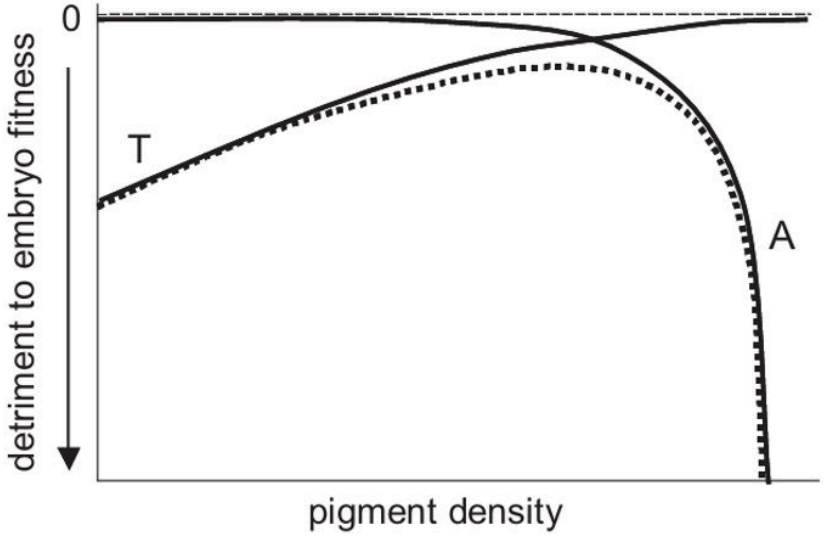
("addition" and "removal" indicate eggs were added or taken away to show indeterminancy; data from Kennedy 1991)

a) because they maximize fitness through care for each offspring
b) because they mazimize fitness through total investment in eggs
c) because they are largely flightless
d) i'm still asleep

Egg pigmentation

- Egg color and pattern varies widely
- *H*: Trade-off between protection from **transmittance** (T) of UV radiation and **absorption** (A) and overheating. (Dashed line total fitness)

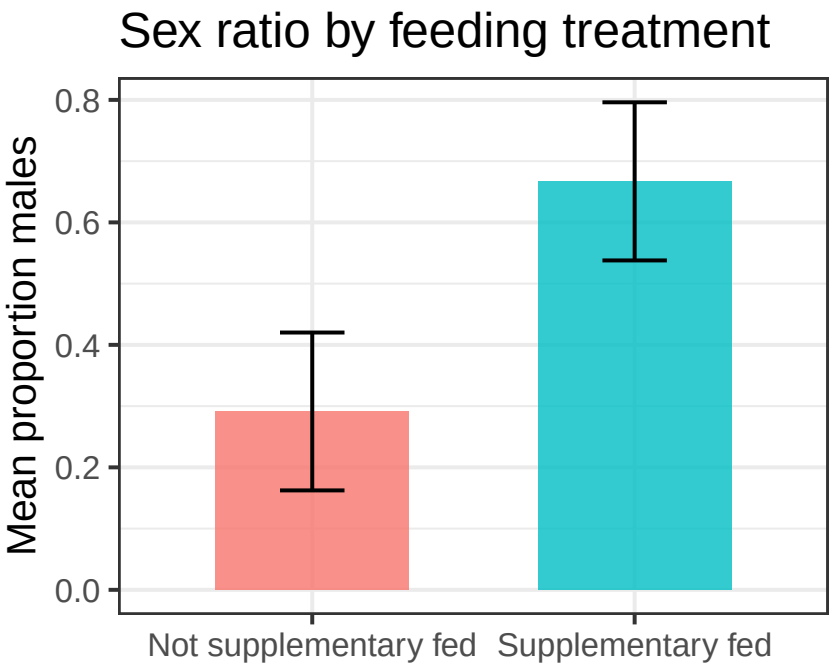


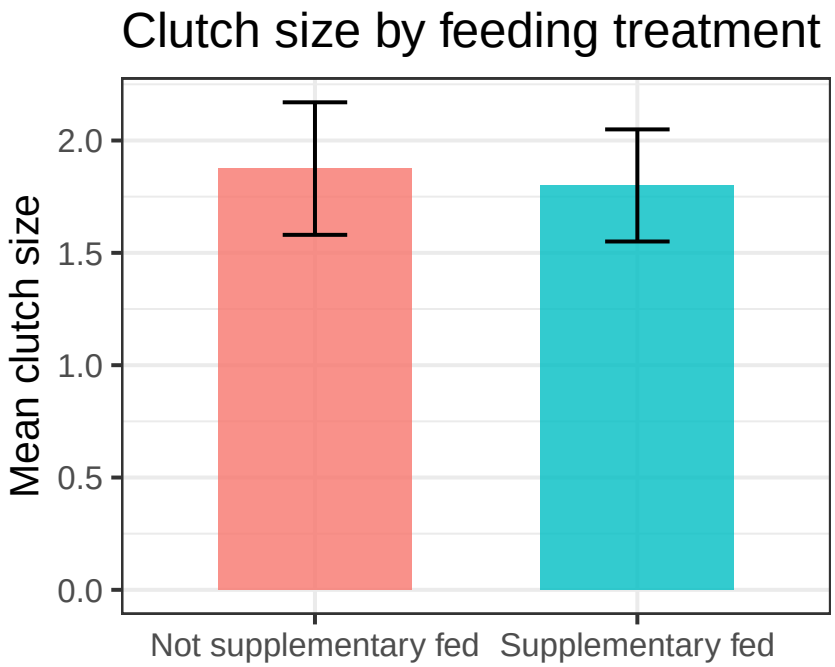


(Lahti & Ardia 2016)

Sex ratio adjustment in birds

- Female birds can adjust which sex chromosome the eggs receive in response to the social and/or environmental conditions!
- Theory predicts females will produce more males to maximize their own fitness in species with high variance in male reproductive success—evidence from kakapo below:



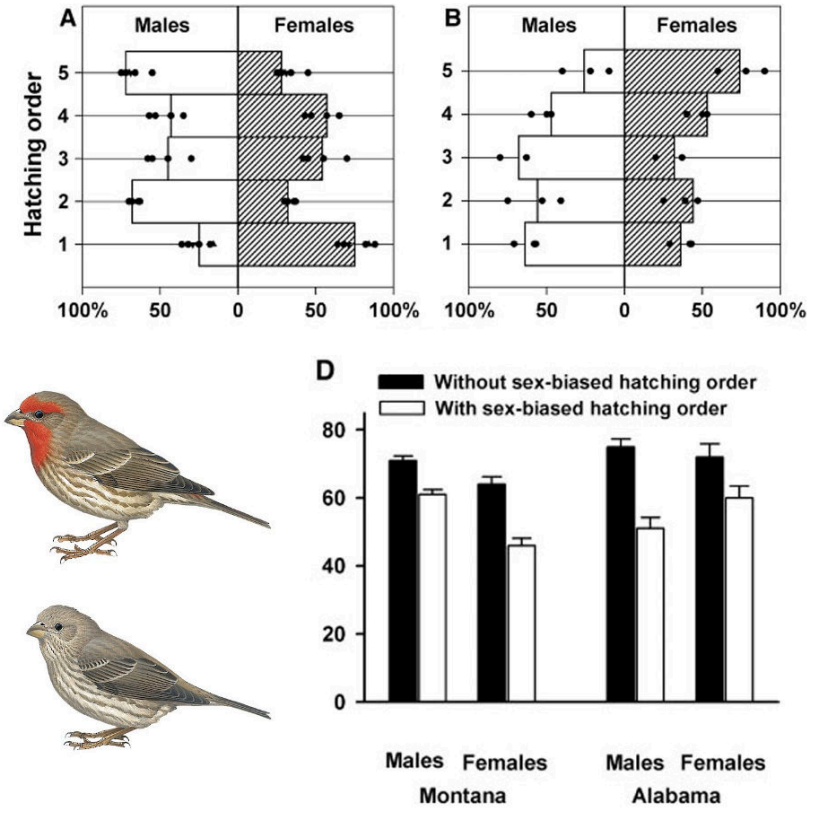


https://www.youtube.com/watch?v=QzqGuFWE2Gs

(data from Clout et al. 2002)

Adjusting hatching order reduces mortality

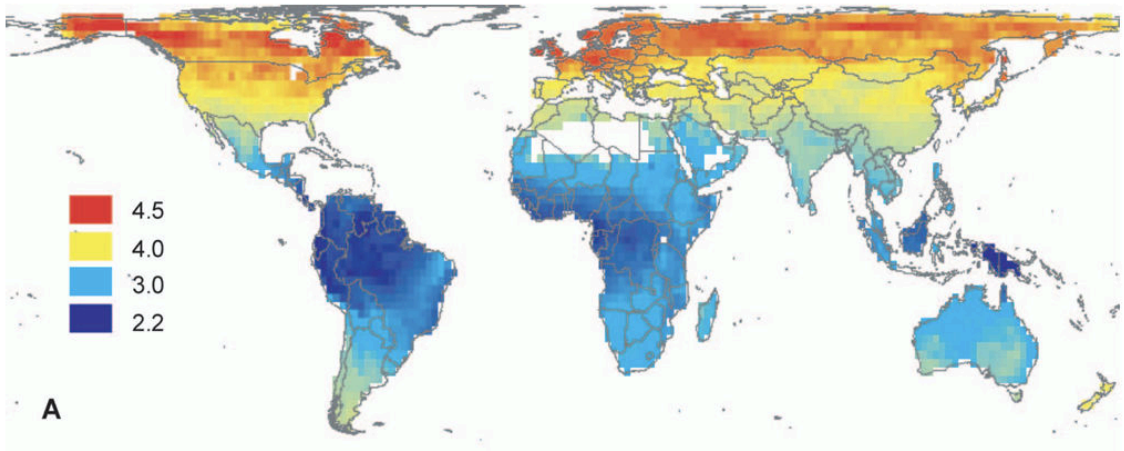
- House Finches in Montana (**A**) and Alabama (**B**) are diverging in tarsus length; hatching order has impacts on growth rate
- By sex-biasing hatching order, females can reduce mortality in offspring (**D**) by matching tarsus length to local environment



(Badyaev et al. 2002)

Is H_1 supported?

- **Clutch size** is number of eggs per nesting attempt
- H_1: Clutch size determined by available resources in breeding season (or morality via seasonality leading to greater investment, or lower population density. . .)
- Prediction: larger clutch sizes at high latitudes



(Jetz et al. 2008)

a) yes
b) no
c) it depends

References

- Title slide species: *Hydropsalis forcipata*, *Grus carunculatus*, *Bucorvus leadbeateri*, *Leuconotopicus albolavartus*
- Gill, F. B., Prum, R. O., & Robinson, S. K. (2019). Ornithology (4th ed.). W. H. Freeman.
- Agate, R. J., Grisham, W., Wade, J., Mann, S., Wingfield, J., Schanen, C., ... & Arnold, A. P. (2003). Neural, not gonadal, origin of brain sex differences in a gynandromorphic finch. Proceedings of the National Academy of Sciences, 100(8), 4873-4878.
- Pyle, P. (1997). Identification guide to North American birds: a compendium of information on identifying, ageing, and sexing" near-passerines" and passerines in the hand. Slate Creek Press.

References

- Schut, E., Magrath, M. J., van Oers, K., & Komdeur, J. (2012). Volume of the cloacal protuberance as an indication of reproductive state in male Blue Tits Cyanistes caeruleus. Ardea, 100(2), 202-205.
- McCracken, K. G. (2000). The 20-cm spiny penis of the Argentine Lake Duck (Oxyura vittata). The Auk, 117(3), 820-825.
- Sotherland, P. R., & Rahn, H. (1987). On the composition of bird eggs. The Condor, 89(1), 48-65.
- Kennedy, E. D. (1991). Determinate and indeterminate egg-laying patterns: a review. The Condor, 93(1), 106-124.
- Lahti, D. C., & Ardia, D. R. (2016). Shedding light on bird egg color: pigment as parasol and the dark car effect. The American Naturalist, 187(5), 547-563.

References

- Clout, M. N., Elliott, G. P., & Robertson, B. C. (2002). Effects of supplementary feeding on the offspring sex ratio of kakapo: a dilemma for the conservation of a polygynous parrot. Biological Conservation, 107(1), 13-18.
- Badyaev, A. V., Hill, G. E., Beck, M. L., Dervan, A. A., Duckworth, R. A., McGraw, K. J., ... & Whittingham, L. A. (2002). Sex-biased hatching order and adaptive population divergence in a passerine bird. Science, 295(5553), 316-318.
- Jetz, W., Sekercioglu, C. H., & Böhning-Gaese, K. (2008). The worldwide variation in avian clutch size across species and space. PLoS Biology, 6(12), e303.