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
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 — Auditory

Mate Attraction — Chemical
- Insect pheromones
- Vertebrates too
  - snakes
  - mammals

Mate Attraction — Visual
- Displays include
  - colors
  - behaviors

Courtship Behavior
(a) Orienting
(b) Tapping
(c) "Singing"
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Courtship Spawning
- In fish & some marine inverts
- Behaviors stimulate gamete release
- Produce fewer eggs but 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, frogs
  - Adpressed Cloacas
    - birds lack intromittive organs

Estrogens & Ovulation
Ovulation triggered by a sharp rise in estrogens

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

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

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

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
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Ovoviviparity: Retain Eggs Internally

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

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!

Aphids — a little bit of everything!

- Aphid yearly cycles

EVOLUTION OF POPULATIONS

- Genetics & Variability
- Non-Adaptive Evolution
- Adaptive Evolution: Natural Selection
- Sexual Selection
### 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 and the Energetic Costs of Reproductive Success

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

  - Mating calling in frogs is the most energetically expensive activity in their life.
  - Aerobic metabolism up 25x for several hours
  1. Advertising calls (chorus)
  2. Aggressive calls
  3. Courtship calls (solo)

### 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.

### Sexual Selection and Game Theory

- **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
Sexual Selection

- Intrasexual Selection
- Intersexual Selection:
  - ability of one sex to woo the opposite sex.
  - a.k.a. Female Choice.

Female Choice

- Bowerbirds: display is separate from bird.

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
  *Ala* lions, primates, mice