insect reproduction: generalizations
- most sexual & gonochoric
- transfer of sperm through copulation
- complex male genitalia
- sperm transfer: spermatophore
- females store sperm in spermatheca

male reproductive organs
- aedeagus
- claspers

female reproductive organs
- genital duct/chamber: variable in shape and size
- bursa copulatrix (pouch-like)

sexual reproduction

asexual reproduction
- males rare or absent
- females develop a diploid gamete (egg)
- egg develops as a diploid female
- parthenogenesis

haplodiploidy
- many Hymenoptera have this type of reproduction
- what is it?
- how does it work?
**copulation: transferring sperm and choosing a mate**

- modes of insemination
  - direct v. indirect
  - female choice
  - mate competition
    - sexual selection

**indirect sperm transfer**

- primitive insects like *O. Collembola*
  - males leave spermatophore on ground
  - may lead female to the packet
  - female places packet in genital duct
  - stores sperm in spermatheca
  - males will eat each others’ packets

**direct sperm transfer**

- males give females the packet directly or inseminate directly
- spermatophore is dissolved, eaten, or ejected
- sperm stored in the spermatheca
- posterior ends of copulating milkweed bugs, *Oncopeltus fasciatus*.

**traumatic *direct* insemination: hemocoelic insemination**

- occurs in many bedbugs
- sperm travel to the ovaries or are dispersed via the hemolymph until some reach the ovaries

**getting together**

- usually involves some female required resource:
  - what resources?
- avoid mistakes
  - how do insects avoid mating with a member of a different species?

Most insects mate repeatedly. Some can store and release sperm at will. So... *WHOSE SPERM IS IT??*


female choice

- females can choose
  - which males to accept
  - which sperm to use
- leads to sexual selection
  - mates chosen in part on external characters, territories, displays, or provisioning of resources

O. Mecoptera: hangingflies, scorpionflies, snowfleas

- Diptera
- other Mecoptera
- Nannochoristidae
- Boreidae
- Siphonaptera

(b)

buying love

- nuptial gift given to female by male to encourage his selection as a mate
- can provide vital nutrients

SCORPIONFLY (Mecoptera)

- interpret these data
- predict preferences of females

hangingflies and nuptial gifts

- assortative mating and the genetic correlation between trait and preference

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(b)
Runaway sexual selection in stalk-eyed flies (O. Diptera: F. Diopsidae)

- only requires that preference is biased in one direction — when preference becomes genetically correlated with trait, positive feedback results, exaggerating trait and preference

Can selection on male trait produce response in female preference?

- 3 Populations
  - control: males and females picked at random
  - short-selected line
  - long-selected line
  - preferences after 13 generations

male competition

- many sperm chasing few eggs
  - male’s success is limited by #of eggs he can fertilize
- limited resources create competition
  - sperm, spermatophores
  - territories
  - nuptial gifts
  - cheaters

paternity assurance

- spermatophores and sperm plugs
- sperm replacement
- long copulation duration
- behavior modifying substances

mating in Odonata

Genital pouch: contains aedeagus

before mating, male transfers sperm to pouch
male grasps female with claspers
female bends body to access pouch
removing sperm from previous matings

males evolved specialized structures to remove spermatophores left by previous males

sperm competition: mate guarding in Odonata

Argia moesta ovipositing

territory competition

- many insects, incl. Orthoptera and Odonata
- tree crickets
  - males have ~50 cm² territory
  - defend with aggressive stridulation
  - fight w/ antennae

- dung beetles
  - males dimorphic
  - longer horned males tend to win more fights
  - competition leads to different behaviors
  - sneaky small males do okay

- dung beetle (sF. Scarabaeinae) horns
  - males dimorphic
  - longer horned males tend to win more fights
  - competition leads to different behaviors
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http://www.youtube.com/watch?v=I1RHmSm36aE
http://www.npr.org/blogs/pictureshow/2009/05/dung_beetles.html
evolution of male dimorphism

- bigger horns mean smaller eyes (or wings) in dung beetles – and so they are costly
- cost constrains sexual selection – most of the time

Hercules beetles (O. Coleoptera, F. Scarabeidae)

- Male-male competition can explain the evolution of many morphological and behavioral traits

paternal care: male water bugs

- guard and moisten eggs above the water (Lethocerus) or carry eggs on back (Abedus, Belostoma).
- Abedus eggs do not develop unless aerated by male.
- water bugs are large as are eggs
- oxygenation is necessary
- Why only male care?
  - Males with one clutch sometimes attract a second female
  - costs of parental care may be disproportionately great for females in terms of lost fecundity.

birthing strategies

- most insects lay eggs in environment
  - oviparous
- in some, eggs are retained inside the female until embryo is ready to hatch
  - ovoviviparous
- in a few, individuals are fully developed larvae at birth
  - viviparous

offspring numbers

- the termite, Kalotermes flavicollis
- 10 x 10⁶ eggs/yr or 27,400 eggs/day
ovipositors

females provision nests with cicadas
males defend territories by dive-bombing
bigger males have larger territories

cicada killers