Reproductive Ecology & Sexual Selection

REPRODUCTIVE ECOLOGY & SEXUAL SELECTION

REPRODUCTION

- Asexual
- Sexual
  - Attraction, Courtship, and Mating
  - Fertilization
  - Production of Young

Benefits of Asex

1. Eliminate problem to locate, court, & retain suitable mate.
2. Doubles population growth rate.
3. Avoid “cost of meiosis”:
   - genetic representation in later generations isn’t reduced by half each time
4. Preserve gene pool adapted to local conditions.

The Evolutionary Enigma of Sexual Reproduction

- Sexual reproduction produces fewer reproductive offspring than asexual reproduction, a so-called reproductive handicap

The Energetic Costs of Sexual Reproduction

- Allocation of Resources

Benefits of Sex

1. Reinforcement of social structure
2. Variability in face of changing environment.
   - why buy four lottery tickets w/ the same number on them?
Relative benefits: Support from organisms both asexual in constant & sexual in changing environments
- aphids have wingless female clones & winged male & female dispersers
- ciliates conjugate if environment is deteriorating
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**TWO SEXES**

- **Conjugation**
  - Ciliate protozoans with + & - mating types.
- **Monoecious**: both sexes in one individual.
- **Dioecious**: separate sexes
  - one sex makes small haploid gametes (sperm)
  - the other makes big ones (eggs)

**Simultaneous Hermaphrodites**

- Advantageous if limited mobility and sperm dispersal and/or low population density
- Guarantee that any member of your species encountered is the “right” sex
- Self-fertilization still provides some genetic variation
- Or prevent self-fertilization by
  - copulation
  - producing sperm or eggs at different times

**Sequential Hermaphrodites**

- **Protandry**: when all else equal
  - make sperm when small
    - you still make more than needed
  - make eggs when large
    - costlier & bigger
- **Protogyny**: when all else isn’t equal
  - especially if big individuals get more mates
    - be a big male: wrasses.

**Determinate (fixed) Gender**

- **Gametic determination**
  - Heterogenic male determination (XY male)
  - Heterogenic female determination (XY female)
  - Haplotypic male determination (XO male)
- **Environmental determination**
  - Temperature
  - Intrauterine position

**Determinate Gender, yet Biased Sex Ratios**

- **Primary Sex Ratio**:
  - Sex ratio at fertilization
- **Secondary Sex Ratio**:
  - Sex ratio at birth
- **Tertiary Sex Ratio**:
  - Sex ratio at sexual maturity
- **Quaternary Sex Ratio**:
  - Sex ratio of adult population

**Biased Sex-ratios in Red Deer**

- ↑ frequency of male calves to dominant mothers
  - Dominant moms more likely to yield dominant bucks → ↑ odds of perpetuating her genes
  - Δ ratio probably from pre-implantation events
- ↓ frequency of male calves in poor conditions (E.g., ↑ density)
  - Males larger → more expensive to raise
  - Δ ratio probably from post-implantation events
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External Fertilization
- Only in water
  - gametes must be moist.
- Gamete release is synchronized.

Broadcast Spawning
- E.g. marine inverts - larval mortality is high.
- Release in response to:
  - smell of other gametes
  - environmental cues
    - Palolo Worm

Mate Attraction — Courtship
- Auditory
- Chemical
  - Pheromones
- Visual
  - Colors
  - Bioluminescence
  - Behaviors

Courtship Behavior
(a) Orienting
(b) Tapping
(c) “Singing”

Courtship Spawning
- In fish, amphibians, & some marine inverts
- Behaviors stimulate gamete release
- Produce fewer eggs but may add in parental care
  - it’s a balance of investment strategy

Internal Fertilization
- Terrestrial forms need internal fertilization so gametes don’t dry out
- Decreases energy spent on sperm production
- Ensure large amounts of your sperm are on target
- Allow females to store concentrated sperm

- Spermatophores are sperm packages
  - spiders, squid, salamanders
- Adpressed Cloacas
  - birds lack intromittive organs
Copulatory Organs

- Legs
  - squids & spiders
- Claspers
  - sharks & rays
- Penises
  - insects
  - turtles, crocodiles — protrusable
  - lizards, snakes w/ paired hemipenes — eversible
  - marsupials w/ bifurcated penis
  - eutherian mammals w/ penis & baculum.

Estrogens & Ovulation

Ovulation triggered by a sharp rise in estrogens

Estrogen rise and female reproductive behavior

- Proceptive behavior: "flirting" — advertising sexual state
- Receptive behavior: attentive to male courting
- Conceptive behavior: accepting copulation

Oviparity: Egg Laying

- Yolk w/ protein & fats
  - Energetically very expensive!
- Protective Coating
  - jelly-like substance in aquatic forms
  - earthworm's cocoon
  - horny egg case of some sharks
  - calcareous or leathery shell of birds & reptiles

Oviparity

- Birds

Continued Parental Investment

- Nest guarding
- Brooding
- Resource allocation
  - Less energy spent on egg production
  - Use energy insuring development of fewer offspring
  - Often, females spend energy on egg production
  - Males do the parental care

Ovoviviparity: Retain Eggs Internally

- "Mobile nest"
- Keeping eggs warmer speeds development.
  - Cold climate reptiles retain eggs rather than laying them.

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Viviparity: Maternal Nourishment
- Maternal Nourishment
  - Spreads maternal energy demand over longer time period
  - Allows embryo to grow beyond original egg size
- Placenta connects embryo to mother for nutrition & gas exchange.
  - Placental mammals
  - Reptiles (rattlesnakes & sea snakes)
  - Fish (sharks, guppies, surf perch)

Viviparity: Maternal Nourishment
- Maternal Nourishment
  - Spreads maternal energy demand over longer time period
  - Allows embryo to grow beyond original egg size
- Aplacental viviparity: intra-uterine feeding.
  - "Uterine milk" - rays
  - Oophagy (& adelphophagy!) - mackerel sharks

Aphids — a little bit of everything!
1. Asexual (parthenogenic) viviparity
   - And "telescoping generations" (born pregnant!)
2. Seasonally alternating with a dioecious generation having:
   Sexual oviparity
   - Parthenogenic live birth (all females)
   - And the baby being born already has a baby!

EVOLUTION OF POPULATIONS
- Genetics & Variability
- Non-Adaptive Evolution
- Adaptive Evolution: Natural Selection
- Sexual Selection

“Survival of the fittest”
“Reproduction of the fittest”
Sexual Selection

- **Natural Selection** (NS): differential reproduction due to differential survival.
- **Sexual Selection** (SS): differential reproduction due to increased Reproductive Success (RS) despite possible decreased survival.

Sexual Selection

- Even though some variations may increase survival, health, competitive success, etc., …
- they will **not** increase in frequency in the gene pool if they are not also associated with increased reproductive success!

- Even though some variations may decrease survival, health, competitive success, etc., …
- they **will** increase in frequency in the gene pool if they are also associated with increased reproductive success!

Sexual Selection and the Energetic Costs of Reproductive Success

- Increased Reproductive Success comes at increased energetic costs → decreased survival

  - Aerobic metabolism up 25x for several hours
  1. Advertising calls (chorus)
  2. Aggressive calls
  3. Courtship calls (solo)

Sexual Selection

- Observed sexual dimorphism
  - sexes differ in size, color, or behavior
- Some differences don’t aid survival
  - dimorphic feature makes animal more obvious

Social Sex

- Promiscuous
  - No social bonding
- Monogamous
  - One female + one male
- Polygamous (sexually dimorphic)
  - Polygynous
    - One male + multiple females
  - Polyandrous
    - One female + multiple males
Sexual Selection

• **Intrasexual Selection:**
  – competition among members of one sex for access to members of the other sex.

**Game Theory (rock-paper-scissors)**

**Frequency-dependent Intrasexual Selection:**

– Oscillating frequencies

**Side-blotch lizard**

– Orange-spotted males
  • Aggressive, large harems

– Blue-spotted males
  • Less-aggressive, small harems
  • Yellow-spotted males
  • Non-aggressive, no harems

Female Choice

• **Intersexual Selection:**
  – ability of one sex to woo the opposite sex.
  – a.k.a. Female Choice.

Female Choice in New Guinea

Birds of Paradise & Hills Tribes

https://www.youtube.com/watch?v=KIYkpwyKEhY
https://www.youtube.com/watch?v=DU-V3OYwwQU

• Bowerbirds: display is separate from bird.
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**Social Learning & Mate Choice**
- Female guppy introduced to unaccompanied males
  - Choose most brightly ornamented
- Female guppy introduced to one accompanied male + unaccompanied males
  - Choose whichever color-pattern the accompanied male has

**Why Females Choose and Males Fight: Parental Investment & Sexual Selection**
- Sex w/ most invested has most to loose:
  - Eggs more “expensive” than sperm
  - Females must be selective
- Female RS limited by # of young they raise.
- Male RS limited by # of females they mate.

**Reversed Dimorphism**
Where the female is the pursuer because she invests less.
- Phalarope females are bigger and brighter.
  - Females lay a clutch every 10-12 days
  - Male clutch care takes 3 months
  - Females will destroy eggs to free up a male
  - Allo male lions, primates, mice

**MATING SYSTEMS**
- Monogamy ~1% of bird spp
- Social monogamy ~90% of bird spp
- Polygyny ~2% of bird spp
- Polyandry <1% of bird spp
- Promiscuity ~6% of bird spp

**Paternal brood care vs. resource supply in species of Eurasian warblers**

**Speaking of the Birds and the Bees . . .**
- Super polyandry / abbreviated promiscuity
- Sperm competition

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