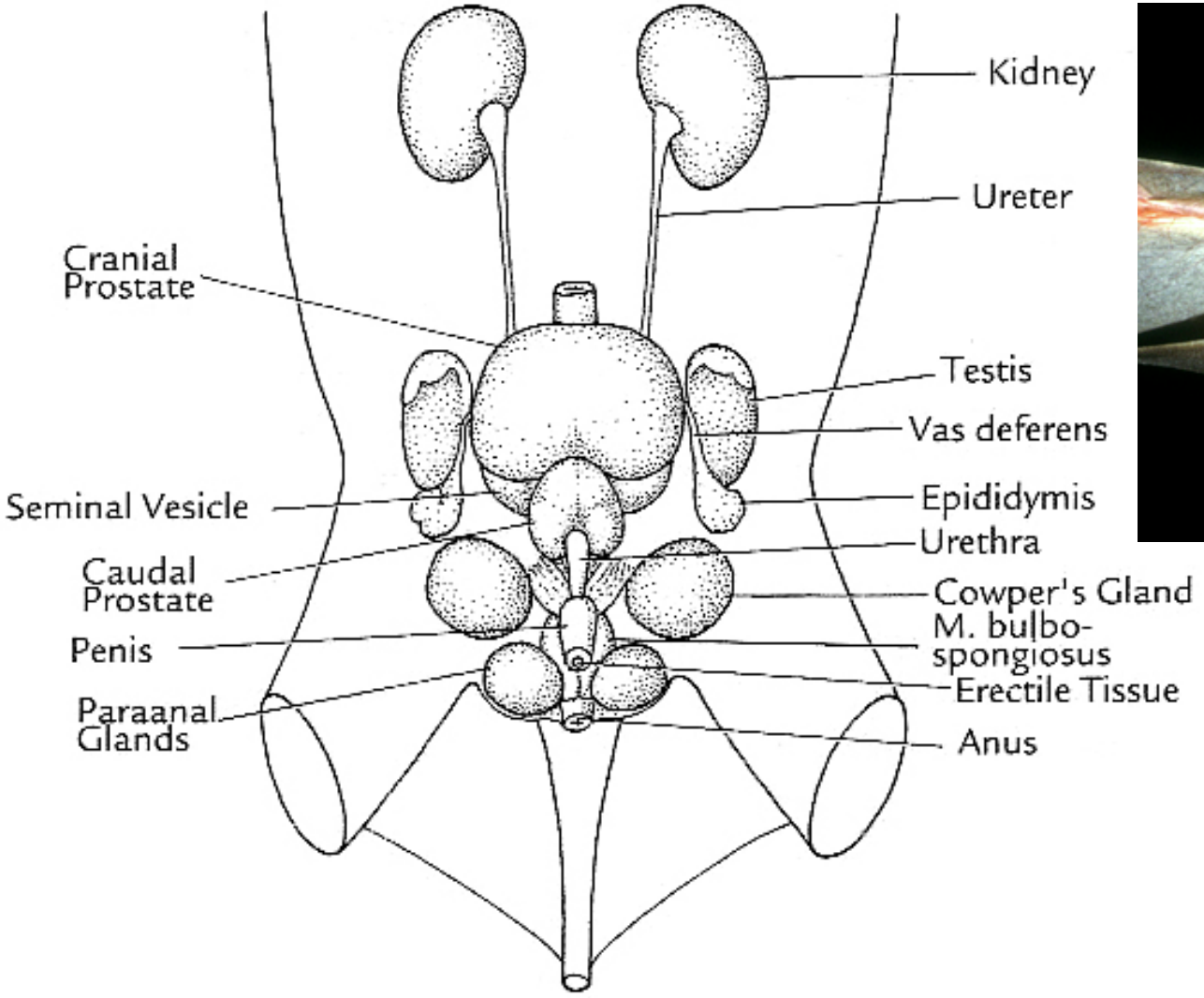
Reproduction and mating

- Reproductive organs and cycles
- Reproductive timing
  - Mechanisms for environmental synchrony
- Mating systems
- Sexual selection
  - Precopulatory
  - Postcopulatory

Male reproductive organs



Sperm storage

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

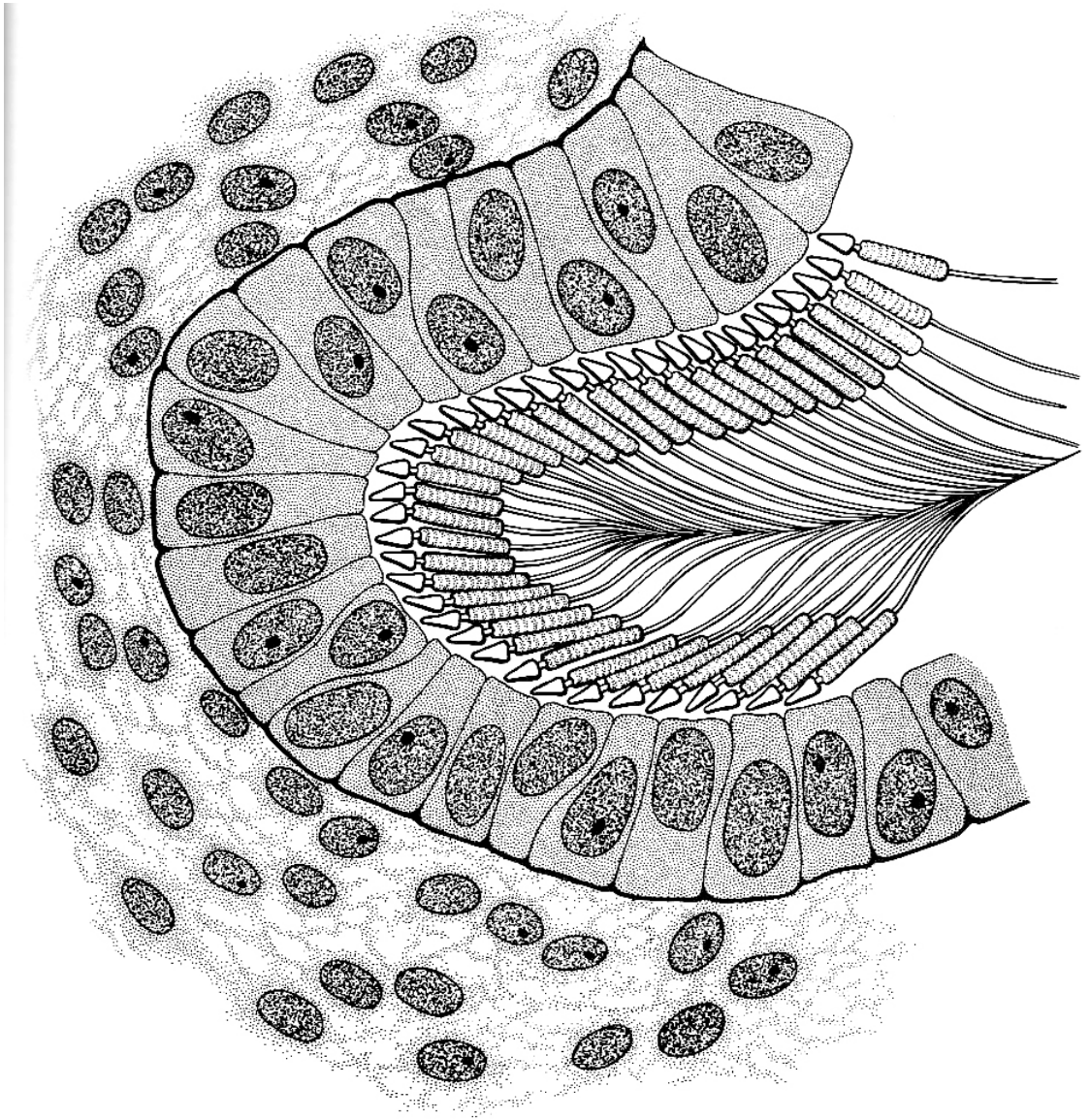


Fig. 7.7 Sperm storage in the uterus of a female Pallid bat (Antrozous pallidus–*Vespertilionidae). Sperm cells are nosed into the uterine mucosa which maintains them through the hibernation period.*

Testicular cycles

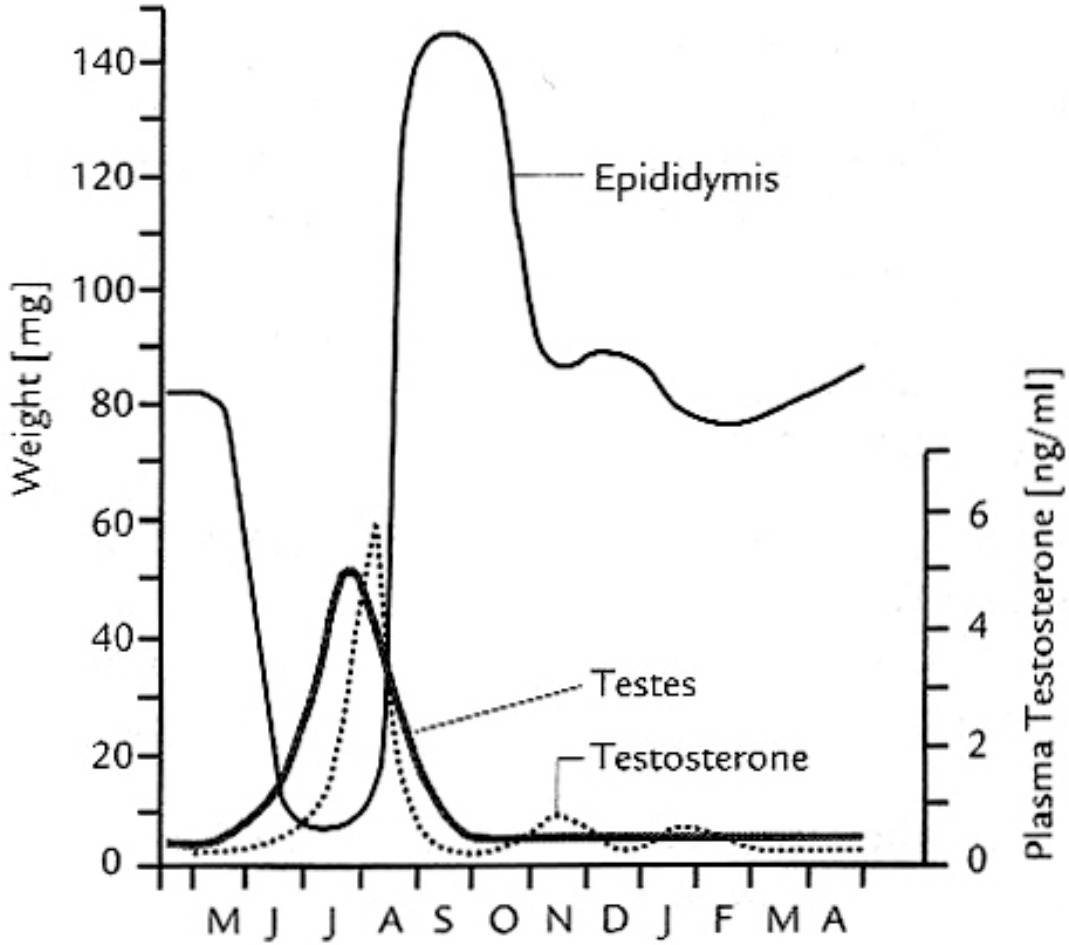
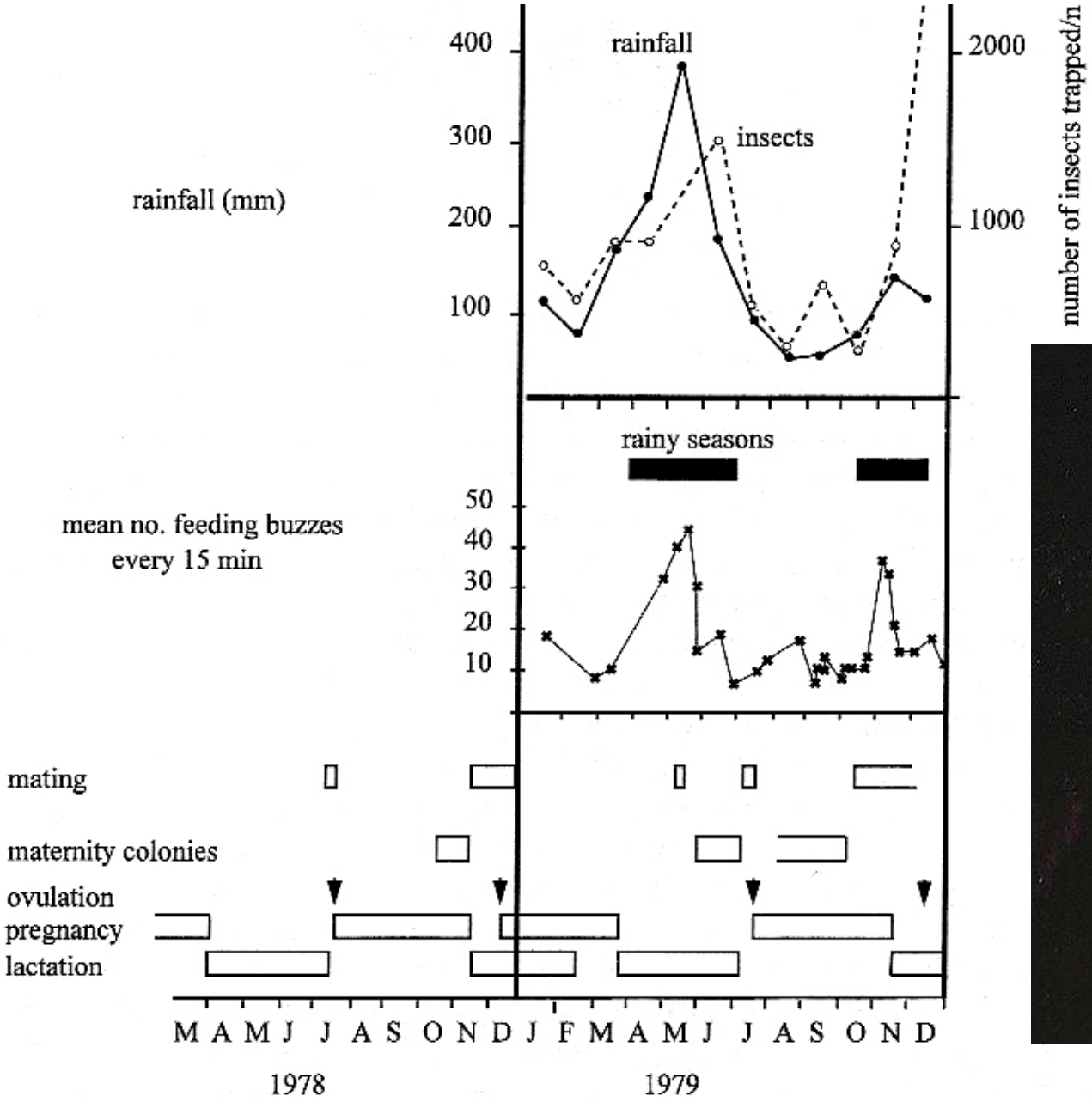


Figure 8.4 The asynchronous male reproductive cycle in *Myotis lucifugus* (Vespertilionidae). Letters on the x-axis indicate months of the year. Weight of the testes is correlated with spermatogenesis and testosterone production; weight of the epididymis is correlated with sperm storage. From Gustafson (1979).

Reproduction is linked to food availability



Coleura afra
Kenya

Female reproductive cycle

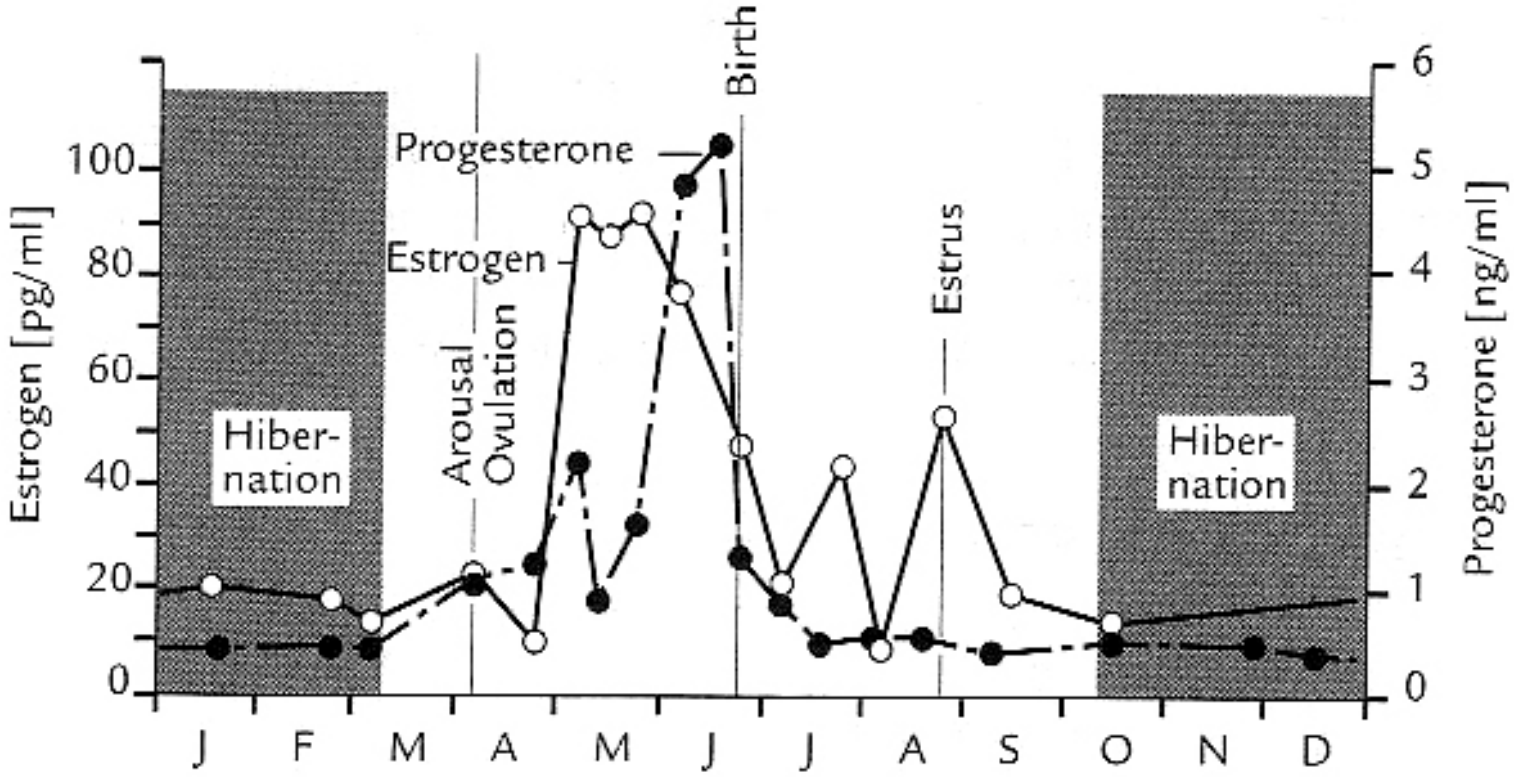
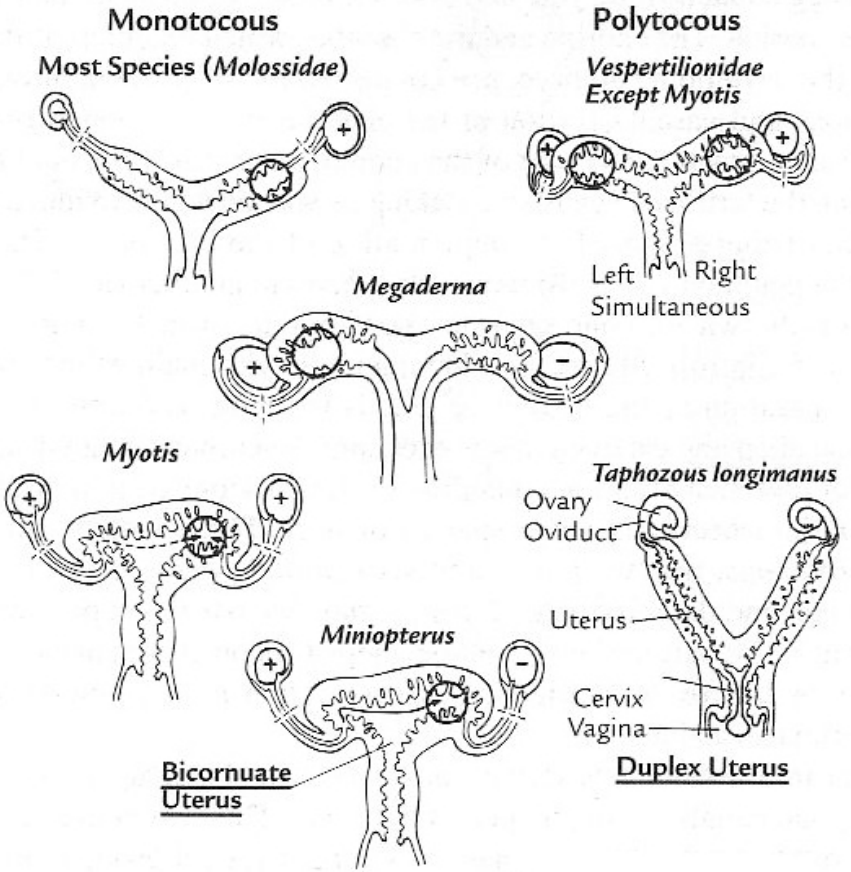


Figure 8.3 The female reproductive cycle and its hormonal control in a hibernating bat, *Antrozoous pallidus* (Vespertilionidae). Letters on the x-axis indicate months of the year. Bats mate during the autumn and winter. Solid line = blood levels of estrogen; dashed line = blood levels of progesterone.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

Uteri, ovulation and implantation



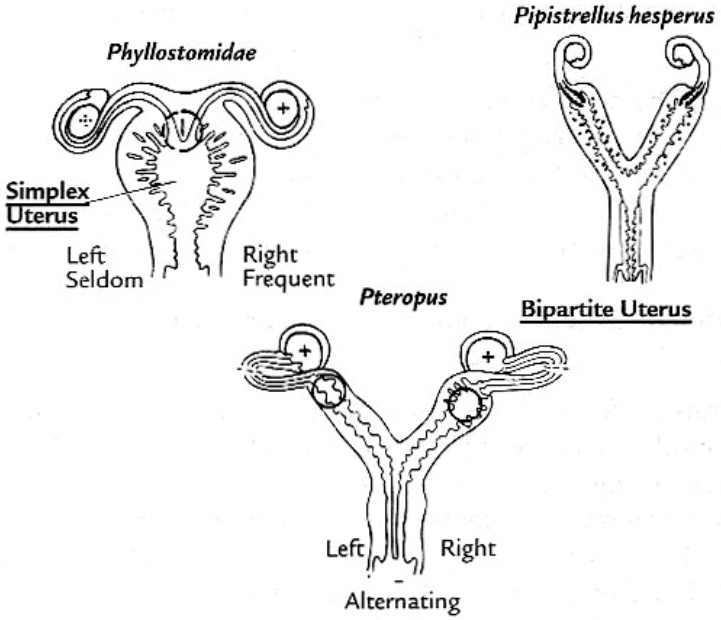


Figure 8.2 Different types of uteri, asymmetric ovulation, and implantation in bats. Ovulation and implantation of the egg usually occur on the right side in molossids, phyllostomids, and *Myotis*, on the left in *Megaderma* and *Miniopteris*. In *Taphozous longimanus* and *Pipistrellus hesperus*, both 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
- Embyronic diapause
  - Embryo implants in uterus, but remains dormant for up to 10 weeks before growing

Reproductive patterns between species

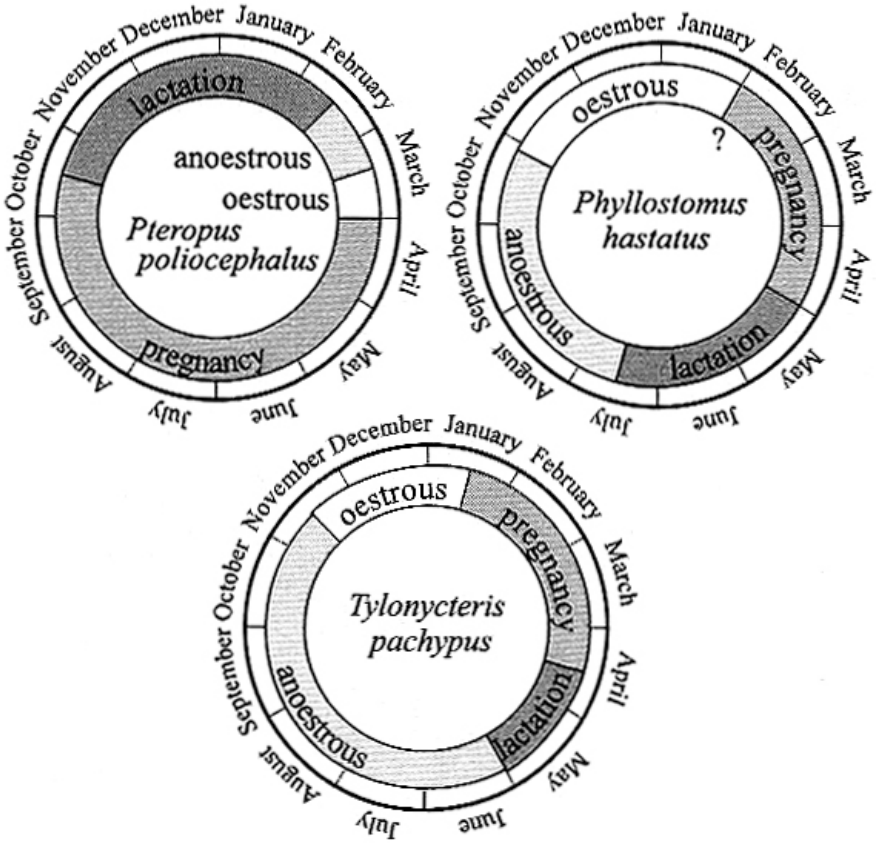
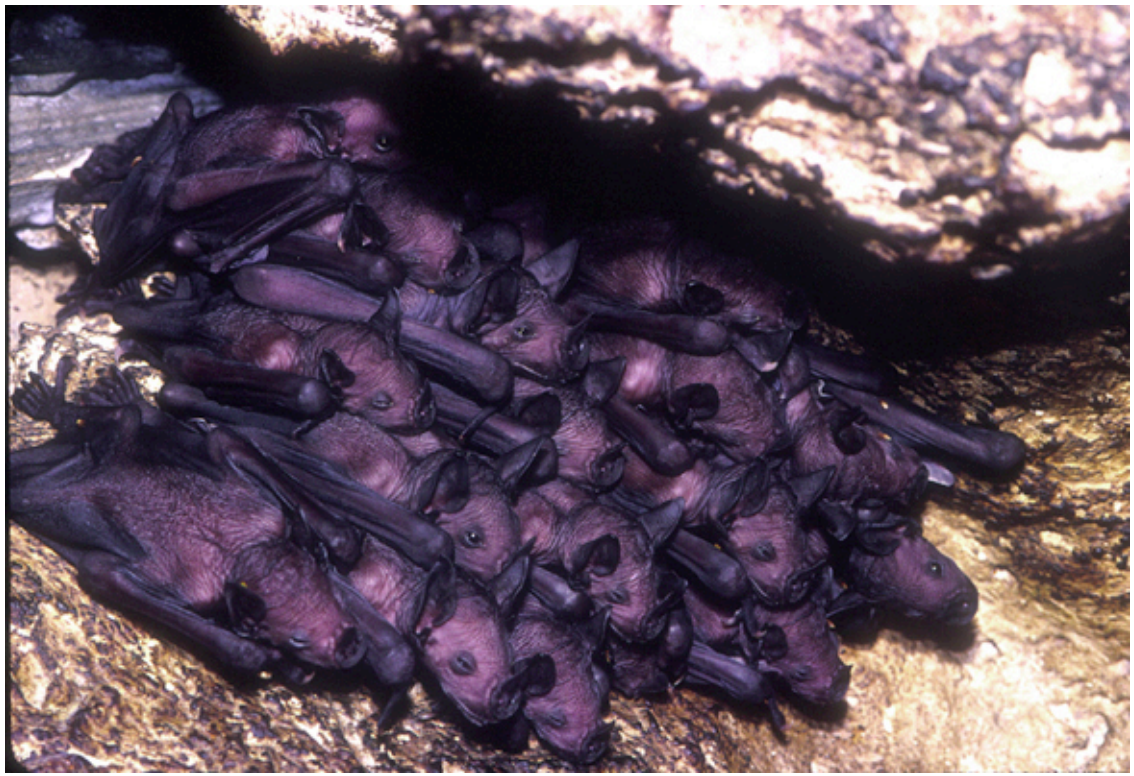
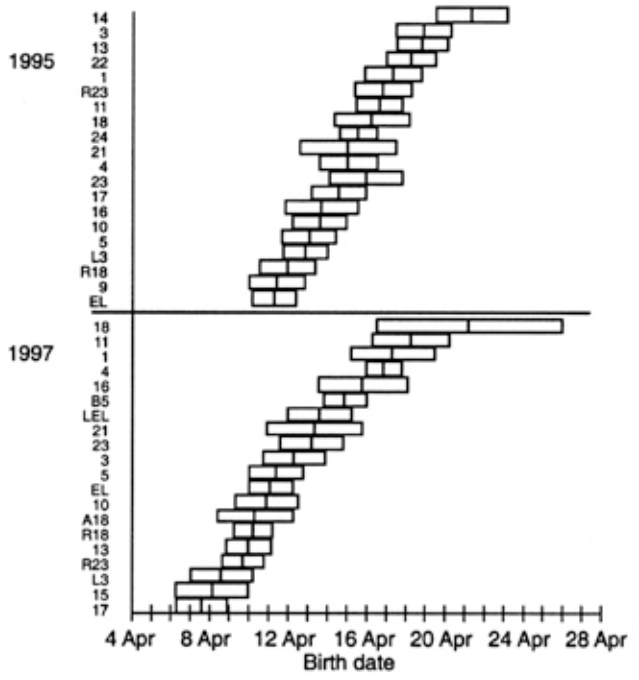


Fig. 5.1. Monoestrous reproductive patterns.

Female *Phyllostomus hastatus* reproduce in synchrony within groups





Mean birth dates (centre vertical line) ± standard error for each of the groups in Guanapo Cave in 1995 and 1997.

But, mating occurs over a two month period in Dec-Jan!

Reproductive patterns between species

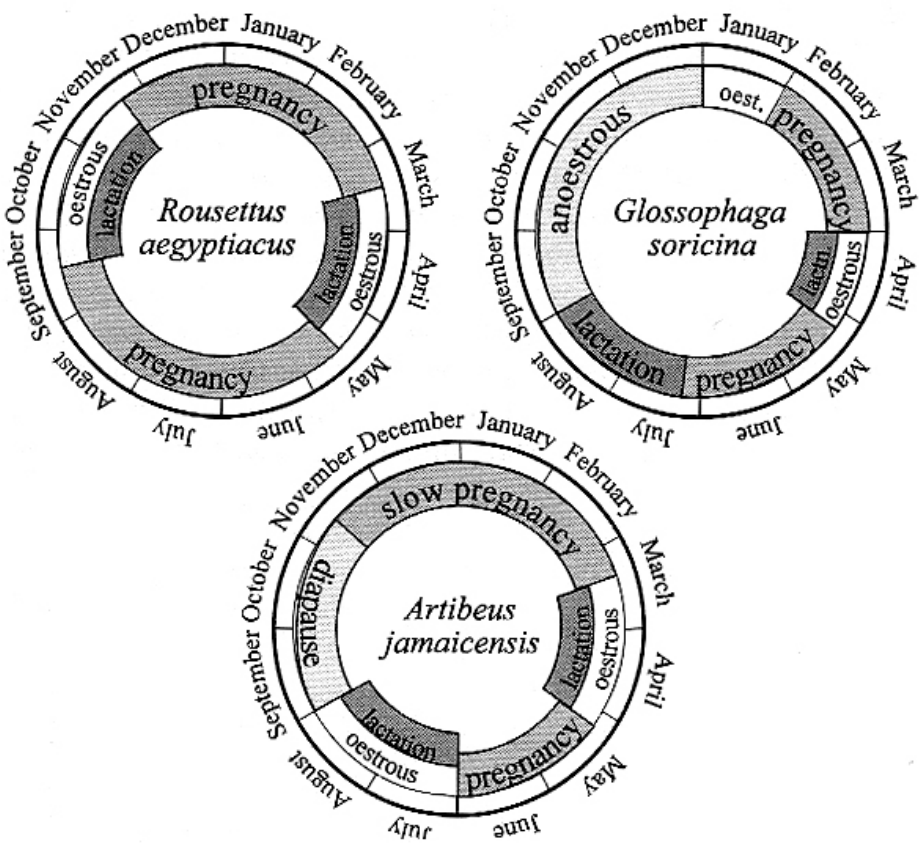


Fig. 5.3. Polyoestrous reproductive patterns.

Artibeus jamaicensis exhibits embryonic diapause

Reproductive patterns within species

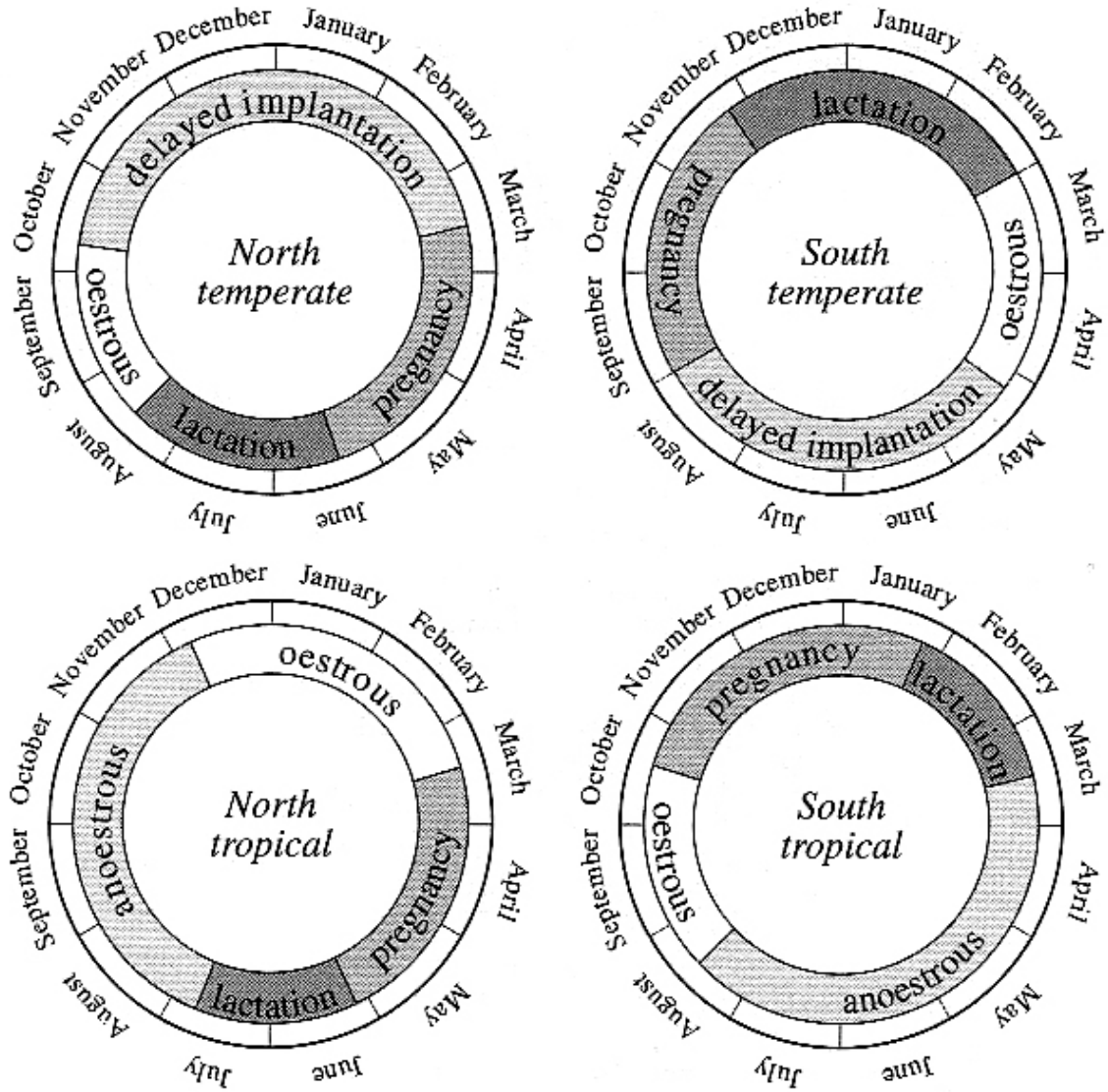
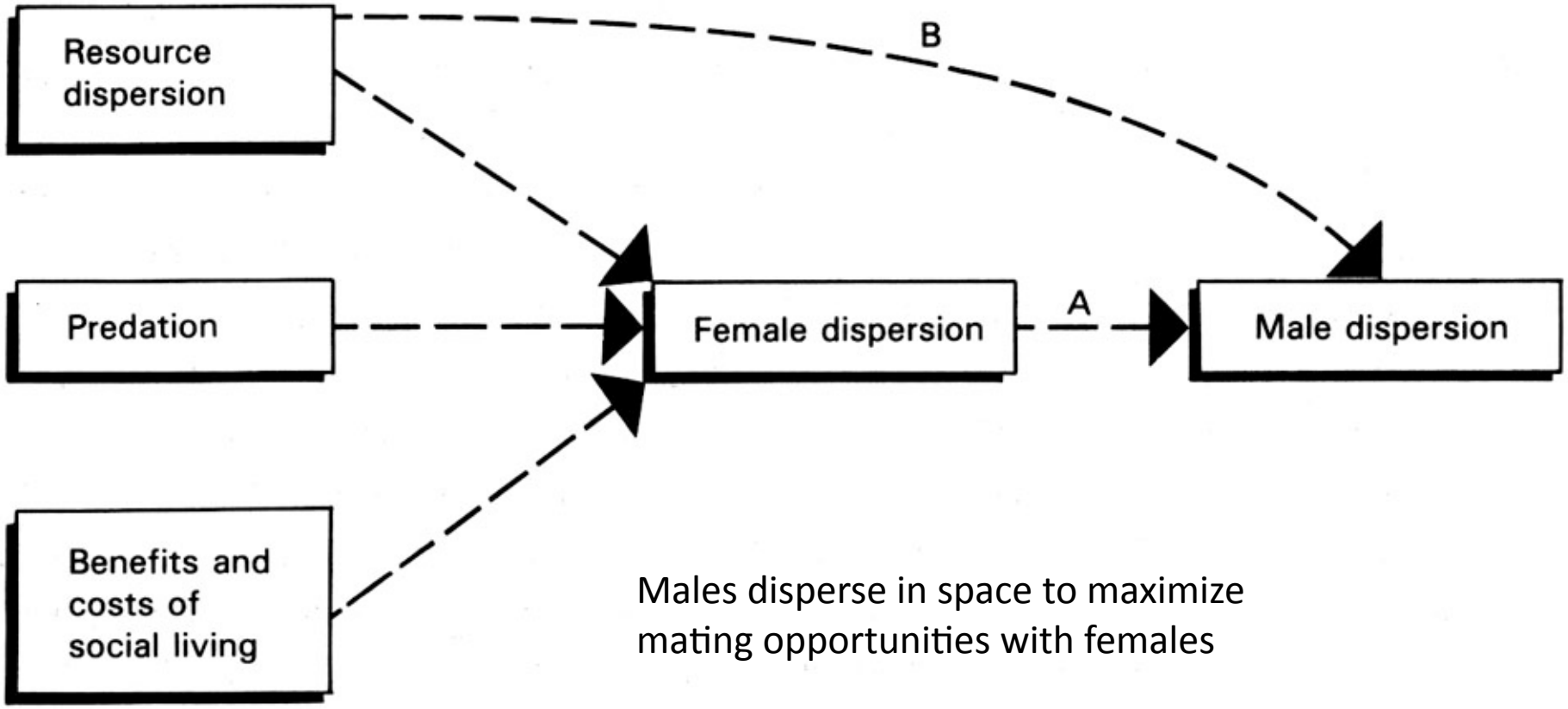


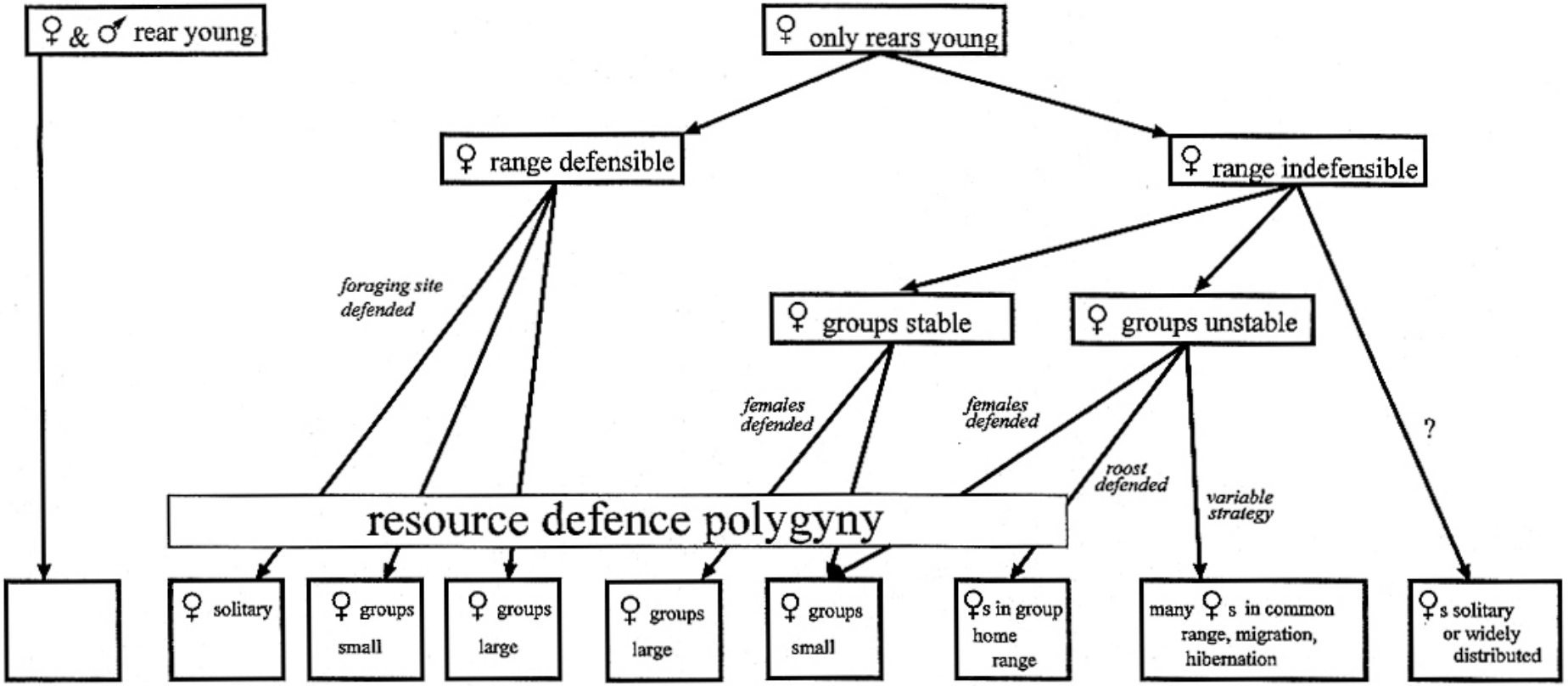
Fig. 5.2. Reproductive patterns in Schreiber's bent-winged bat, *Miniopterus schreibersii*.

Causes of spacing patterns

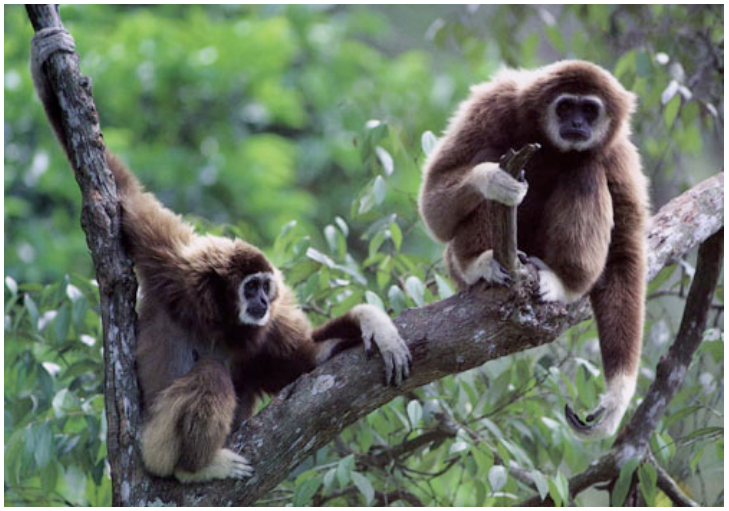


Males disperse in space to maximize mating opportunities with females

Bat Mating Systems



Monogamy



Lar gibbon

Vampyrum spectrum

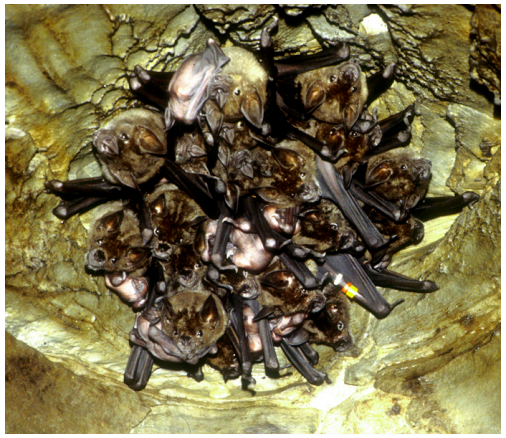
Silver-backed jackal

Mating system types

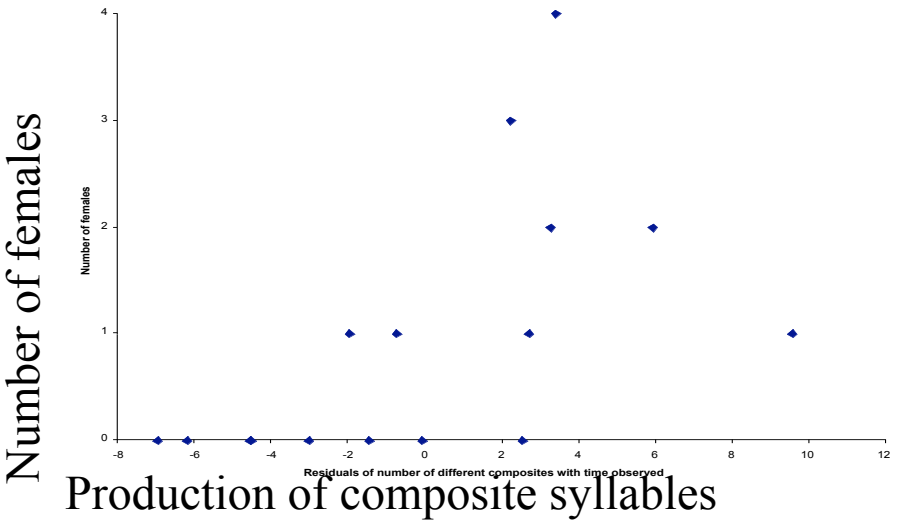
- Polygyny
  - > 90% of mammals
  - < 10% of birds
- Females solitary, but ranges defensible by male
  - prosimian primates (bushbaby, tarsier)
  - Some *Rhinolophus, Saccopterux leptura*?
- Females solitary, range not defensible
  - Moose, orangutan
  - No known bat examples

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



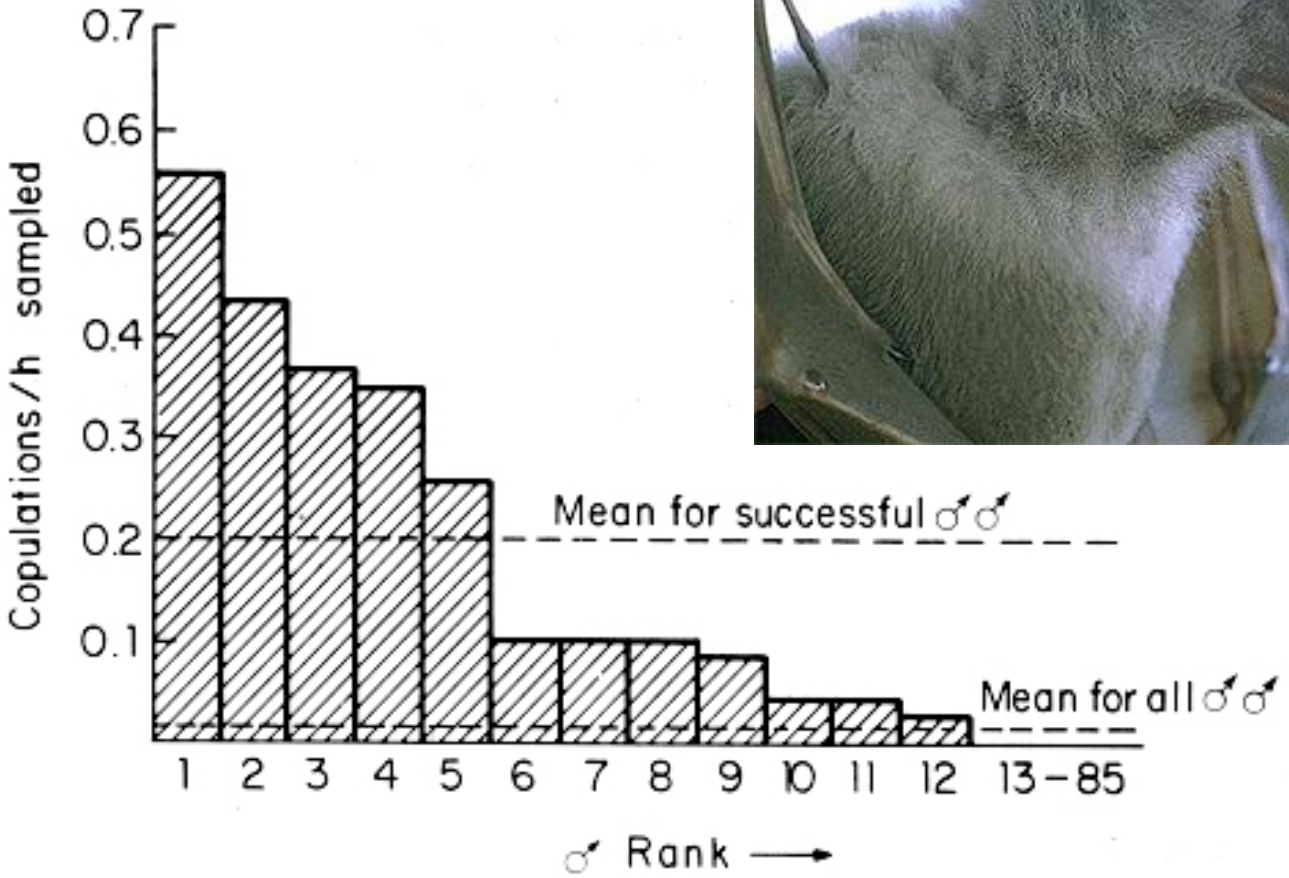
Saccopteryx bilineata



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 *Hypsignathus* lek in Gabon



Males defend tiny territories on a lek

TYPE AND EXAMPLE	DISPERSION OF MALES
1. RESOURCE DEFENSE Example: Antelopes	
2 QUASI-LEK Example: Epomops	
3 LEK Example Hypsignathus	

Epomophorus wahlbergi

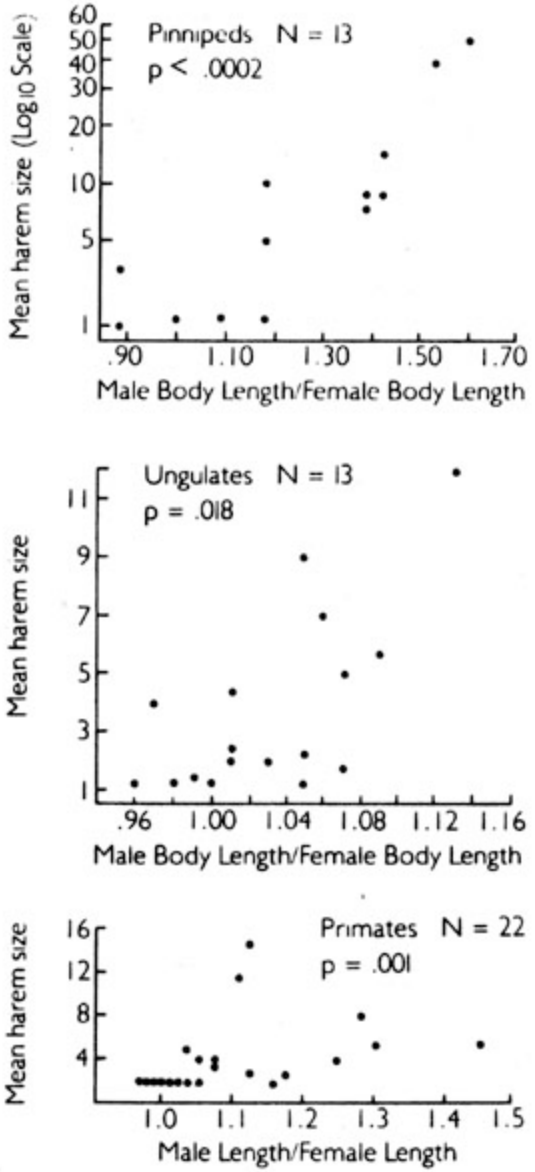
Epomophorine bat adaptations for calling

Epomops franqueti

Epomophorus wahlbergi

Hypsignathus monstrosus

Sexual dimorphism in body size reflects the intensity of selection on males



Elephant seal

Harbor seal

In mammals, $V_{LRSmale}$ is usually > $V_{LRSfemale}$

Elephant seals

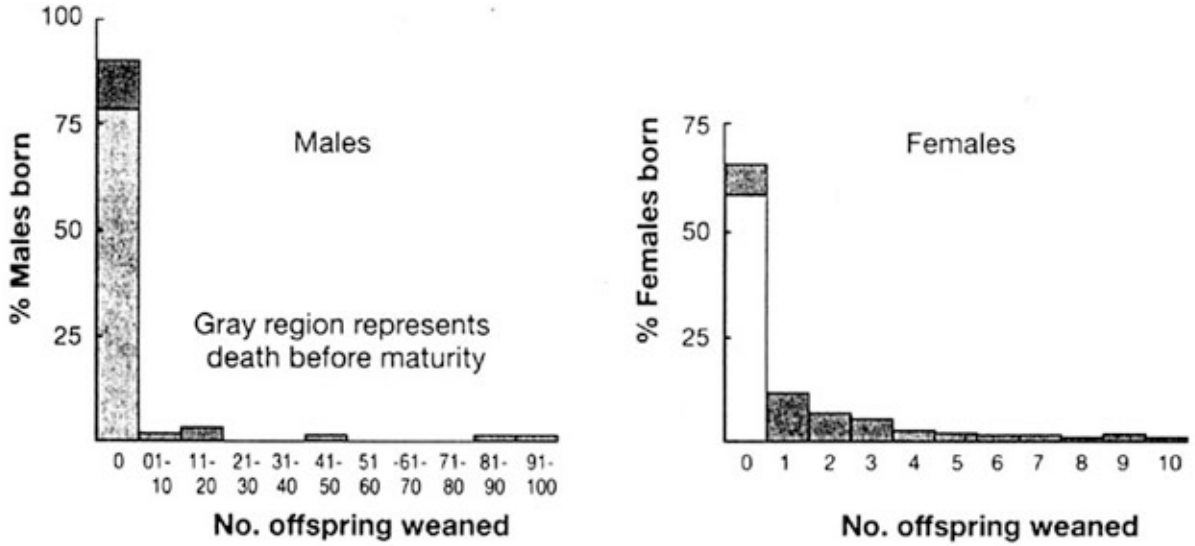


Figure 15.32 Distributions of lifetime reproductive success in male and female elephant seals

Kipsigis

Human maxima: male paternity: 888

female maternity: 69

Human mating systems

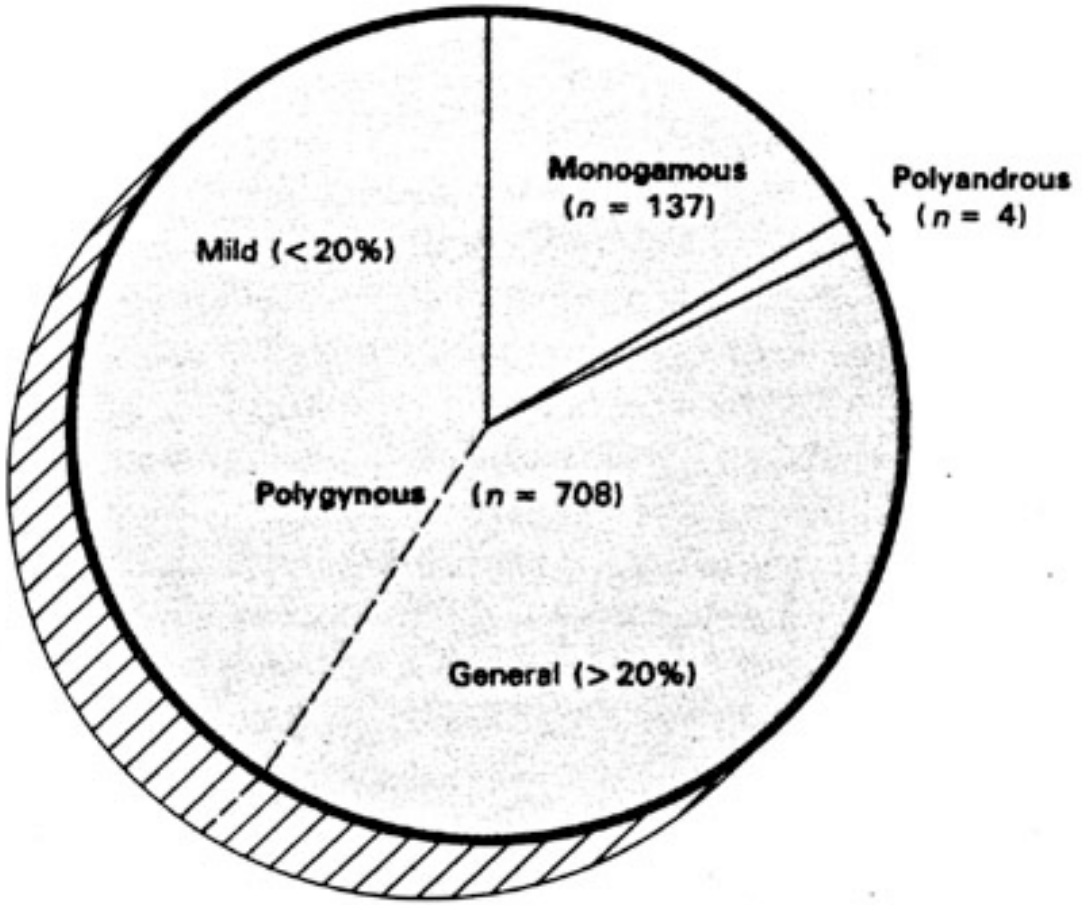


Fig. 3.3 Marriage patterns in 849 societies. Data from Murdock (1967); from Flinn & Low (1986).

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

	Approximate weight of testes of mature male		Approximate number of sperm per ejaculate
	Grams	(% *of body weight*)	*ejaculate*
Chimpanzee	120	0.3	60×10^7
Man	25–50	0.04–0.08	25×10^7
Orangutan	35	0.05	7×10^7
Gorilla	35	0.02	5×10^7

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

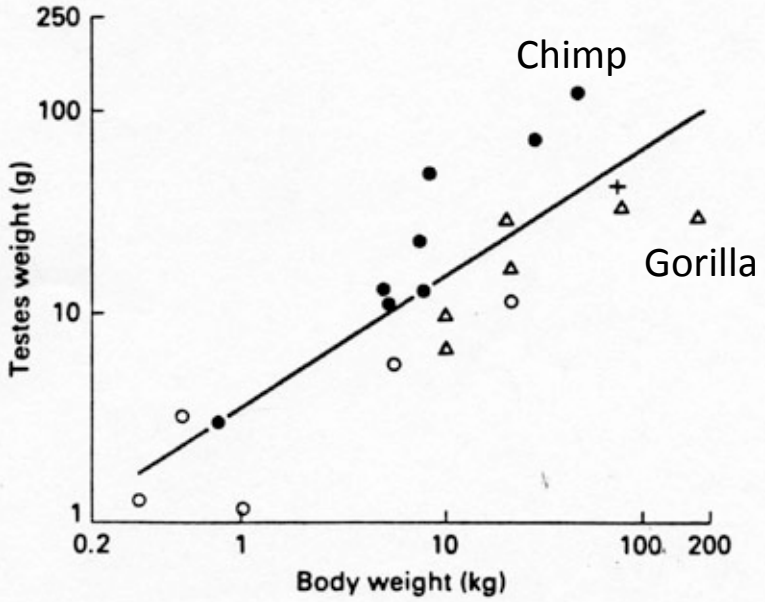
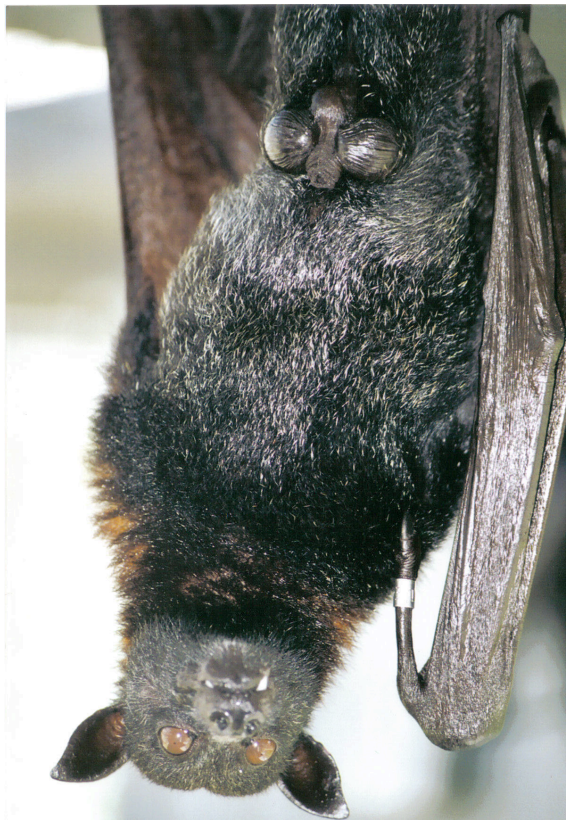
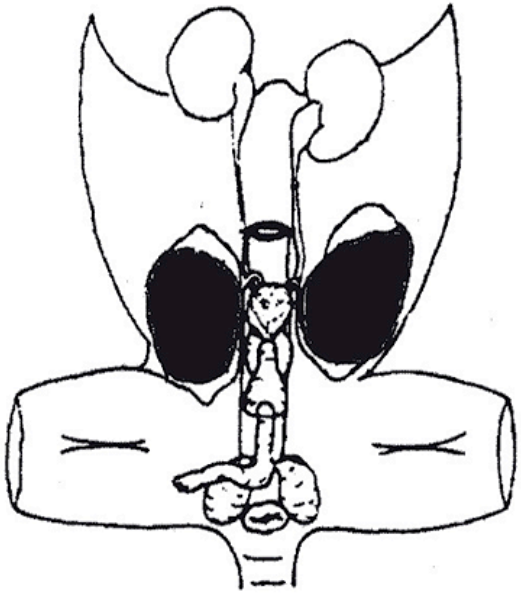


Fig. 2.6. Log combined testes weight (g) versus log body weight (kg) for different primate genera. ● Multi-male breeding system; ○ monogamous; △ single-male; + *Homo*. From Harcourt *et al.* (1981).

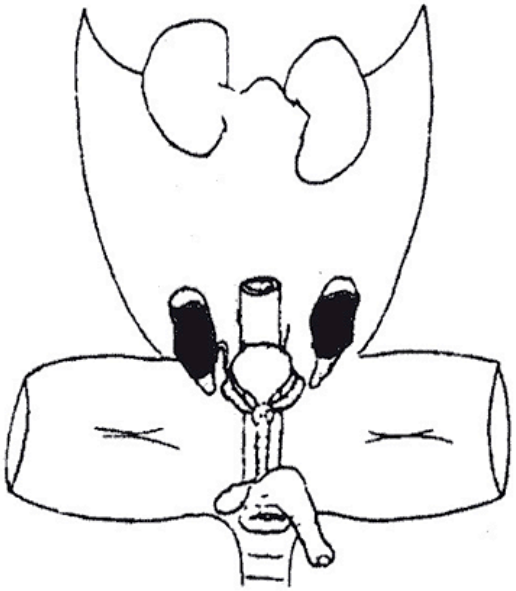
Since species that live in multi-male groups exhibit larger testes, infer sperm competition.
But, species are not independent!

Testis size in bats





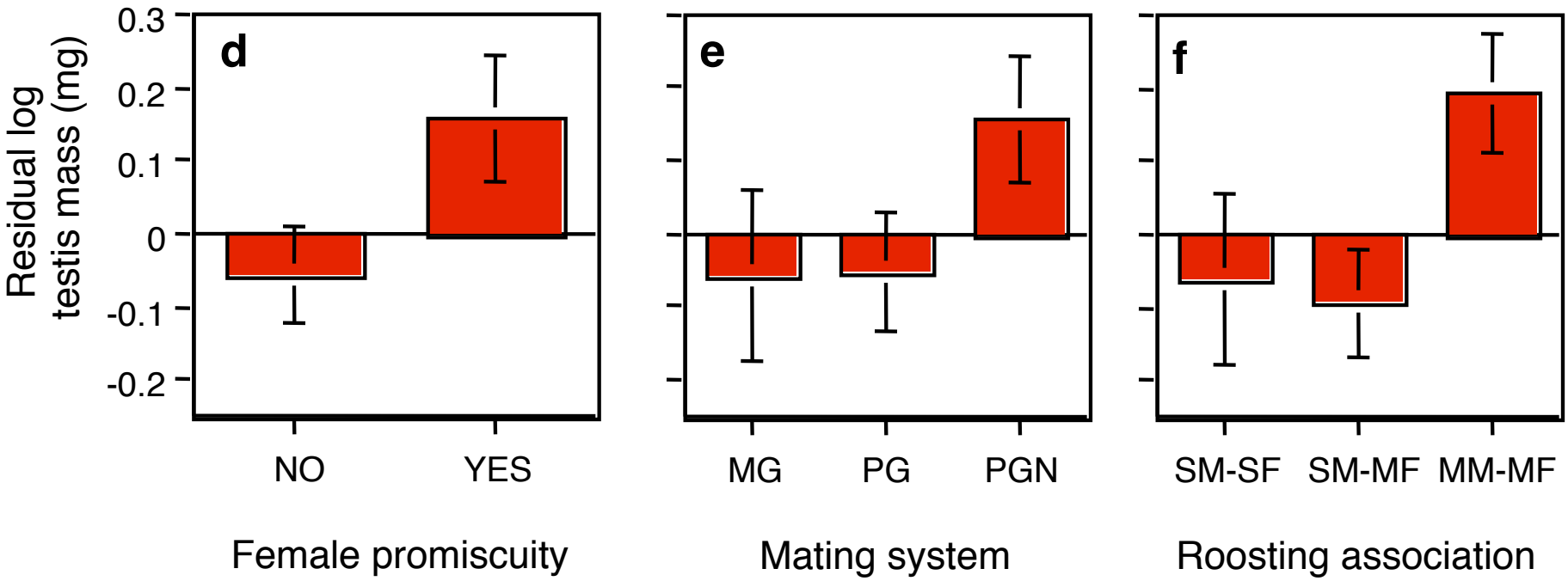
Rhinopoma kinneari
8.4% of body mass



Taphozous longimanus
0.1% of body mass

In bats, testis mass differs among mating systems

(controlling effects of body size)



(Wilkinson & McCracken 2003)

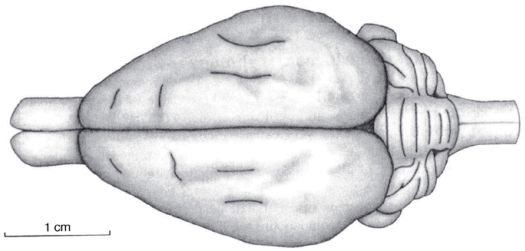


Figure 3 *Pteropus vampyrus*

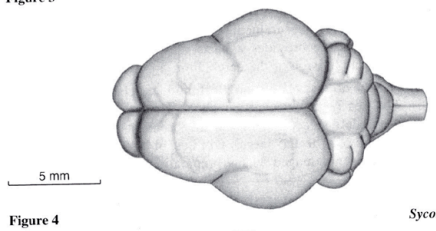


Figure 4 *Syconycteris australis*

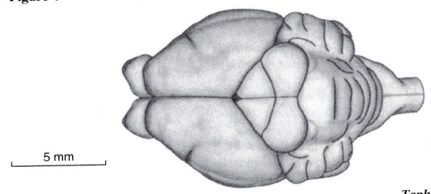
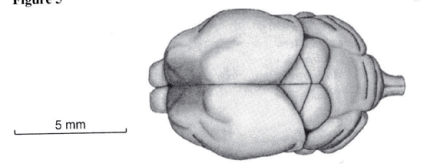


Figure 5 *Taphozous mauritianus*



Nycteris nana

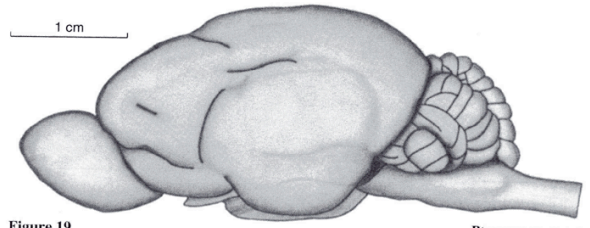


Figure 19 *Pteropus vampyrus*

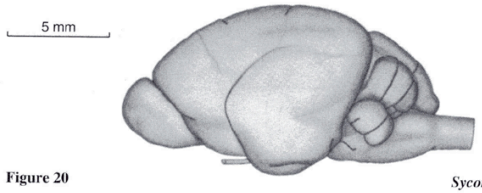


Figure 20 *Syconycteris australis*

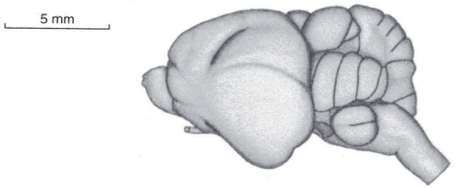
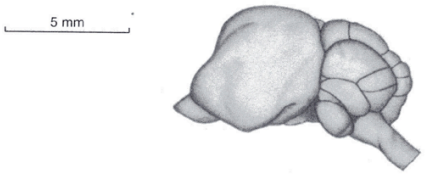


Figure 21 *Taphozous mauritianus*



Nycteris nana

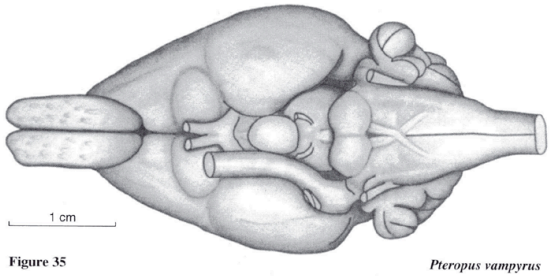


Figure 35 *Pteropus vampyrus*

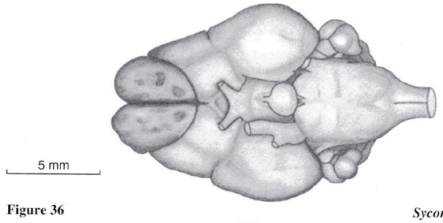


Figure 36 *Syconycteris australis*

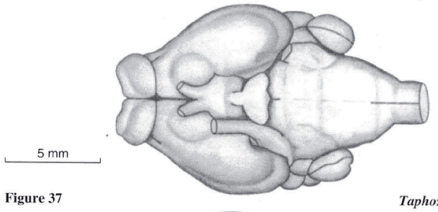
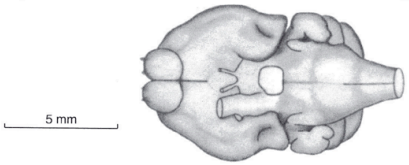


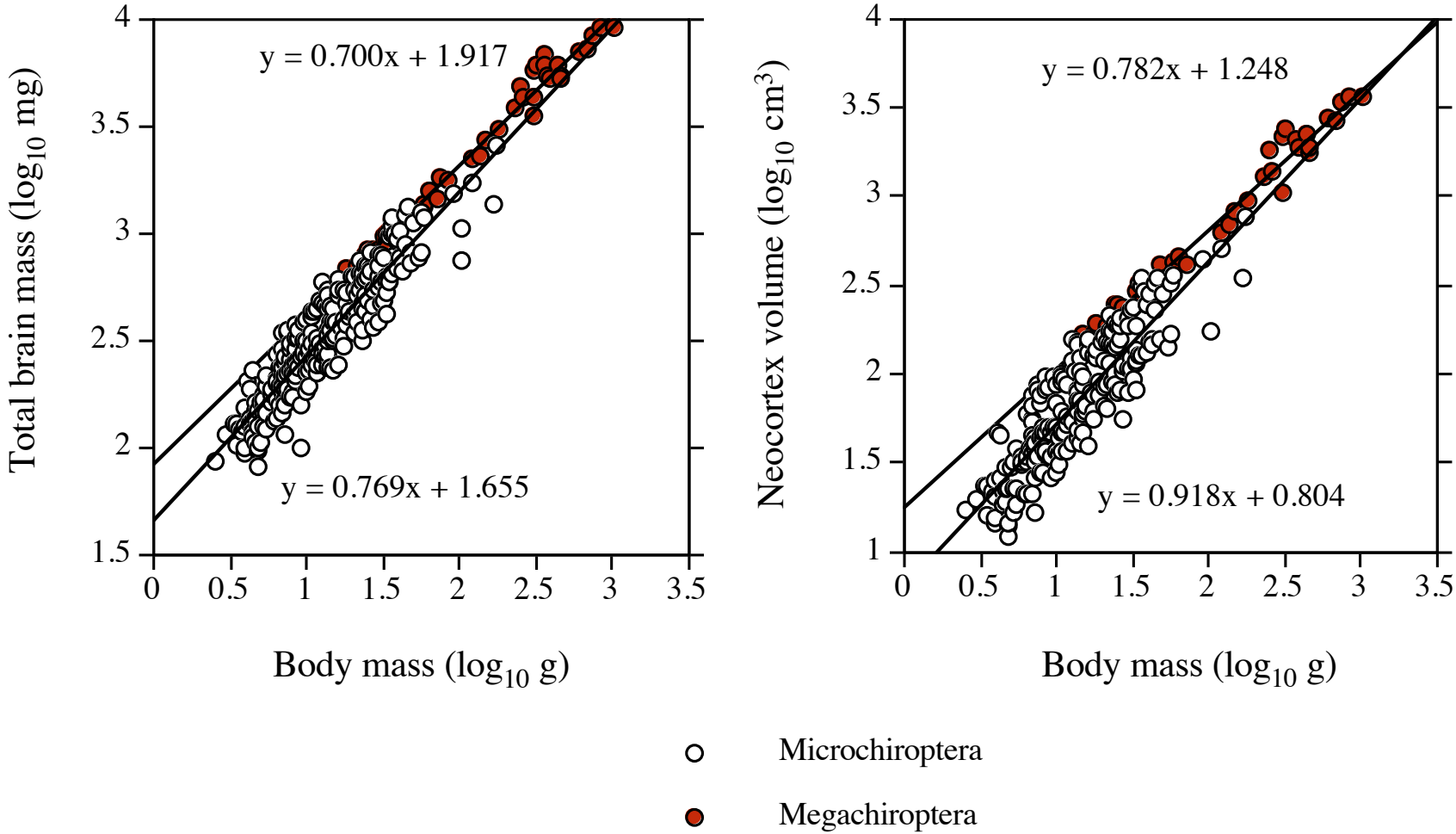
Figure 37 *Taphozous mauritianus*



Nycteris nana

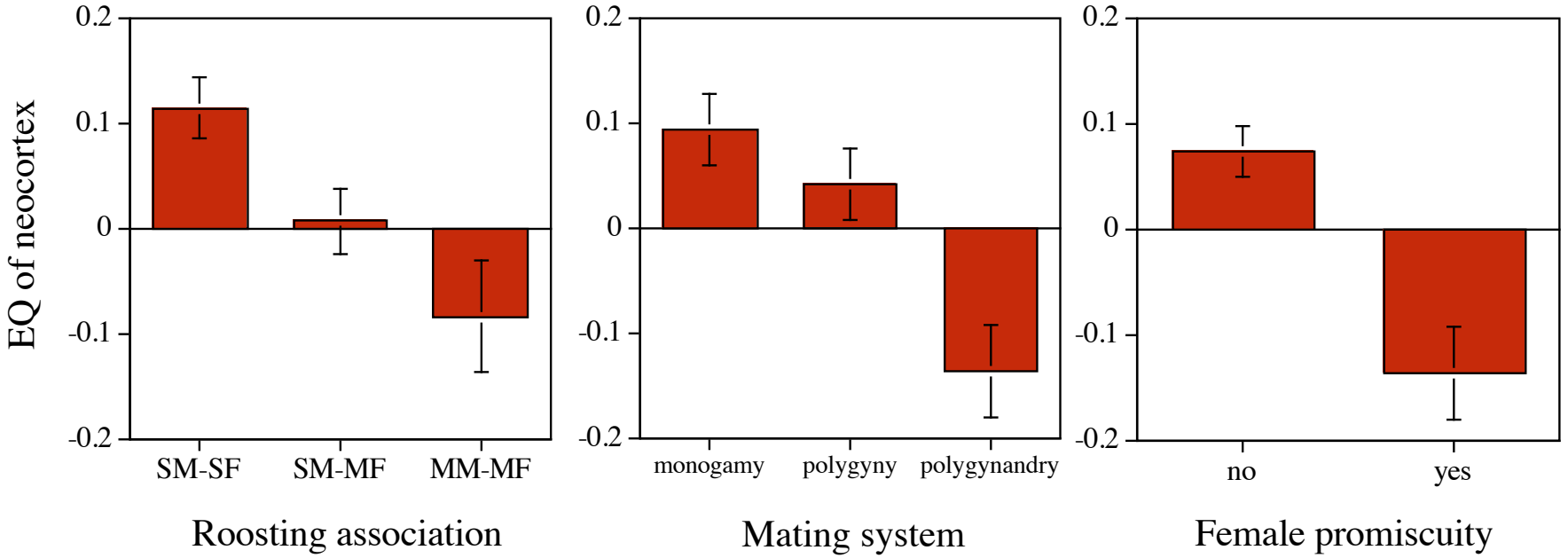
N = 349 for brain, testes and or breeding system data

Bat brain size and body size



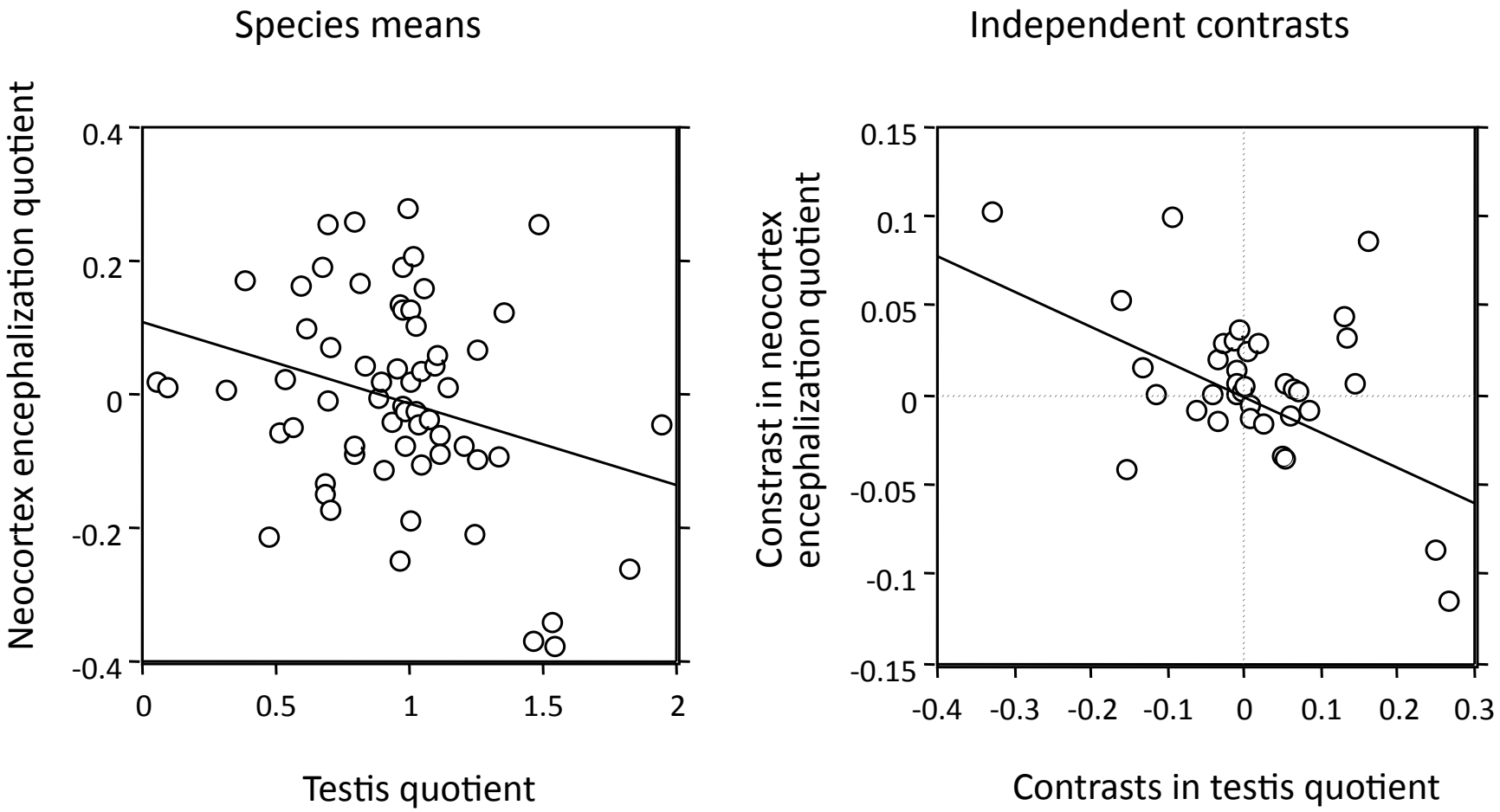
Bat brain size also varies with mating system

(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

- Wigby S, Chapman T 2004. Sperm competition. Current Biology 14: R100-R103.
- Wilkinson, G.S. and McCracken, G.F. 2003 Bats and balls: Sexual selection and sperm competition in the Chiroptera. In: *Bat Ecology* (T.H. Kunz and M. B. Fenton, eds.) pp. 128-155. University of Chicago Press, Chicago.
- Pitnick, S., Jones, K.E. and Wilkinson, G.S. 2006 Mating system and brain size in bats. Proceedings of the Royal Society of London, B 273: 719-724.