

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

Figure 23.16

The Energetic Costs of Sexual Reproduction

- Allocation of Resources

Brood Size	Male (%)	Female (%)
Reduced brood size	~90	~10
Normal brood size	~60	~40
Enlarged brood size	~30	~70

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?

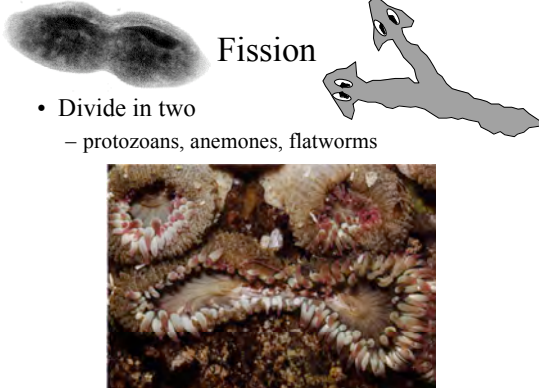
Relative benefits: Support from organisms both asexual in constant & sexual in changing environments

- aphids have wingless female clones & winged male & female dispersers
- ciliates conjugate if environment is deteriorating

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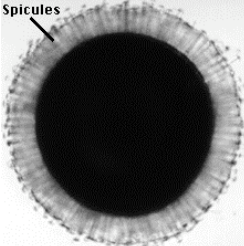
Fission

- Divide in two
 - protozoans, anemones, flatworms




Cloning

- Grow cells
 - Gemmules of sponges.



Parthenogenesis

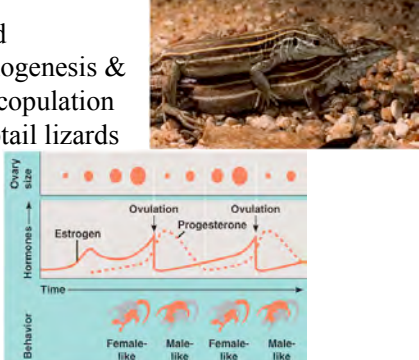
- Eggs develop w/o fertilization
 - some rotifers, fish, crustaceans, insects, & lizards.
- *Obligatory*
 - Whiptails
- *Facultative*
 - Snakes
 - Aphids



*Whiptails — *Cnemidophorus uniparens**

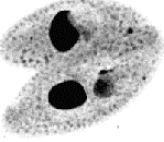
Parthenogenesis

- Derived parthenogenesis & pseudocopulation in whiptail lizards




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



Simultaneous sperm exchange

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Sequential Hermaphrodites

- **Protandry**: male → female
 - anemonefish



Sequential Hermaphrodites

- **Protogyny**: female → male
 - wrasses



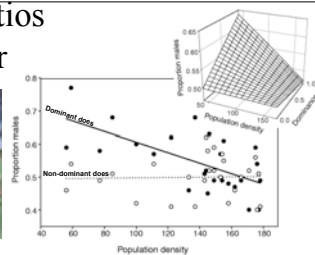
Sequential Hermaphrodites

- **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

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

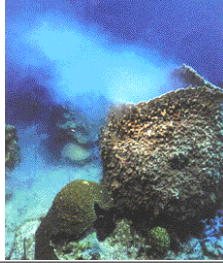
- Only in water
 - gametes must be moist.
- Gamete release is synchronized.



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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



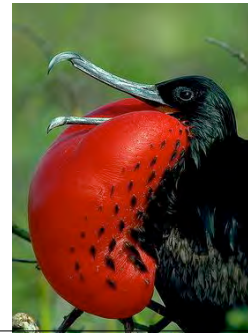
Mate Attraction —Chemical

- Insect pheromones
- Vertebrates too
 - snakes
 - mammals



Mate Attraction —Visual

- Displays include
 - colors
 - behaviors



Courtship Behavior



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



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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



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**.



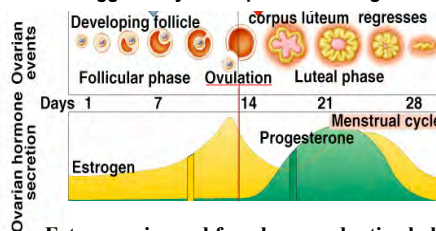
Copulatory Organs

- Insects



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



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.



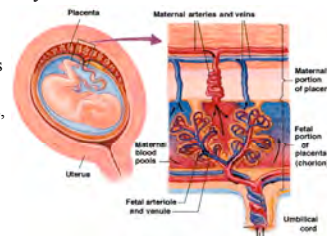
Dogfish shark “candle” from female’s uterus



“Candle” opened to show small embryos with large yolk

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)



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

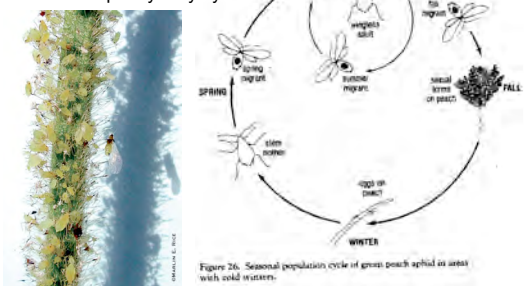


- Parthenogenic live birth (all females)
- And the baby being born already has a baby!

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.

Reproductive Ecology & Sexual Selection


Sexual Selection



- Sexual Selection (SS): differential reproduction due to *increased* Reproductive Success (RS) despite possible *decreased* survival.
 - Louder vocalizations → stronger attraction for mates
 - Louder vocalizations → stronger attraction for predators!


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



(a) Monogamous species




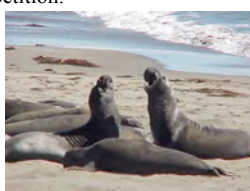
(b) Polygynous species



(c) Polyandrous species




Sexual Selection

- Intrasexual Selection:**
 - competition among members of one sex for access to members of the other sex.
 - a.k.a. Male-Male Competition.

Sexual Selection

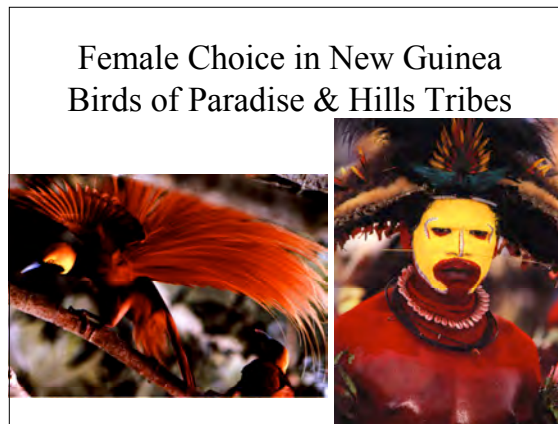
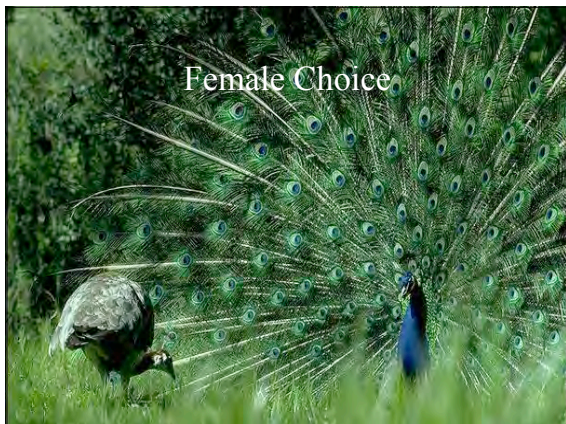
- Game Theory** (rock-paper-scissors)
- Frequency-dependent Intrasexual Selection:**
 - Oscillating frequencies
- Side-blotch lizard**
 - Orange-spotted males
 - Aggressive, large harems
 - Blue-spotted males
 - Less-aggressive, small harems
 - Yellow-spotted males
 - Non-aggressive, no harems

Sexual Selection

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

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Female Choice in New Guinea
Birds of Paradise & Hills Tribes

Female Choice

- Bowerbirds: display is separate from bird.

Social Learning & Mate Choice

- Female guppy introduced to unaccompanied males
 - Choose most brightly ornated
- 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 lose:
 - 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