Whiptail Lizard

1

Sexual Selection

- Charles Darwin and Alfred Russell Wallace
- Noticed that males of many species have highly elaborated traits that seem maladaptive (secondary sexual characters)

2

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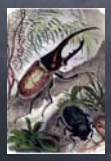
Antlers
Irish Elk (extinct)

Horns
Bighorn Sheep

Elephant Tusks

Hercules Beetle

Male



Female

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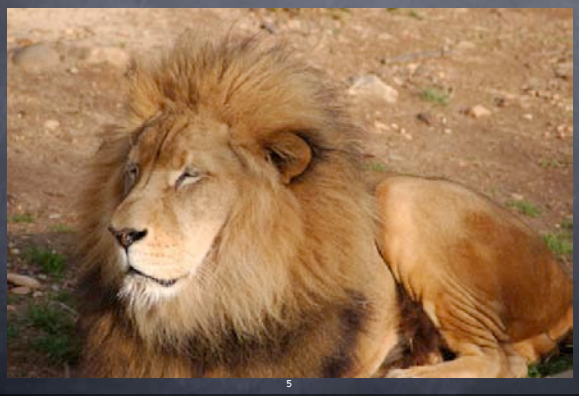
African Lion: Mane is used for protection during male clashes (male-male competition)



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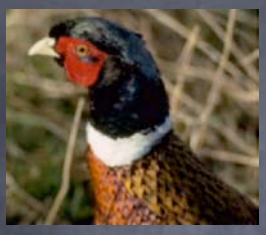

Pheasant: Elaborate bright red wattle on cheek

Pheasant: Elaborate spur used in male-male fighting and by females to choose.

(Notice the fake spur on the right. Some males try to trick females, but do not fight.)

6

Two Types of Sexual Selection

- Male-male competition (intra-sexual selection)
- Mate (female) choice (inter-sexual selection)

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Male-male competition

- Within group dominance
- Female-defense polygyny
- Territorial polygyny
- Lekking (competition for a position in the lek)

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Within group dominance

Grey Wolves

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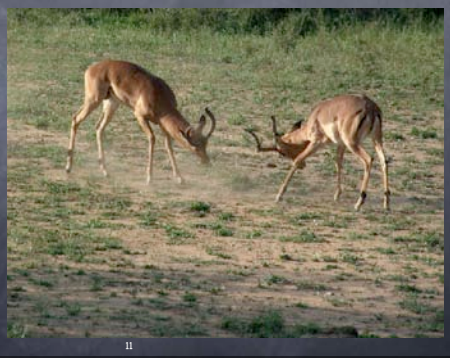
Female defense polygyny

Northern Elephant Seals

10

Territorial defense polygyny

Impala



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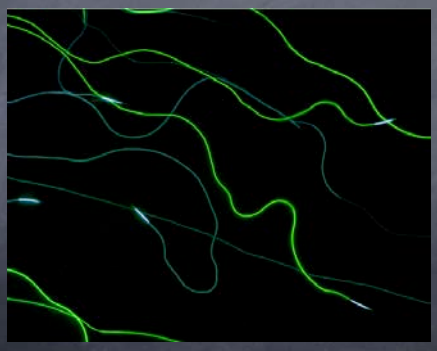
Waterbucks head butting

12

Sperm competition



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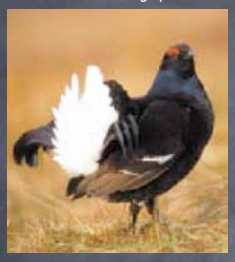
Grouse, a lekking species



Mate Choice

Two broad categories:

- Resource based
- Non-resource based

In most cases, females are the choosy sex, but not always.

Why?

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Why are females choosy?

- Investment cost
  - eggs are expensive relative to sperm
  - internal fertilization and carrying young to term is costly

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When are males choosy?

(sex-role reversal)

- When their contributions exceed the cost of making eggs
- The chances of mating with multiple females is small (biased sex ratio—many females and very few males)

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Example: Sea Horse (males care for the young)

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Mate choice

(Why choose in the first place?)

- mate with correct species
- better fertilization ability or higher fecundity
- provides more food
- better parental ability
- better breeding territory or defended resource
- lower risks or hazards (e.g., predation)
- partner offers higher heritable viability or other heritable qualities that are important

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Mate choice

- Direct benefits (proximate benefits)

Example: Bush crickets (nuptial gifts)

1. Males provide spermatophores which females feed on. Often consist of up to 30-40% of male body weight (i.e., very costly)

2. More spermatophores allow female to lay more eggs.

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Mate Choice

- Indirect benefits (ultimate benefits)
  - Good genes
  - Others (e.g., Fisherian runaway sexual selection, which will not be discussed)

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Good Genes

- Females (or males) choose a mate which offers high quality genes influencing survival
- Mate quality is indicated by a secondary trait
- Secondary trait must be heritable
- Must be heritable variation in mate quality
- No, low, or high cost to males bearing the trait (e.g., bearing the cost is an indicator of good genes..."handicap model")

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Good Genes Example

Gray Tree Frog (Hyla versicolor)
Short vs. Long Calls

22

Fitness Measure	High Food	Low Food
Larval growth	LC	LC
Time to meta.	LC	
Mass at meta.		
Larval survival		
Postmeta. growth		LC

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Final Topics

- Lekking and the evolution of leks
- Sensory bias/exploitation

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What are leks?

An aggregation of males which females visit only for the purpose of mating.

- No male parental care (only contribution is sperm)
- An area that males aggregate and mate with females that is not associated with feeding, etc.
- Display sites of males contain no significant resources to females (e.g., nesting site)
- Females have the opportunity to choose, or shop, among available males

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Evolution of leks

- lower predation risk for males and females
- passive attraction; more males is better
- hotspot model (males congregate in areas that increase the probability of encountering females)
- black hole model (females are not choosy, but wish to avoid dangers associated with mating)
- hotshot model (females choose the "best" male; poor males congregate near good males in the hopes of increasing their chances)

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Bowerbirds

An example of sexual selection in a lekking species: Males build and decorate courtship arenas, called bowers, on leks for the purpose of courting females.

Females prefer males with lots of blue and yellow objects at the bower. They also prefer neat bowers.

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While the female (grey) sights and watches, the male produces an elaborate courship display, including dances, jigs, wingflips, and vocalization. Males, hoping to woo females, will even clasp a yellow flower or feather in the beak.

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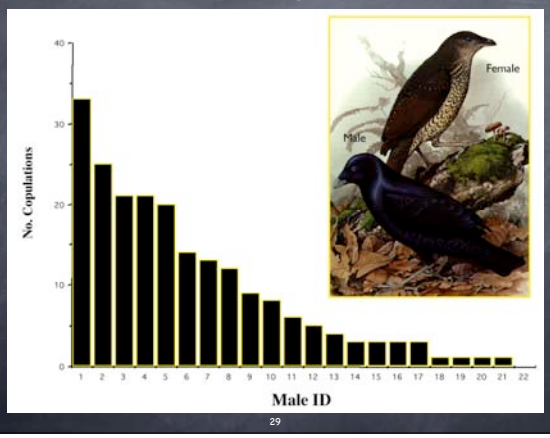
Males with the best of all these traits get the most matings.



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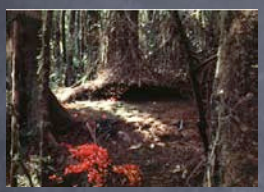
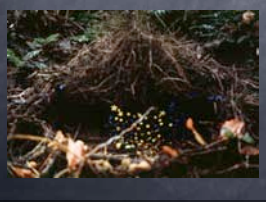
Many species of bowerbirds build elaborate bowers, decorate them with colorful objects, and have elaborate courship displays



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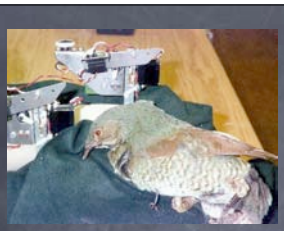
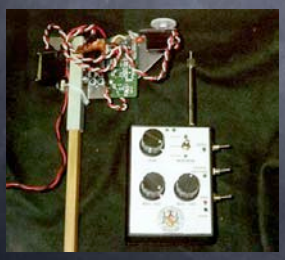


Fembots



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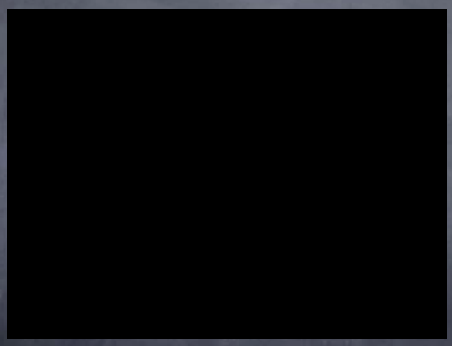

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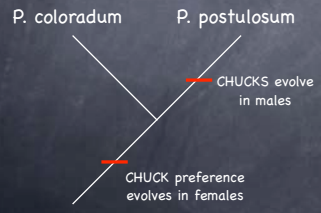
Sensory Bias/Exploitation

Latent preferences in females are used by males to gain greater reproductive success.

Physaleumus Frogs



P. coloradum: Males attract mates by calling using WHINES

P. postulosum: Males attract mates by calling using WHINES and some use CHUCKS

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Experiment

Take tape playback unit with recording of P. coloradum WHINES with P. postulosum CHUCKS to pond. Play and observed, relative to just WHINES, how many females are attracted.

	Female Pref.
WHINE	NO
WHINE+CHUCK	YES

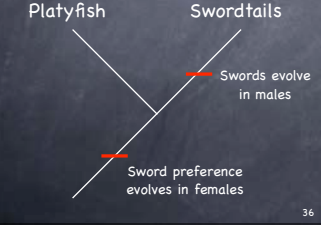
35

Swordtails

Swordtails

Platyfish: No swords. When males are modified to have swords, the female Platyfish prefer them

Swordtails: The males of some species have swords. Females prefer males with long swords.



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Helpful behaviors

- Alarm calls (e.g., Belding ground squirrel)
- Sentinel behavior (e.g., meerkats)
- Nest helping
- Eusocial behavior

Actor performs some action that benefits another (the recipient).

39

How do you explain the evolution of helpful behavior?

- Mutualism (actor benefits)
- Reciprocal altruism (actor eventually benefits)
- Kin selection (indirect selection)

40

Interaction	Social Donor	Social Recipient
Mutualism	+	+
Reciprocity	+ (delayed)	+
Altruism	-	+
Selfishness	+	-
Spitefulness	-	-

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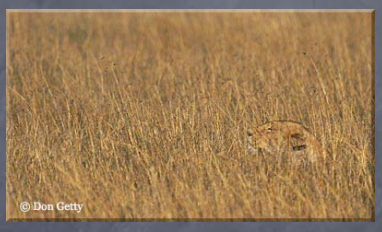
Mutualism



Groups of lions can bring down larger prey and better defend the prey from other lions and hyenas.

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Bluegill Male: Males form nest sites of 50 to 100 males. Mutualistic because predation is lower if your nest is surrounded by others.

Male lions will often cooperate in ousting resident males from a pride, or in defending a pride from other (outside) groups of males. Often, the males in a pride are closely related.

Reciprocal Altruism

Dispense an altruistic (beneficial) act, which is later returned as an equally beneficial act.

Most likely when:

- Repeated interactions between individuals
- Many opportunities for altruism
- Good memories
- Potential altruists interact in symmetrical situations

Groomer helps groomee by removing parasites & debris

Favor is returned in baboon females

Females hang out together in groups of about 10

Often fail to feed (on blood!) in a given night

Will share blood by regurgitating blood meals to others

Share more frequently with relatives, nestmates, and those that shared with them earlier.

"Would I lay down my life to save my brother? No, but I would to save two brothers or eight cousins."

— JBS Haldane

- "The Creator, if He exists, has a special preference for beetles."
- " Four stages of acceptance: i) this is worthless nonsense; ii) this is an interesting, but perverse, point of view; iii) this is true, but quite unimportant; iv) I always said so."
- "Now my own suspicion is that the Universe is not only queerer than we suppose, but queerer than we CAN suppose."

— JBS Haldane

49

William Hamilton (1936–2000)

Hamilton, W. D. 1964. The genetical evolution of social behavior, I and II. J. Theor. Biol. 7:1-52.

50

Kin Selection

Hamilton's rule: A gene for altruistic self sacrifice will spread through a population if the cost to the altruist is outweighed by the benefit to the recipient devalued by a fraction representing the genetic relatedness between the two.

51

$$Br - C > 0$$

$$w_i = a_i + \sum_j r_{ij} b_{ij}$$

w = inclusive fitness
a = direct benefit
r = relatedness
b = benefit

52

Direct Selection	N_1 survive without parental care
	N_2 survive because of parental care
Indirect Selection	N_3 survive because of help

53

Direct Selection	N_1 survive without parental care
	N_2 survive because of parental care
Indirect Selection	N_3 survive because of help

Direct Fitness = (N_1 X r) + (N_2 X r)

Indirect Fitness = N_3 X r

Direct + Indirect Fitness = Inclusive Fitness

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Half-siblings

Shared Parent

Actor Recipient

r = 1/4

Full-siblings

Mother Father

Actor Recipient

r = 1/2

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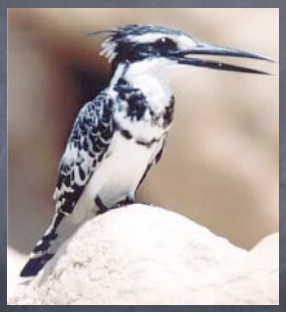

Pied Kingfisher

56

Reyer, H. U. 1984. Investment and relatedness: A cost/benefit analysis of breeding and helping in the pied kingfisher. Animal Behavior 32:1163-1178.

- Year-old males that fail to find a mate can become primary helpers, secondary helpers, or delayers.
- Primary helpers help their mother raiser her nestlings, really throwing themselves into the job.
- Secondary helpers help an unrelated individual a little, or they can just sit out the year, becoming delayers

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Eusociality

- Overlap in generations between parents and offspring
- Cooperative brood care
- Specialized castes of nonreproductive individuals

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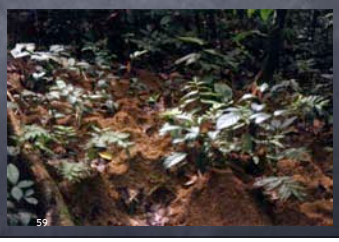

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Haplodiploidy

Mother (diploid) Father (haploid)

1/2 1 1/2

Sister Brother

r(sister-sister) = 3/4
r(sister-brother) = 1/4
r(mother-daughter) = 1/2
r(mother-son) = 1/2

60

Because sisters are highly related, a female worker should bias her help towards reproductively competent sisters, rather than toward her brothers.

The queen is equally related to sons and daughters, and favors equal investment in each.

Conflict between queen and daughters (parent-offspring conflict).

61

Sisters share three times more genes with each other than with brothers. This favors a stable investment ratio of 3:1 in favor of sisters.

Queen wants a 1:1 investment.

62

Are hymenopteran colonies biased in their allocation of resources to males/females?

Yes:

(1) Trivers and Hare (1976) found the expected 3:1 investment ratio (weight of all female reproductives vs. male reproductives).

(2) Mueller (1991) showed that worker hymenopterans can alter their investment in colony mates depending on their relatedness.

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Mueller (1991)

- When a colony is founded by a single female, the asymmetry in relatedness (r=3/4) persists, and workers invested more energy in females.
- If queen is removed, a worker takes over her role. Now workers are helping raise their nieces (r=0.375) and nephews (r=0.375). The investment in males increases.

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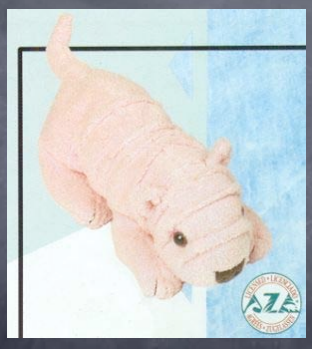

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Naked mole rat

- Live underground in groups of up to 200 individuals
- Breeding restricted to a single "queen" and to several "kings"
- Others are non-reproductive and act as workers
- Diploid, but colonies composed of closely related individuals (inbred, r is about 0.81)
- Up to 85% of all matings are between parents and their offspring, or between full sibs.

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