Reproduction and mating

• Reproductive organs and cycles
• Reproductive timing
  – Mechanisms for environmental synchrony
• Mating systems
• Sexual selection
  – Precopulatory
  – Postcopulatory
Male reproductive organs

- Kidney
- Ureter
- Testis
- Vas deferens
- Epididymis
- Urethra
- Cowper's Gland
- M. bulbospongiosus
- Erectile Tissue
- Anus
- Seminal Vesicle
- Prostate
- Paraanal Glands
- Penis
Sperm storage

• Strategies used
  – Continuous sperm production in testes
  – Seasonal sperm production, storage in epididymes
  – Seasonal sperm production, storage in uterus

Fig. 7.7 Sperm storage in the uterus of a female Pallid bat (Antrozous pallidus-Vespertilionidae). Sperm cells are housed in the uterine mucosa which maintains them through the hibernation period.
Figure 8.4  The asynchronous male reproductive cycle in *Myotis lucifugus* (Vespertilionidae). Letters on the x-axis indicate months of the year. Weight of the testes is correlated with spermatogenesis and testosterone production; weight of the epididymis is correlated with sperm storage. From Gustafson (1979).
Reproduction is linked to food availability

Coleura afra
Kenya
Female reproductive cycle

Figure 8.3 The female reproductive cycle and its hormonal control in a hibernating bat, *Antrozooon pallidus* (Vespertilionidae). Letters on the x-axis indicate months of the year. Bats mate during the autumn and winter. Solid line = blood levels of estrogen; dashed line = blood levels of progesterone. From Oxberry (1979).
Uteri, ovulation and implantation

Figure 8.2  Different types of uteri, asymmetric ovulation, and implantation in bats. Ovulation and implantation of the egg usually occur on the right side in molossids, phyllostomids, and Myotis, on the left in Megaderma and Miniopterus. In Taphozous longimanus and Pipistrellus hesperus, both sides are active. Ovaries marked with a “+” produce mature eggs, ovaries marked with a “-” do not. Circled areas indicate sites of implantation of the fertilized egg. Names of the different types of uteri are underlined. From Wimsatt (1979) and Hill and Smith (1984).
Mechanisms of manipulating reproductive timing

• Delay ovulation and fertilization
  – Common in temperate species of vesper and horseshoe bats
  – Mating occurs in fall and winter
  – Sperm are stored in oviduct or uterus, can survive up to 180 days!

• Delay implantation
  – Ovulation occurs right after mating
  – After a few cell divisions, development is arrested
  – After delay of up to 5 months, implantation occurs

• Embryonic diapause
  – Embryo implants in uterus, but remains dormant for up to 10 weeks before growing
Reproductive patterns between species

Fig. 5.1. Monoestrous reproductive patterns.
Female *Phyllostomus hastatus* reproduce in synchrony within groups

But, mating occurs over a two month period in Dec-Jan!
Reproductive patterns between species

Artibeus jamaicensis exhibits embryonic diapause
Reproductive patterns within species

Fig. 5.2. Reproductive patterns in Schreiber's bent-winged bat, *Miniopterus schreibersii*. 
Causes of spacing patterns

Males disperse in space to maximize mating opportunities with females
Bat Mating Systems

- **♀ & ♂ rear young**
  - Female ranges are defended
  - Foraging site defended

- **♀ only rears young**
  - Female groups are defended
  - Females defensed
  - Roost defended
  - Variable strategy

- **♀ range indefensible**
  - Female groups are unstable
  - Mating aggregation/swarming
  - Roving ♂
  - Temporary harem territories

- **♀ range defensible**
  - Female groups are stable
  - Mating territories
  - Mating aggregation/swarming
  - Lek
  - Temporary harem territories

**Resource defence polygyny**

- **♀ solitary**
- **♀ groups small**
- **♀ groups large**
- **♂ groups**
  - Multi ♂ groups
  - Multi groups
  - Uni ♂ groups (harems)

**Species**

- *Nycteris* spp?
- *Saccopteryx leptura*
- *Pteropus giganteus*
- *Rhinolophus nasus*
- *Phyllostomus hastatus*
- *Pipistrellus pipistrellus*
- *Myotis esferus*
- *Myotis lucifugus*
- *Hypogeus monstrosus*
- *Tylonycteris* spp.
Monogamy

Lar gibbon

Vampyrum spectrum

Silver-backed jackal
Mating system types

• Polygyny
  – > 90% of mammals
  – < 10% of birds

• Females solitary, but ranges defensible by male
  – prosimian primates (bushbaby, tarsier)
  – Some *Rhinolophus, Saccopterux leptura*

• Females solitary, range not defensible
  – Moose, orangutan
  – No known bat examples
Mating system types

• Females social, range defensible
  – Seasonal harems
    • elephant seals, impala, *Nyctalus noctula, Ectophylla alba*
  – Permanent harems
    • baboons, zebra, spear-nosed bats, sac-winged bats

• Females social, range not defensible
  – Female movements unpredictable
    • males follow females, e.g. elephants
    • males display on leks
  – Female movements predictable
    • Males mate at hibernacula many vesper bats
Saccopanorhinus bilineata

Production of composite syllables

Number of females
Leks

- Swedish for mating arena
- No male parental care
- No resource on territory
- Males aggregate and display at traditional sites
- Default strategy when males cannot defend females
Male mating success on *Hypsognathus* lek in Gabon
Males defend tiny territories on a lek

<table>
<thead>
<tr>
<th>TYPE AND EXAMPLE</th>
<th>DISPERSION OF MALES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. RESOURCE DEFENSE</td>
<td><img src="image" alt="Resource Defense Example: Antelopes" /></td>
</tr>
<tr>
<td>2. QUASI-LEK</td>
<td><img src="image" alt="Quasi-Lek Example: Epomops" /></td>
</tr>
<tr>
<td>3. LEK</td>
<td><img src="image" alt="lek Example: Hypsignathus" /></td>
</tr>
</tbody>
</table>

Epomophorus wahlbergi
Epomophorine bat adaptations for calling

Epomops franqueti
Epomophorus wahlbergi
Hypsognathus monstrosus
Sexual dimorphism in body size reflects the intensity of selection on males.
In mammals, $V_{LRSmale}$ is usually $> V_{LRSfemale}$

Human maxima: male paternity: 888
female maternity: 69

Figure 15.32 Distributions of lifetime reproductive success in male and female elephant seals.

(b) Women

Lifetime reproduction success

-2 -4 -6 -8 -10 +
Human mating systems

Fig. 3.3 Marriage patterns in 849 societies. Data from Murdock (1967); from Flinn & Low (1986).
Mating system and testis size in primates

Gorillas live in single-male groups.

Chimpanzees live in multi-male groups.

Which species has bigger testes (relative to body size)?
Testis size indicates sperm competition

<table>
<thead>
<tr>
<th>Species</th>
<th>Approximate weight of testes of mature male</th>
<th>Approximate number of sperm per ejaculate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grams (of body weight)</td>
<td></td>
</tr>
<tr>
<td>Chimpanzee</td>
<td>120 (0.3)</td>
<td>60 × 10^7</td>
</tr>
<tr>
<td>Man</td>
<td>25–50 (0.04–0.08)</td>
<td>25 × 10^7</td>
</tr>
<tr>
<td>Orangutan</td>
<td>35 (0.05)</td>
<td>7 × 10^7</td>
</tr>
<tr>
<td>Gorilla</td>
<td>35 (0.02)</td>
<td>5 × 10^7</td>
</tr>
</tbody>
</table>

Source: After Short, 1981 [566]; Warner et al. 1974 [651].

Since species that live in multi-male groups exhibit larger testes, infer sperm competition. But, species are not independent!

Fig. 2.6. Log combined testes weight (g) versus log body weight (kg) for different primate genera. ● Multi-male breeding system; ○ monogamous; △ single-male; + Homo. From Harcourt et al. [1981].
Testis size in bats

Rhinopoma kinneari
8.4% of body mass

Taphozous longimanus
0.1% of body mass
In bats, testis mass differs among mating systems (controlling effects of body size)

(Wilkinson & McCracken 2003)
N = 349 for brain, testes and or breeding system data
Bat brain size and body size

- **Total brain mass (log\(_{10}\) mg)**
  - Microchiroptera: \(y = 0.769x + 1.655\)
  - Megachiroptera: \(y = 0.700x + 1.917\)

- **Neocortex volume (log\(_{10}\) cm\(^3\))**
  - Microchiroptera: \(y = 0.782x + 1.248\)
  - Megachiroptera: \(y = 0.918x + 0.804\)
Bat brain size also varies with mating system (effects of body size, diet and phylogeny controlled)

(Pitnick, Jones & Wilkinson 2006 Proc R. Soc B)
Bats with larger brains have smaller testes!

(Pitnick, Jones & Wilkinson 2006 Proc R. Soc B)
Additional Reading

