

Sexual Selection

In nature, we see that the two sexes, almost invariably, look different!
Why?



Twelve-wired Bird-of-Paradise (*Seleucidis melanoleuca*)
Male (left) and Female (right)



Greater Bird of Paradise
Male (Top) and Female (bottom)



Gibbons

Eclectus Parrots



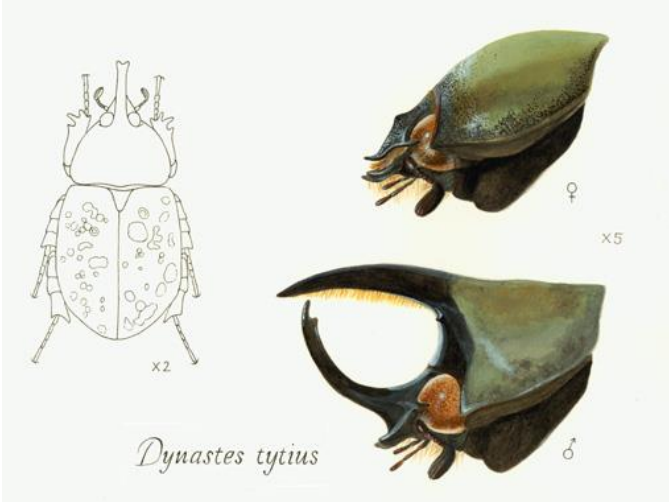
Elephant Seals



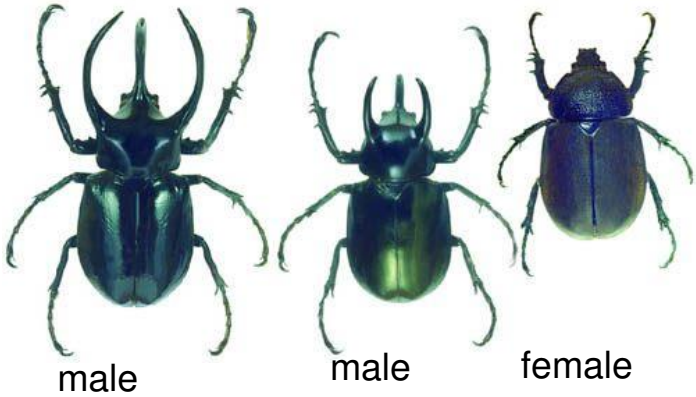
Paradise Birdwing



Sexual dimorphism- Weapons



Dynastes tytius



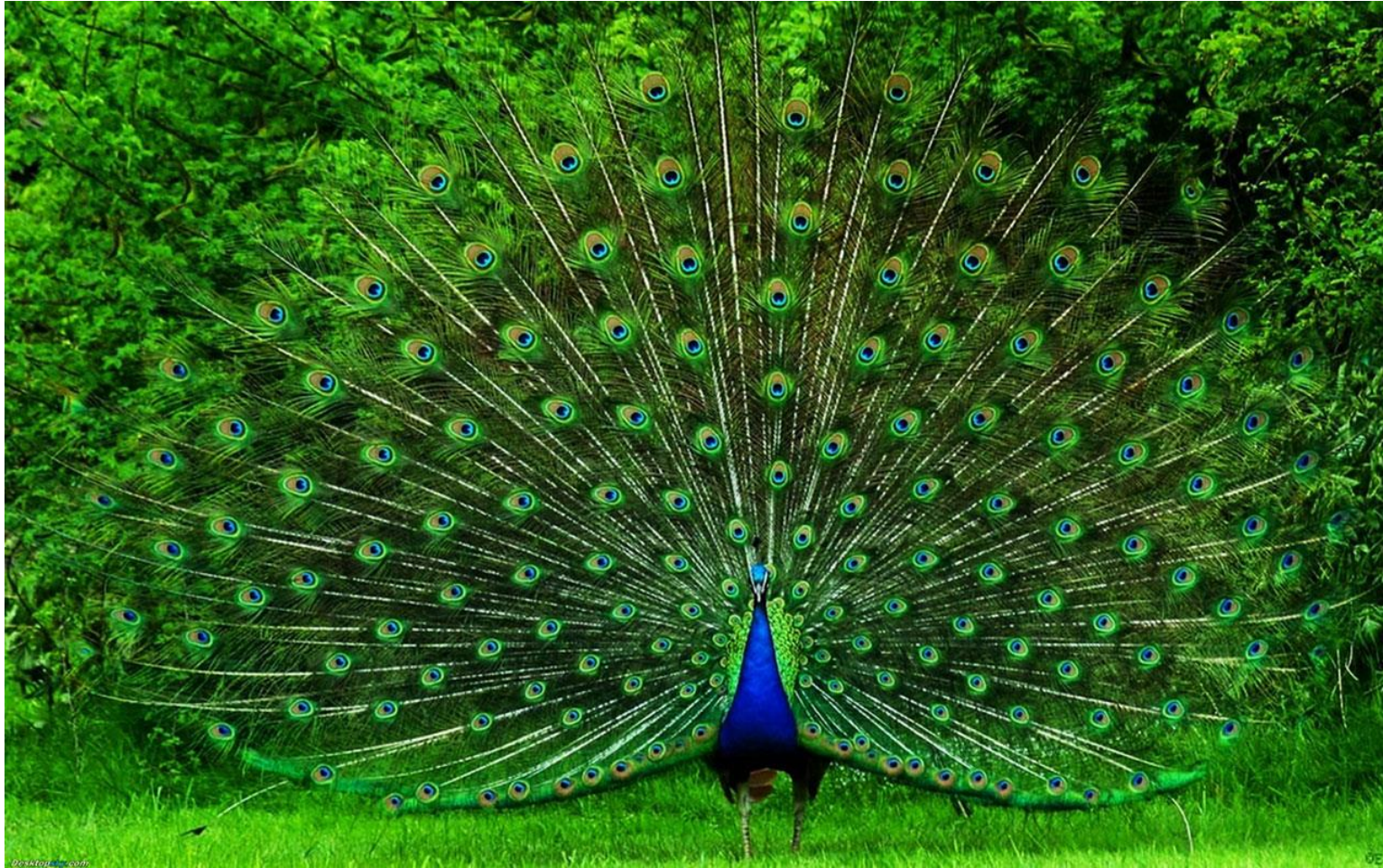
male

male

female

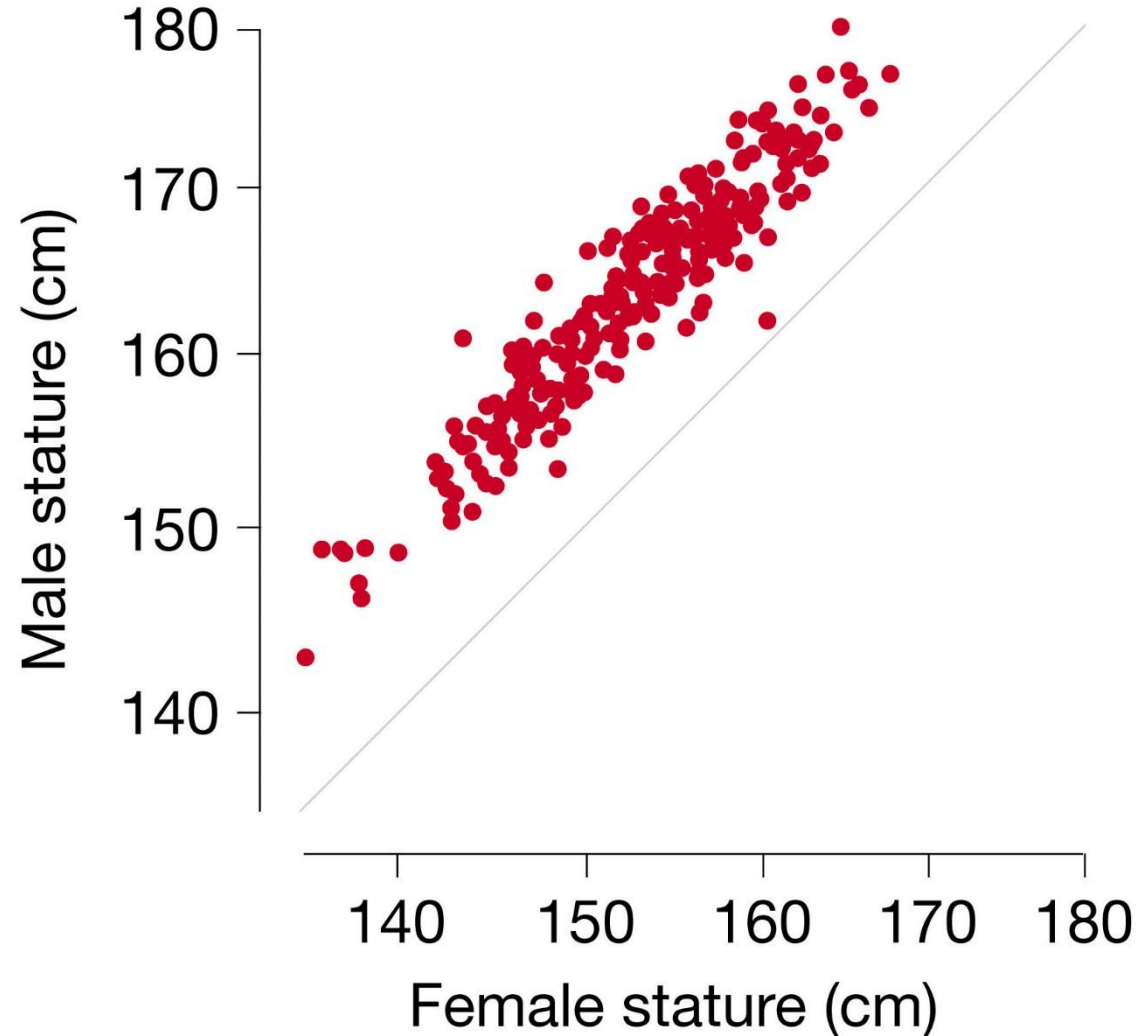


Sexual dimorphism- **An Extreme Example**



Sexual Dimorphism in Humans

- Less extreme sexual dimorphism occurs in humans.
- Males about 10% taller on average.

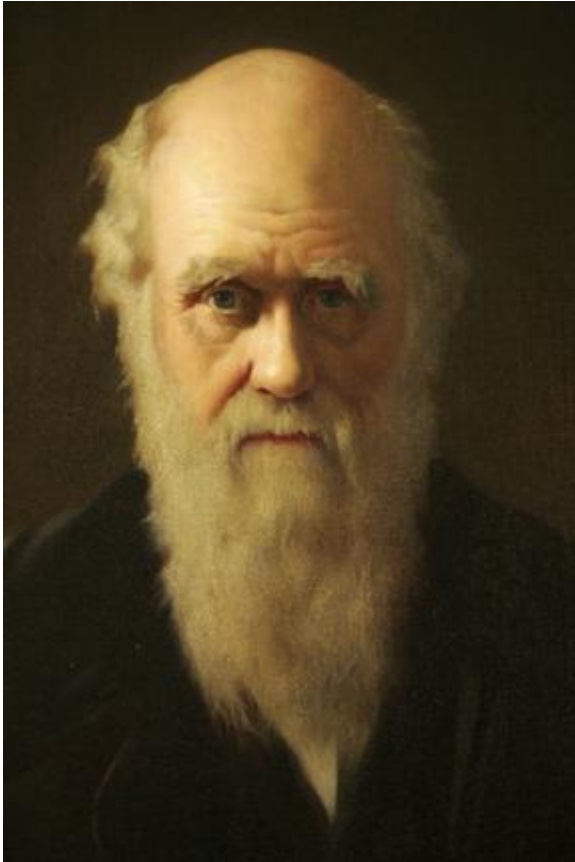


Sexual dimorphism

- Why does sexual dimorphism occur?
- Why does one sex (usually male) is often larger, showier; while the other (usually females) are smaller and very drab to look at!
- Interestingly, many of the traits seen in the showier sex seem likely to reduce prospects of survival (A Male peacock is easily visible to predators!).
- Therefore, evolution by natural selection cannot explain showy traits.
- Darwin came up with an explanation



A male mandrill (a type of baboon)



Darwin's second "major" book:

1871 *On the Descent of Man, and Selection in Relation to Sex*

Why a theory of sexual selection?

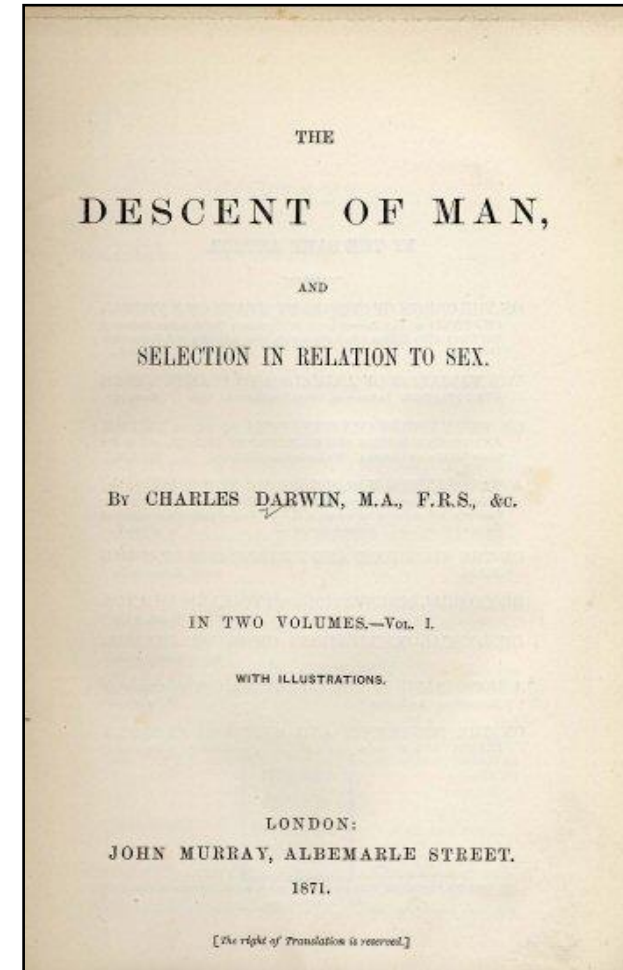
Darwin needed a theory to explain the many extravagant traits that seem to reduce survival

e.g. the peacock's tail

What is sexual selection?

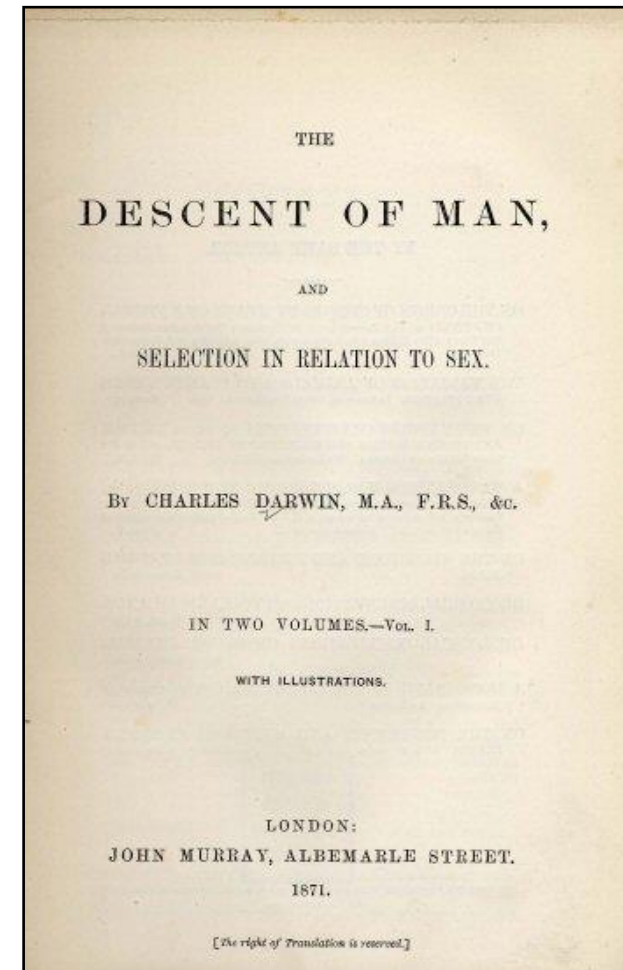
Darwin (1871) defined sexual selection as:

Differential reproductive success due to variation among individuals in success at getting mates.



- The key to this variation lies in the differential roles that males and females play.
- Males can produce a large number of very cheap gametes (sperm)
- Females, however, produce much fewer, but larger gametes (eggs).
- Therefore, males are not limited by the number of gametes they can produce while females are!

- But before that two definitions.....



A key difference in concepts!

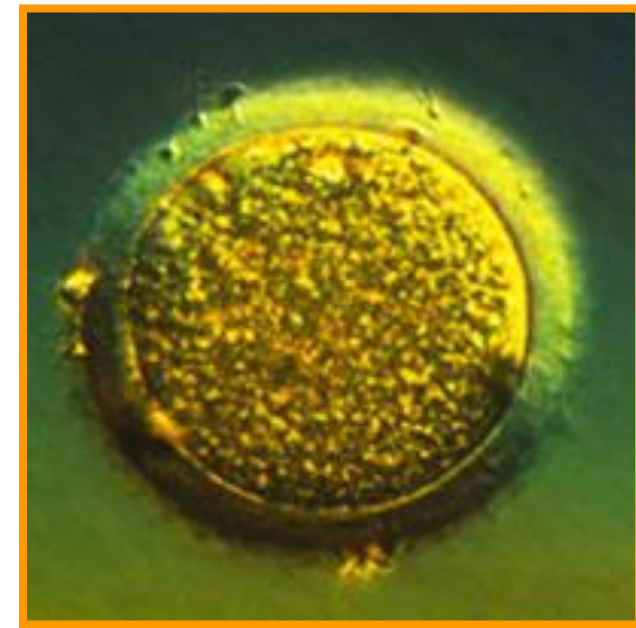
Sex vs. Reproduction

- Sex - process by which a genome is changed by rearrangement and combining of genes, *i.e.*, recombination
- Reproduction - process by which individuals are added to a population

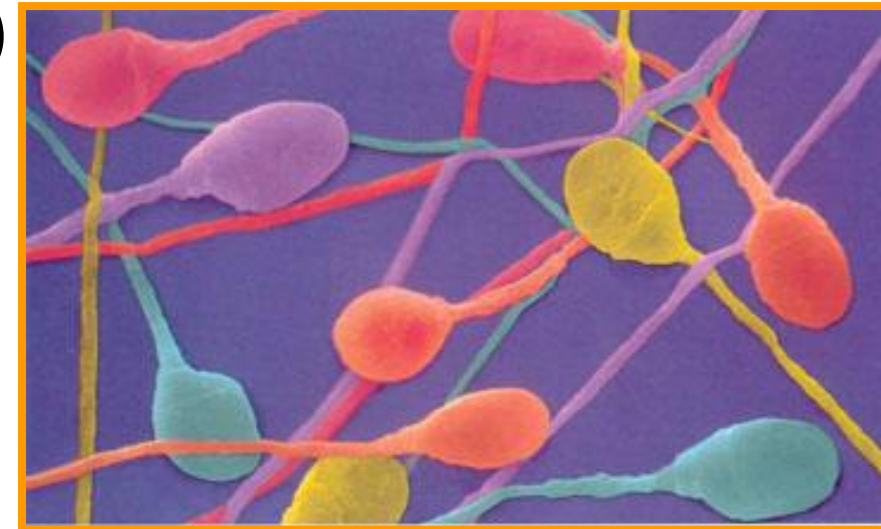
- Sex -changes in kinds of individuals in populations through recombination
- Reproduction -changes in the number of individuals in populations

- This differential production of gametes is known as anisogamy!
- Therefore, males who want to increase individual fitness is selected to mate with as many females as possible.
- Females, on the other hand, are selected to reproduce only with a very few 'selected' males.
- This difference females much more 'choosy' when deciding which male to mate with.
- Another reason why female are choosy is in the difference in parental investment.

FEMALES: Sex that produces few, well-provisioned gametes (eggs)



MALES: Sex that produces innumerable, "cheap" gametes (sperm)



Parental Investment

- Differences in amount of **parental investment** by members of each sex are key in determining which sex will be the choosier.
- Parental investment: energy and time expended on offspring.
- In general, mothers invest more heavily in offspring than fathers.
- In 90% of mammals, females provide substantial parental care and males little or none.
- In general, because of difference between sexes in investment, a female's lifetime reproductive success will be limited by the number of young she can rear.
- In contrast, a males will be limited by the number of matings he can obtain.
- This disparity suggests sexual selection likely to be a more powerful influence on evolution of males than on females.

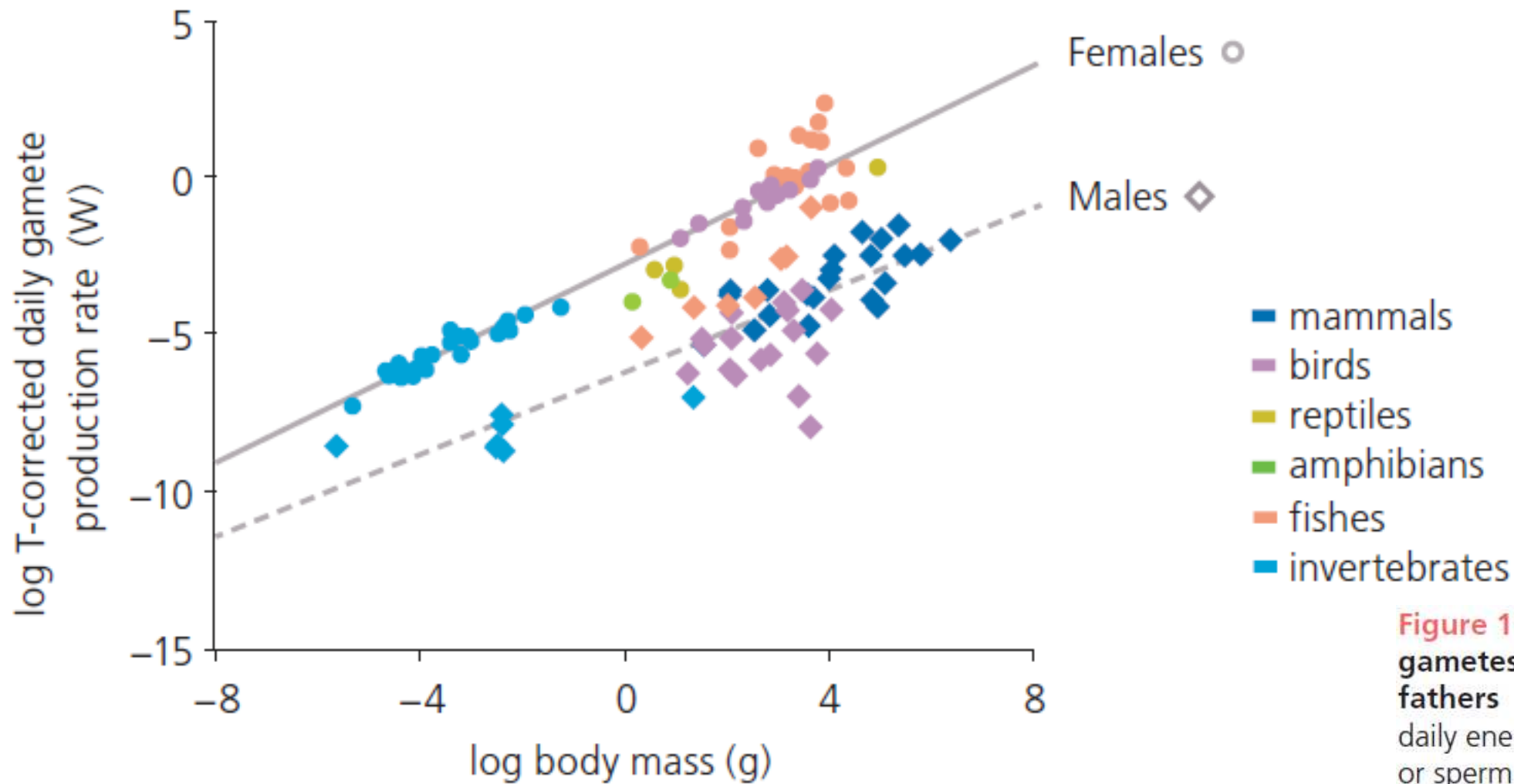


Figure 11.6 Investment in gametes by mothers versus fathers The vertical axis plots daily energy expenditure in eggs or sperm, calculated in Watts and corrected for differences in temperature, for adults in a variety of animals. The horizontal axis represents body mass in grams. Note that both axes use logarithmic scales. From Hayward and Gillooly (2011).

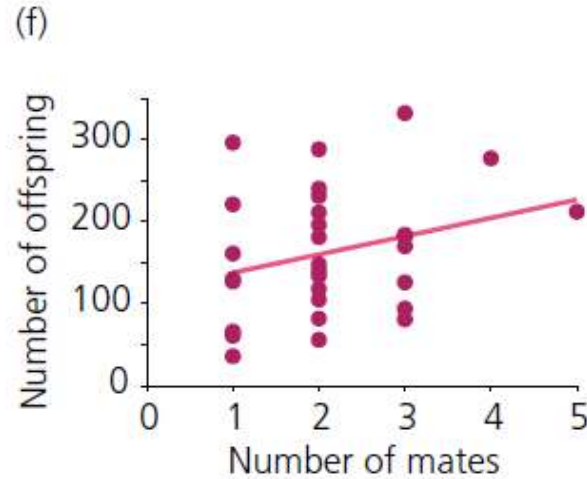
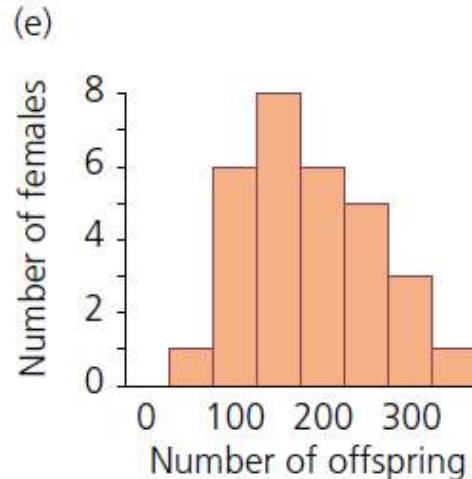
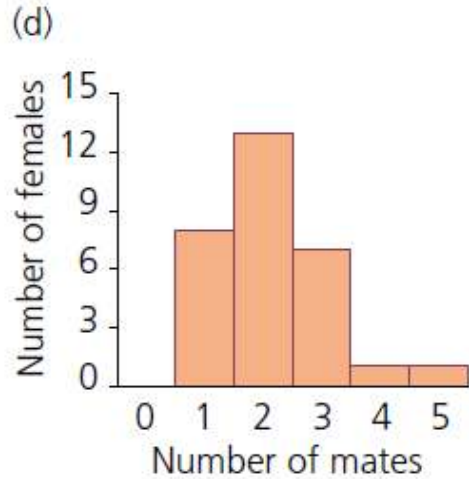
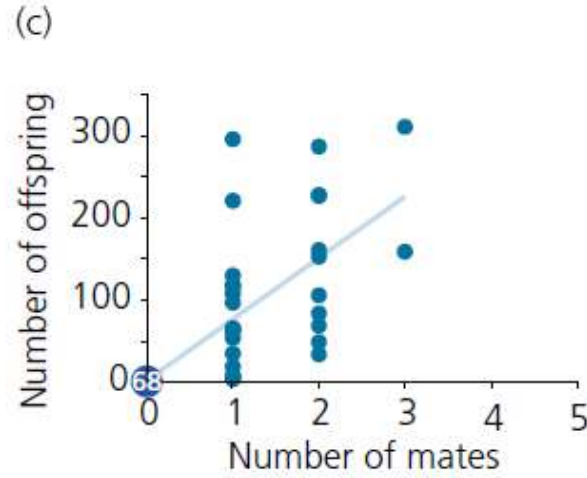
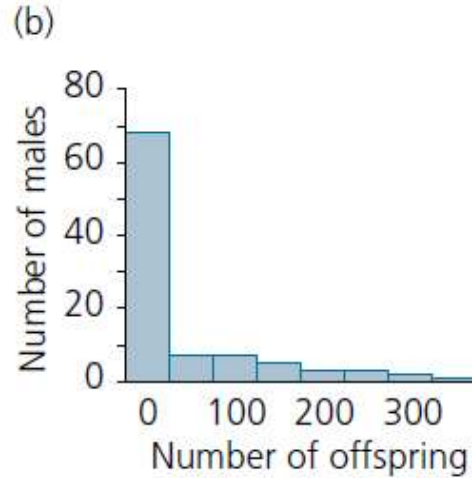
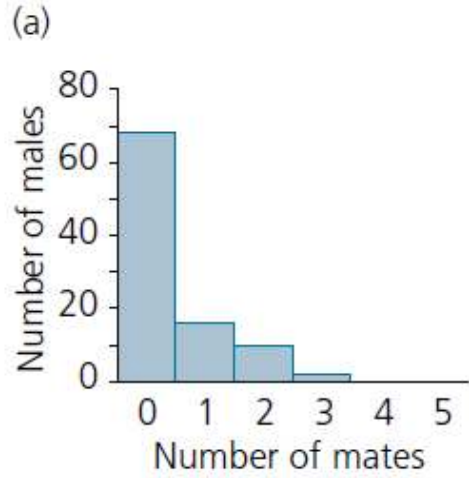
Examples of investment differences

- Rough-skinned newts: males compete to mate with females at ponds. Females visit pond, mate then leave.
- Jones et al. (2002) sampled all males and females and used molecular analyses to assign paternity to all offspring.



Rough-skinned newt (*Taricha granulosa*)

Figure 11-5a Evolutionary Analysis, 4/e
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- Most males failed to mate and there was much greater variation in male mating success. In contrast, all females mated at least once.

- Most males fathered no young and a few males fathered almost all of them. All females reproduced.

Behavioral consequences of this asymmetry of fitness limits

- Males should be competitive with other males
- Females should be choosy in the males they select
- These differences are not inherent to maleness and femaleness so much as they are dictated by survival and fitness.

Forms of sexual selection

- Two ways in which process of sexual selection may develop.
- Males may fight among themselves to control a resource important to females or to control a group of females: **Intrasexual Selection**; **Male-male competition**.
- Males may advertise for females by displaying, fighting or singing: **Intersexual Selection**; **Female choice**.

Sex 'Role reversal'-Females fighting for males!



Bronze-winged Jacana

Giant Water Bugs



Pregnant male Seahorses



Intrasexual selection

- Occurs when individual males can monopolize access to females.
- Fight for control of mates and/or control of resources vital to mates
 - Types of intra-sexual selection:
 1. Combat
 2. Sperm competition
 3. Infanticide
 4. Sneaky strategy

Intrasexual selection

- occurs when individual males can monopolize access to females.

1. Combat

- leads to **sexual dimorphism in size**

Example: northern elephant seals.



♂ ~ 4,000 lbs

♀ ~1500 lbs

Intrasexual selection

1. Combat

- leads to **sexual dimorphism in size**

Example: northern elephant seal.

- can also lead to the evolution of **weaponry**

Example: horns in ungulates and beetles.



Intrasexual selection

2. Infanticide

Example: the African lion



Figure 11-16 Evolutionary Analysis, 4/e
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- Lions live in groups (prides) which are controlled by females.
- One male, usually, mates with all the females in the pride.
- Therefore, all the cubs are fathered by one male.
- When another male takes over the pride, it kills all the cubs of the previous male.
- This induces the females to come into estrous and thereby, willingness to mate with the new male.

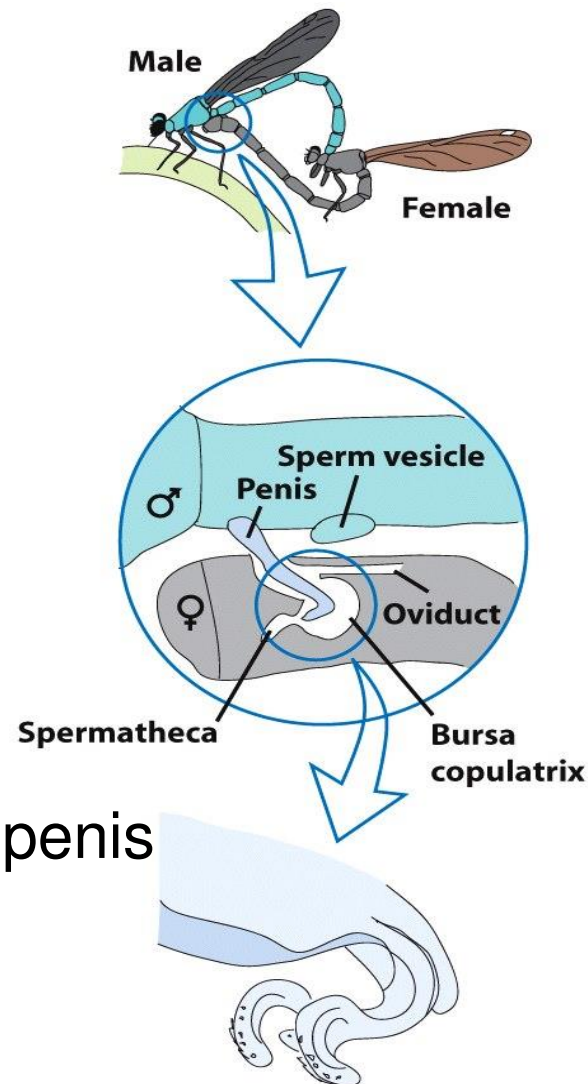
Intrasexual selection

3. Sperm competition

- If a female mates with two or more males, the male whose sperm wins the race to the eggs has higher reproductive success.
 - Ex. of traits needed to be successful
 - Large ejaculates
 - More and longer mating occurrences
 - Other examples include Sperm plugs, scooping out sperm, prolonged copulation, guarding of mate, applying hormones that reduce female's attractiveness to other males.

Sperm competition in damselflies

- The last male to mate was found to fertilize up to 95% (x=80%) of the eggs of the first clutch laid after mating.
- Dissection of females collected before, during, and after copula showed that a male removes a maximum of 87% of the sperm by volume of a previous mate.
-
- This is done by specialized structures on its genitalia

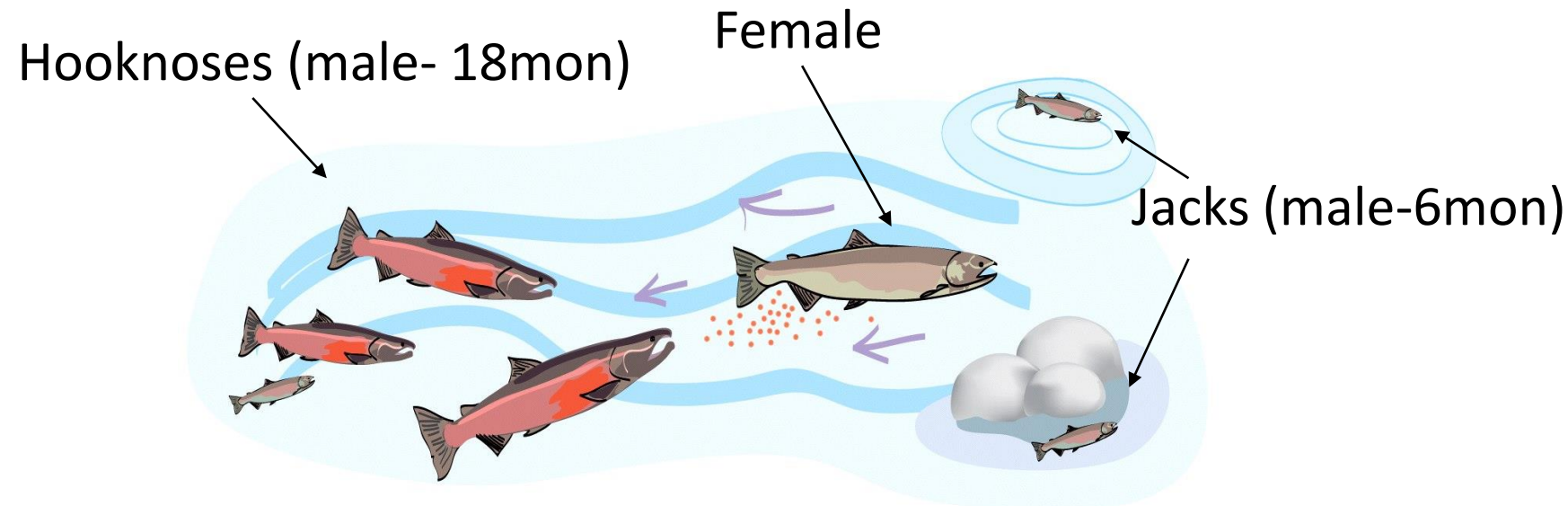


barbed horns on penis

Intrasexual selection

4. Alternative male reproductive strategies.

Example: Sneaky strategy in Pacific coho salmon. Two kinds of males are found, large ones called hooknoses and smaller ones called jacks. These smaller males can mate by sneaky strategy.



Intersexual selection

- occurs when males “advertise” for mates and females choose among different males.
 - Elaborate courtship displays: singing, dancing, or showing off bright color
 - leads to **sexual dimorphism in ornate features**

Intersexual Selection/ Female choice



Are Females Really Choosy?

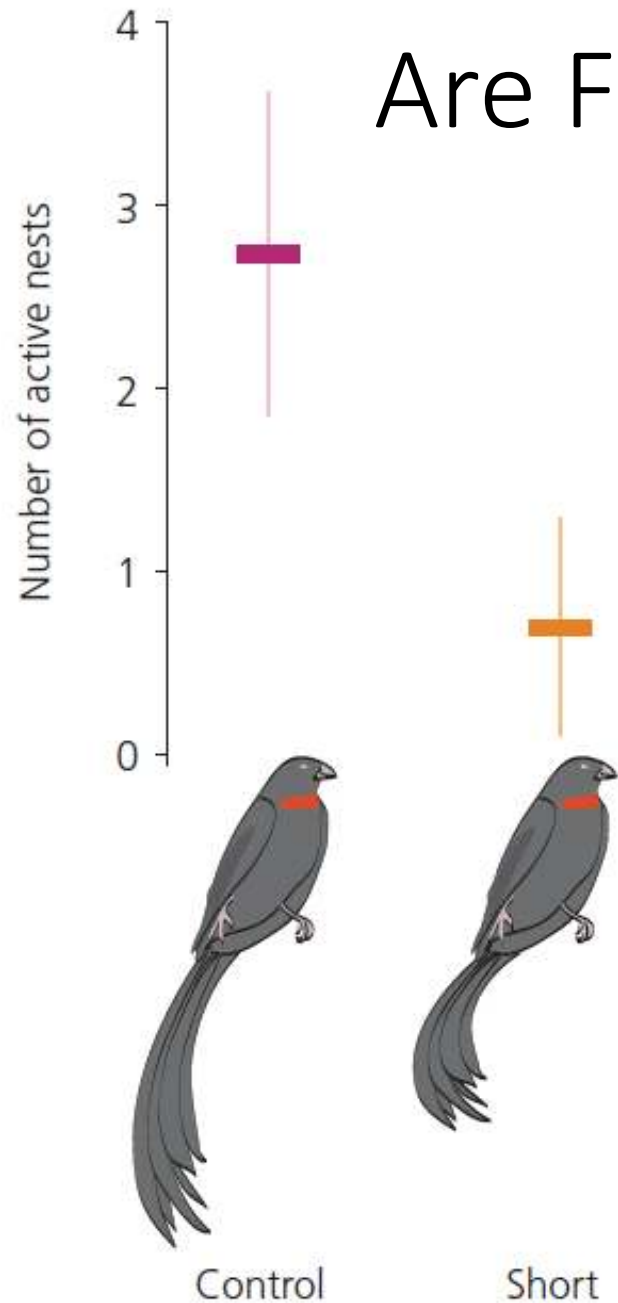


Figure 11.25 Female red-collared widowbirds prefer long-tailed males. Symbols show mean \pm standard deviation number of females that nested in territories of control versus short males. From Pryke and Andersson (2005).

Is Intersexual Selection Costly on males?

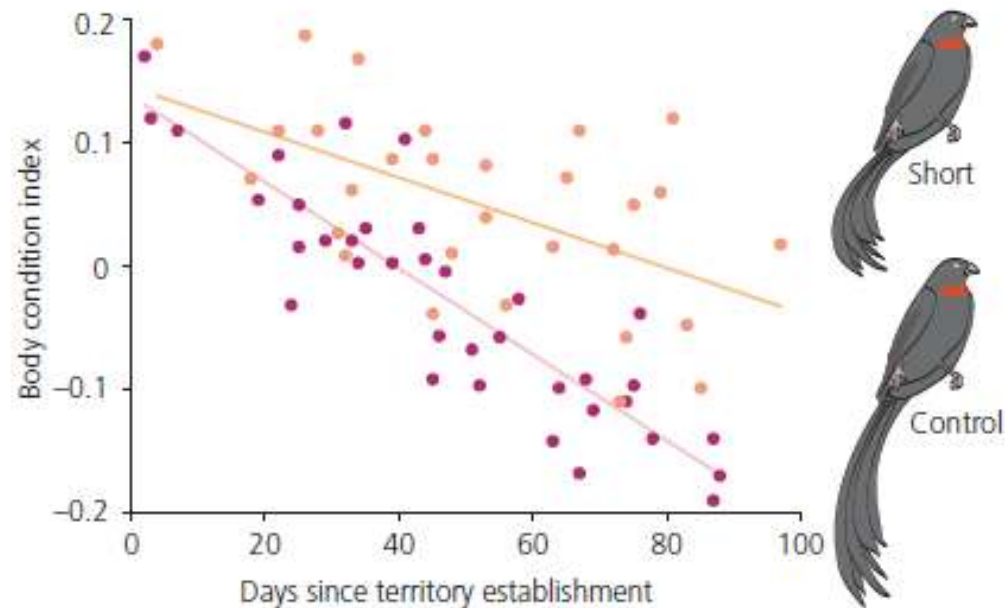


Figure 11.24 Long tail feathers are a ball and chain for male red-collared widowbirds. This graph shows the decline in body condition (weight relative to linear size) throughout the breeding season for males with experimentally shortened tail feathers versus controls. The control males lost weight much more quickly. From Pryke and Andersson (2005).

Are Costly Ornaments Helping Males get More Mates?

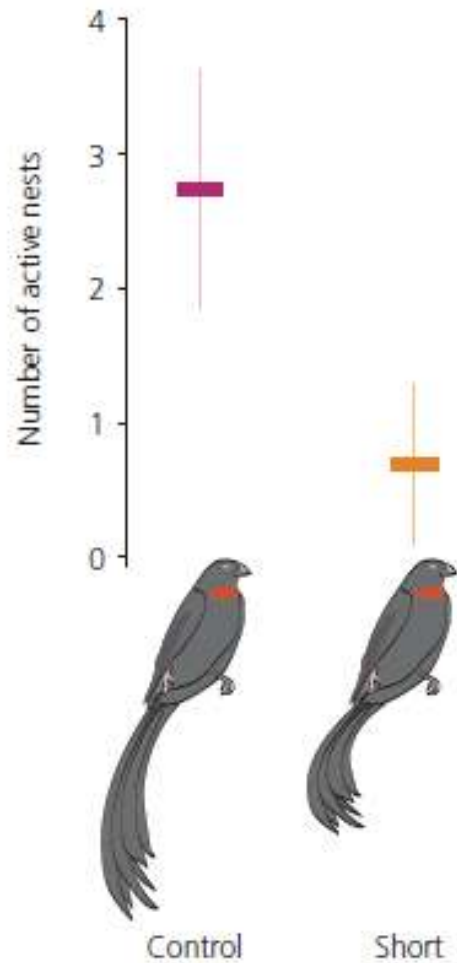


Figure 11.25 Female red-collared widowbirds prefer long-tailed males. Symbols show mean \pm standard deviation number of females that nested in territories of control versus short males. From Pryke and Andersson (2005).

Models of Intersexual selection

Types of intersexual selection:

1. Direct Benefits

- Acquisition of resources

- Good genes

2. Pre-sensory Bias

3. Runaway selection

Intersexual selection

1. Direct benefits- Acquisition of resources

- females directly benefit from choosing certain males.

Example: the common tern

females show a strong preference for males that bring a lot of food.

the amount of food a male brings during courtship is strongly correlated with the amount he brings to feed young.



Direct Benefits- Good genes

- females choose males with certain traits because they are honest “indicators” of overall genetic quality.
- calling in frogs
- -calling in birds
- -plumage color

Zahavi’s “handicap” hypotheses

Extravagant male traits are costly to develop and maintain

Choosing a mate with “good genes” requires an honest signal of genetic quality

Only males in good condition (those with good genes) will be able to fully develop and maintain an ornament

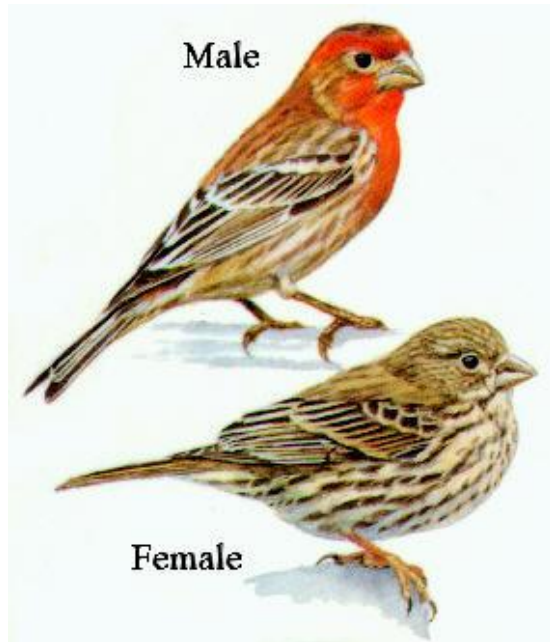


Amotz Zahavi

Zahavi's handicap hypothesis

Some candidate "handicaps"

Note that the handicap itself need not be heritable...it need only provide a reliable index of fitness, and fitness must be heritable



Bright color honestly signals immunocompetence and parasite/disease resistance



Traits that encumber the owner are physiologically costly (exertion in flight) as well as being more expensive to develop



Asymmetry is indicative of developmental instability and possibly "bad genes". Symmetry is chosen in some species

Sensory bias

- predicts that female preference for certain male traits evolves **prior to** the appearance of the male trait.
- females have a pre-existing sensory bias for the trait and males exploit this preference.

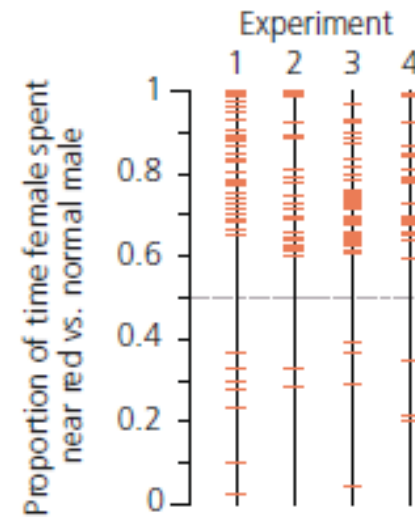
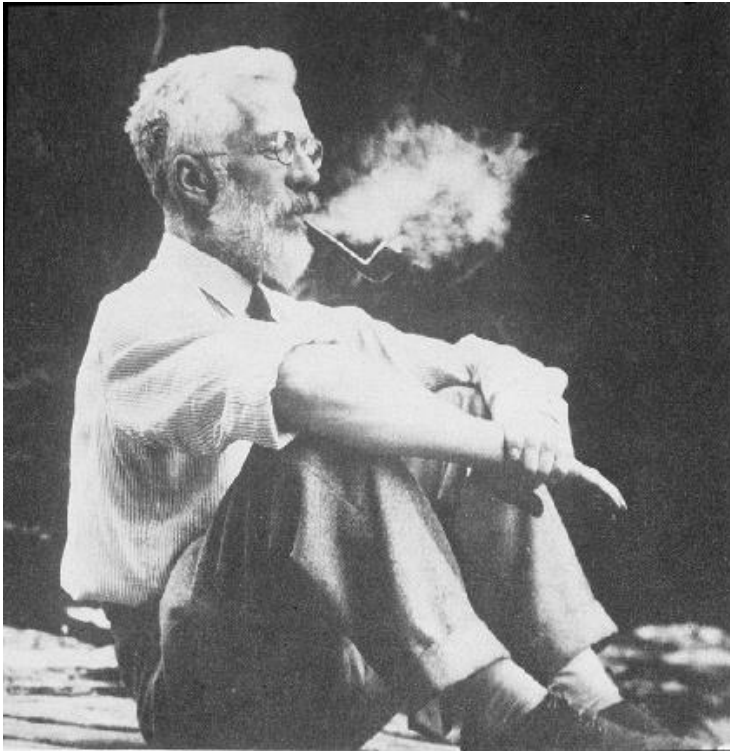


Figure 11.31 Female zebrafish prefer red fluorescent males Each tick represents a female. In all experiments, females given a choice spent, on average, significantly more time near a red fluorescent male than a normal male. Graph redrawn from Owen et al. (2012).

Models of Female Preference?

Runaway Sexual Selection



Ronald Fisher

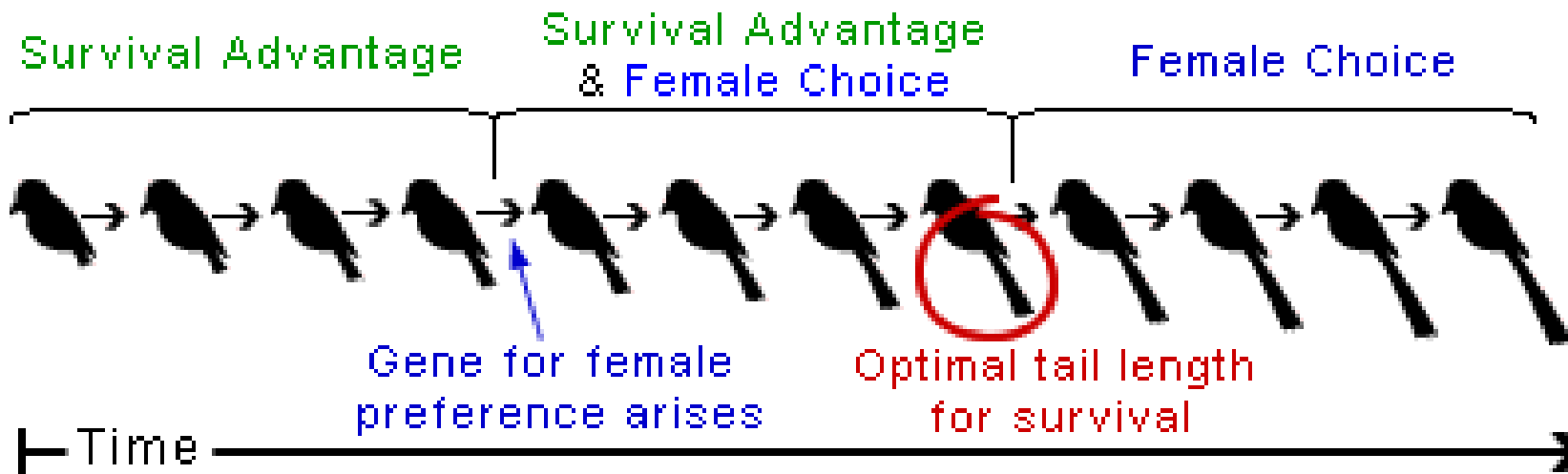


Fisherian Runaway Sexual Selection

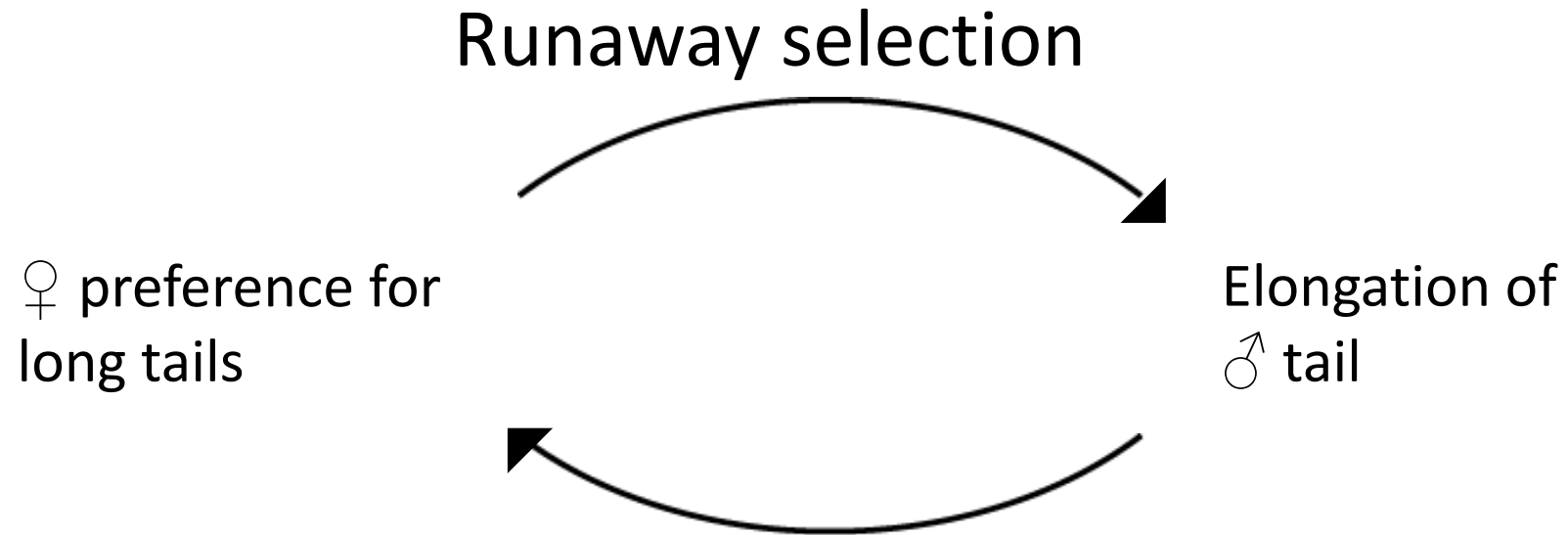
- Imagine a bird population in which females choose mates at random.
- Males with slightly longer tails fly a little better, avoid predation, and so, survive better than males with slightly shorter tails.
- In this situation, a gene for female choosiness (longer tail = sexier) will be favoured, since—by choosing a long-tailed male—she will have sons with longer tails.
- This trait will spread through the population until most males have long tails and most females prefer long-tailed mates.

Fisherian Runaway Sexual Selection

Tail Length increases because of...



Fisherian Runaway Sexual Selection



Fisherian Runaway Sexual Selection

- However, once this has happened, the process may run out of control, until the male trait becomes so exaggerated that it is disadvantageous.
- In other words, female preference, instead of survival advantage, may begin to drive the evolution of ever-longer tails, until males are encumbered by showy plumage that no longer helps them avoid predation

Recap

- Sexual selection explains sexual dimorphism in nature
- Asymmetry in parental investment leads to differential selection pressures in males and females (sexual selection)
- Sex that invests less is more “competitive”, sex that invests more is “choosy”
- Sexual selection is more potent force of evolution in males than in females (with few exceptions like pipe-fishes)
- Intersexual selection (male-male competition): leads to combat, sperm Competition, infanticides, alternative male strategies
- Intrasexual selection (female choice): due to direct benefits like resources, good genes *etc.*, female sensory bias, runaway selection