

# Mammalogy (BIOEE 451)

## Lab 2 – Post-cranial skeleton and Dentition II

### Mammalian Diversity: Metatheria (marsupials)

#### Business:

1. **Diving into mammalian diversity** – Today we will begin to dig into the incredible diversity of mammals. This may feel overwhelming at times as you are introduced to more and more taxonomy. In light of this, I want to be clear about expectations for lab. You will need to learn all the mammalian orders, but only the families that are highlighted in the lab handouts. For example, we will examine all 7 of the metatherian orders, but only 12 of the 21 families. Within each family you will be expected to know one or two species that represent the family. These will usually be the species in the lab demonstrations. Other levels of classification (e.g. suborder) may be useful for you to keep in mind as a way of organizing the diversity in your mind, but I will not ask you to remember their names. I will list the taxa for which you are responsible in bold under the mammal diversity classification section.
2. **Local diversity** – The exception to the above will come when we start getting into groups that are represented by species here in upstate New York. At that time, we will have lab stations devoted to local diversity, and you will be expected to learn about each species (classification, life history, identification, etc.).

#### Goals for today's lab:

1. Learn major post-cranial bones and features of mammals
2. Learn major skeletal features that differ among prototherians, metatherians, and eutherians
3. Learn major characteristics of teeth and toes that differentiate some marsupial orders
4. Learn basic elements of tooth development
5. Learn 7 marsupial orders and 12 representative families, including names and major characteristics of highlighted species
6. Review mammal teeth – tribosphenic molars, adaptations to diet, etc. from Lab 1

#### **Station 1 – Post-cranial skeleton of mammals:**

(Martin et al. – Chapter 6; Vaughan et al. – pp. 22-24 and 33-34)

At this station you will learn the major bones and features of the post-cranial skeleton of mammals. With a good knowledge of the skeletal “landscape” you will be able to identify homologous bones from animals that represent a diverse range of life-histories, and you will be better able to interpret how their skeletons have been sculpted by natural selection. For example, at first glance the highly modified limbs of a horse (Family Equidae) seem bizarre and one of a kind. However, with knowledge of the identity of the bones we can see that evolution has strengthened and elongated the skeletal elements of the limbs through loss and fusion of some bones, and elongation of others. These changes are perfectly consistent with a history of adaptation for a life of running. Likewise, the bat's wings are unique among mammals, but with an understanding of skeletal morphology we can easily see that the “veins” of the wings are really just elongated fingers. These examples highlight the marvelous diversity of forms that have evolved from the same basic body plan in mammals.

Using your lab manual and the articulated cat skeleton at this station, identify the major elements of the post-cranial skeleton. First, be able to distinguish the **axial** and **appendicular** portions of the skeleton. Starting with the axial skeleton, identify the first two cervical vertebrae - **atlas** and **axis**. These vertebrae, in combination with the paired occipital condyles on the skull, were a major innovation for mammals, permitting the head to rotate (shake your head “no”; involves atlas and axis) and nod (“yes”; involves occipital condyles and atlas) across a larger range of motion than was possible for our reptilian ancestors. Examine the loose atlas and axis and see how they fit together and rotate against each other. Be certain you can identify which is which. With rare exceptions (e.g., sloths, armadillos, manatees, some cetaceans), all mammals have 7 cervical vertebrae. However, these vertebrae may be highly specialized. In cetaceans (whales and dolphins) and some jumping mammals (e.g., heteromyid rodents – kangaroo rats and mice) the cervical vertebrae are fused. This presumably is an adaptation for keeping the line of the body rigid during locomotion. Examine the example of cetacean cervical vertebrae. These examples are not perfectly fused, but they clearly fit together as a single rigid unit. Can you count the vertebrae?

Continuing down the axial skeleton past the axis, note the differences in form among the **cervical**, **thoracic**, **lumbar**, **sacral**, and **caudal** vertebrae. Examine the loose vertebrae and the major differences among them. For example, note the tall neural spine and articulation points for ribs on the thoracic vertebrae and the relatively large centrum and long transverse processes of the lumbar vertebrae. If you were given a loose vertebra, could you identify from which section of the axial skeleton it came? Rounding out the axial skeleton are the **ribs** and the **sternum**, which enclose the heart and lungs in the thoracic cavity.

The appendicular skeleton consists of the **pectoral** and **pelvic girdles**, and the four limbs that are attached to them. In the pectoral girdle, identify the **scapula**, **scapular spine**, and **clavicle**. Note that in many running species the clavicle is reduced or missing entirely. The **humerus**, **radius**, **ulna**, **olecranon process** (part of the ulna; forms the elbow), **carpals** (wrist bones), **metacarpals**, and **phalanges** (bones of the digits) make up the forelimb. The digits in these limbs are numbered beginning with the medial **pollex** (thumb) and counting outward. Note that the primitive condition for mammals is to have five digits. Throughout the semester you will see many examples of mammals that have fewer than five digits. This is the result of either fusion or loss of digits through evolutionary time. For example, the horse essentially has a single digit (the 3<sup>rd</sup>) on each limb. Imagine running on tiptoe, and only using one toe per foot!

The pelvic girdle consists of three pairs of bones that are generally fused together, the **ilia** (hip bones), **ischia**, and **pubic** bones. These bones encircle the exit point for the digestive, urinary, and reproductive tracts. All offspring must pass through that bony portal, which indicates one advantage of marsupials in bearing partially developed young. Giving birth must be a physically easier process for marsupials than for placentals simply because of the relative size of the offspring. Given the success of placental mammals, though, it would seem that the benefits of giving birth to highly-developed young must outweigh the costs. For some placental mammals, the **pubic symphysis** (where the two pubic bones meet) is not completely fused and can flex with the passage of large offspring. The limb that articulates with the pelvic girdle consists of the **femur**, **tibia**, **fibula**, **patella** (knee cap), **tarsals**, **metatarsals**, and another set of **phalanges**. The largest of the tarsals (the heel in humans) is the **calcaneus**. As in the forelimb, the digits of the hindlimb are counted starting with the medial **hallux** (big toe).

A final bone that bears mentioning is not part of either the axial or appendicular skeleton. It is the **baculum** (os penis), and it is found in the penis of many male placental mammals. A much reduced, presumably homologous, bone called the **baubellum** (os clitoris) is found in the glans clitoris of females. These are hard and dense bones unlike most other bones in the skeleton. Bacular morphology can vary among even closely related species, so baculum shape is often used in taxonomic descriptions of species. Bacula are found in primates (except humans), rodents, some insectivores, chiropterans (bats), and carnivores.

### **Station 2 – Skeletal comparisons among Prototheria, Metatheria, and Eutheria:**

(Martin et al. – Chapter 11; Vaughan et al. – p. 73)

Now that you are relatively familiar with the major features of the mammalian skeleton, you should be able to spot some differences among the major evolutionary lineages of mammals. At this station there are skeletons of a monotreme (echidna), marsupial (opossum), and placental (pangolin). What morphological differences can you pick out? The primitive pectoral girdle of the monotreme is relatively robust and complex in comparison to the other two skeletons. This highlights the trend toward reduction and simplification of skeletal structures in mammalian evolution. Both the opossum and the echidna have epipubic bones, which are lacking in the placental.

Examine the skulls at this station. The skull of an echidna or platypus is certainly easy to identify, but what about the marsupial and placental skulls? If you were given a dentary or cranium from a mammal, could you determine which major lineage it represents? Teeth are not always the best thing to look at because of convergence between placentals and marsupials. However, marsupial dentaries are usually easy to identify because they have a **medially inflected angular process**.

- Compare the marsupial angular process to that of the placental dentary. It should be clear that in the placental all the processes on the posterior end are in the same plane, whereas there is a bend in the marsupial dentary.

The marsupial cranium can be distinguished by the large **vacuities in the palate**, as well as the fact that the **mandibular fossa** (the articulation point for the mandibular condyle of the dentary) is usually formed by both the jugal and the squamosal bones. In the placental skull the mandibular fossa is entirely within the squamosal. Another good indicator for identifying marsupial skulls is the **size of the auditory bullae** (usually very small; the exception is the monito del monte, Order Microbiotheria) and the fact that the **auditory bullae are largely formed by the alisphenoid**. In placentals this structure is usually formed by the tympanic, basisphenoid, or other cranial bones.

- Using the skulls at this station, test your ability to find each of these distinguishing characteristics.

### **Station 3 – Major features of metatherians – teeth and toes:**

(Martin et al. – Chapter 11; Vaughan et al. – pp. 83-100)

Metatherian diversity can be divided up based on two major types of morphological variation, one relating to the teeth and the other relating to the toes (digits of the hind feet). First, only Order Diprotodontia is truly **diprotodont**. The first two lower incisors are particularly large and forward-pointing (**procumbent**), and a large diastema is usually evident between the first incisors and the

remaining teeth (e.g., see Martin et al. figures 11.17 and 11.20). Another order (Paucituberculata) is also described by some authors (see Martin et al. p. 67) as having diprotodont teeth, but for our purposes we consider Diprotodontia to be the only group with true diprotodont teeth. The species in Paucituberculata can be distinguished from most true diprotodonts because they lack a clear diastema. The remaining orders of marsupials are considered to be **polyprotodont**.

- Examine the diprotodont and polyprotodont skulls at this station to become familiar with their overall structure. Practice determining their dental formulae.

The second major feature that distinguishes different groups of marsupials is the organization of the toes. Two orders (Diprotodontia and Peramelemorphia) have **syndactylous** toes. Syndactyly means that two or more digits are fused together in a single sheath of skin. In the case of syndactylous marsupials, it is the second and third digits of the hind feet that are fused. The other five marsupial orders have **didactylous** toes, meaning that all five digits are free.

- Examine the feet of the koala at this station. Note the two nails on one toe, revealing the fusion between digits 2 and 3.

A final term describes the state of the fingers of some marsupial forefeet. **Schizodactyly** describes the forefeet of many climbing diprotodonts. This means that the first two digits oppose the remaining three, creating a stronger grip on branches (imagine moving your pointer finger over to use as a second thumb).

- Koalas offer a great example of schizodactyly. Can you see the cleft between digits 2 and 3?

Diprotodonty and syndactyly allow us to identify the metatherian orders Diprotodontia and Peramelemorphia unambiguously, but how do we distinguish the other five, which are all polyprotodont and didactylous? The table that follows gives a breakdown of some characteristics that taken together offer a means of identifying these orders.

	Toes	Teeth	Incisor formula	Auditory bullae	Distribution
<b>Diprotodontia</b>	syndactyl	diprotodont	3/2-3	small	Australian
<b>Peramelemorphia</b>	syndactyl	polyprotodont	4-5/3	small	Australian
<b>Didelphimorphia</b>	didactyl	polyprotodont	5/4	small	Nearctic, Neotropical
<b>Paucituberculata</b>	didactyl	polyprotodont; “diprotodont-like”	4/3-4	small	Neotropical
<b>Microbiotheria</b>	didactyl	polyprotodont	5/4	large	Neotropical
<b>Dasyuromorphia</b>	didactyl	polyprotodont	4/3	small	Australian
<b>Notoryctemorphia</b>	didactyl	polyprotodont	4-3/3	small	Australian

Based on the above, it should be possible to distinguish all of the orders, with the exception of Dasyuromorphia and Notoryctemorphia. However, Notoryctemorphia consists of only two species of highly derived marsupial “moles”. These species have massive spade-like claws that make them easy to identify in practice. Unfortunately we do not have any specimens of Paucituberculata, Microbiotheria, or Notoryctemorphia for you to look at closely.

- When you get to the diversity section of the lab, examine specimens for the morphological characteristics listed in the table. What information would you need to determine to which order a given specimen belongs? Which orders can you distinguish based solely on cranial morphology? How could you narrow down the range of possibilities?

#### **Station 4 – Tooth development**

Mammalogists spend a great deal of time studying teeth because they tell us a great deal about the mammals in which they are found. They also represent an area of extreme innovation that makes mammals unique among living creatures. It is therefore useful to establish a basic understanding for the developmental process that leads to the production of mammalian teeth. At this station you will find compound microscopes with demonstration slides showing different stages of tooth development in a fetal pig. Each slide is a cross section through the developing jaw. Use the labeled pictures to find the major landmarks (e.g., tongue, developing tooth, etc.) on the slide. Do not only look at the pictures. You will need to be able to look through a microscope and interpret what you see on the practical, so it is a good idea to get used to doing this now. Do not worry about memorizing all the information that is in the labeled photos. The major points for which you are responsible are in the handout.

*Please remember proper microscope etiquette – use only the fine focus when slides are under high magnification!*

Teeth are formed from an interaction between two different layers of tissue in the developing embryo, the **oral epithelium** (i.e., the cells that line the inside of your mouth), and the **neural crest cells** that migrate into the jaw. Microscope 1 shows an early stage of tooth development, in which the oral epithelium has already become invaginated and formed the pocket in which the new tooth will grow. At this stage you can see the early **dental organ** (derived from the oral epithelium; this will ultimately lay down the **enamel** on the developing tooth) and **dental papilla** (derived from the neural crest; this will ultimately produce the **dentine** and **pulp cavity** of the tooth). Note that the teeth are already in development, well before there is a jaw ready to receive them.

Microscope 2 shows a later stage (“bell” stage) of tooth development. The dental papilla and dental organ are now well developed. Enamel is already beginning to be deposited by the cells of the dental organ (visible as a thin line between the two tissue layers). Finally, microscope 3 shows the finished product. The enamel, dentine, and pulp cavity are in place. Be sure that you can identify each under the microscope.

#### **Station 5 – Mammalian diversity – Metatheria**

(Martin et al. – Chapter 11; Vaughan et al. – Chapter 6)

*Note – if you have questions about where these animals can be found, consult the world map*

**Classification: Class Mammalia**

**Subclass Metatheria**

**Order Didelphimorphia**

**Family Didelphidae**

**Order Paucituberculata**

**Family Caenolestidae**

- Order Microbiotheria**
  - Family Microbiotheriidae**
- Order Notoryctemorphia**
  - Family Notoryctidae**
- Order Dasyuromorphia**
  - Family Thylacinidae
  - Family Myrmecobiidae**
  - Family Dasyuridae**
- Order Peramelemorphia**
  - Family Thylacomyidae
  - Family Chaeropodidae
  - Family Peramelidae**
- Order Diprotodontia**
  - Suborder Vombatiformes
    - Family Phascolarctidae**
    - Family Vombatidae**
  - Suborder Phalangeriformes
    - Family Burramyidae
    - Family Phalangeridae
    - Family Pseudocheiridae**
    - Family Petauridae
    - Family Tarsipedidae
    - Family Acrobatidae**
  - Suborder Macropodiformes
    - Family Hypsiprymnodontidae
    - Family Potoroidae
    - Family Macropodidae**

### **Cohort Ameridelphia**

The Ameridelphia marsupials consist of the Orders Didelphimorphia and Paucituberculata. They are found exclusively in the New World (most in South or Central America). The only New World species that is not included with the Ameridelphia is *Dromiciops australis*, the only extant member of the Order Microbiotheria. The Ameridelphia are united by the fact that their spermatozoa become paired in the epididymis during maturation. These orders are also considered to be relatively ancient and may be the basal metatherian lineages, although some relationships within Metatheria remain uncertain. Compare the following phylogenetic hypotheses (based heavily on molecular data) to the one presented in Vaughan et al. (Figure 6-1). If you are not familiar with how to read phylogenies, be sure to ask your TA for a brief refresher.

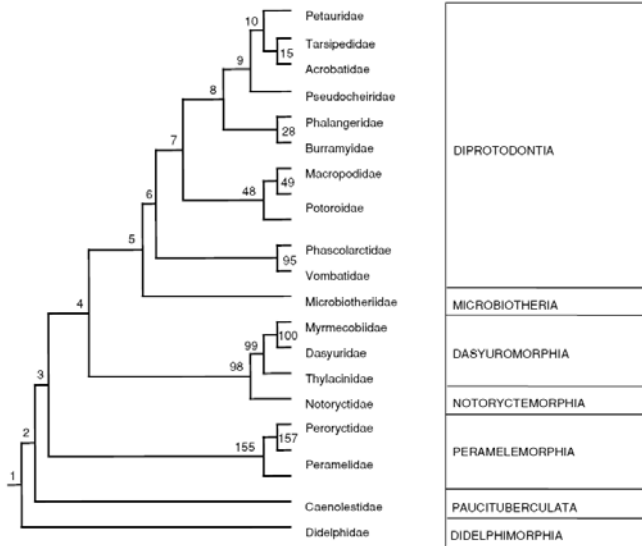


Fig. 2. Unweighted supertree relationships among the families and orders of marsupials recognized by Wilson & Reeder (1993). Note that Potoroidae and Peramelidae are paraphyletic. Branch lengths are arbitrary. Nodes are numbered sequentially.

Cardillo et al. 2004. J. Zool 264:11-31

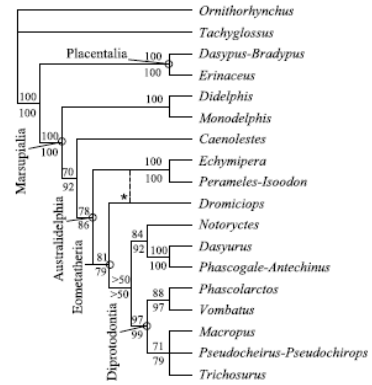


Fig. 3. Consensus tree from nine likelihood and two parsimony analyses of the static alignment based on molecular data alone, using taxa at least 49% complete. Numbers above nodes indicate bootstrap support derived from 100 replicates of a 10-rep random addition sequence based on equally weighted parsimony; numbers below nodes represent bootstrap support based on 78 replicates from the HKY85 model, starting trees obtained from neighbor joining. Hyphenated taxa represent chimeric terminals, as shown in supplementary data. The asterisk indicates the different placement by GTR+G+I of *Dromiciops* in a clade with peramelians. All other static analyses placed peramelians as the first australidelphian clade, followed by *Dromiciops*. Parsimony and HKY85+ss differed from the remaining analyses by placing *Trichosurus* and *Pseudocheirus-Pseudocheirus* together; the others placed the latter with *Macropus*.

Asher et al. 2004. MPE 33:240-250

### Order Didelphimorphia, Family Didelphidae

The didelphids are the New World opossums. They represent the most basal lineage in the marsupial phylogeny, and as such they retain many primitive characteristics (e.g., the tribosphenic teeth that we examined last week). Didelphids occupy a broad range of different habitats and are typically omnivorous.

The didelphid *Didelphis virginiana* (Virginia opossum) is the only marsupial to have a range that extends into the United States. This nocturnal animal is terrestrial and arboreal. It is a scavenger, eating anything that is available, but primarily consuming animal matter. As a scavenger it does well wherever humans (and their waste) can be found. We are close to its northern limit because its naked tail and exposed ears are not ideally suited for cold environments. Frost-bitten opossums are not uncommon. Because it is a local species, you should be confident in your ability to identify it and discuss aspects of its life history.

- Distinguishing characters: naked prehensile tails; opposable thumbs; tribosphenic molars; primitive 5/4 1/1 3/3 4/4 dental formula
- Number of species: 87
- Representative species: Virginia opossum, *Didelphis virginiana*  
Yapok or water opossum, *Chironectes minimus*
- Geographic distribution: North, Central, South America (Nearctic and Neotropical regions)
- Diet: omnivorous and opportunistic; diet ranges from fish and arthropods to flowers and nectar
- Habitat: tropical and temperate forests, grasslands, mountains
- Behavior: typically nocturnal and arboreal, though the group is so diverse that it defies simple categorization; the Virginia opossum feigns death quite convincingly to avoid predation; most opossums are solitary
- Size: 0.2-5.5 kg; 12-110 cm
- Reproduction: can carry up to 3 litters per year and 20 or more offspring per litter;

reproductive success is limited to the number of nipples available  
Lifespan: 1-3 years  
Other notes: some didelphids have a well-developed marsupium while others have none; *Chironectes* is the only semi-aquatic marsupial

### **Order Paucituberculata, Family Caenolestidae**

Distinguishing characters: resemble shrews; polyprotodont, but with “diprotodont-like” lower incisors; tail is not prehensile; no marsupium is present; dental formula 4/3-4 1/1 3/3 4/4  
Number of species: 6  
Representative species: Silky shrew opossum, *Caenolestes fuliginosus*  
Geographic distribution: Andes Mountains (Neotropical region)  
Diet: primarily carnivorous; eats invertebrates and small vertebrates, also fungi and seeds  
Habitat: wet montane forests  
Behavior: probably nocturnal; primarily terrestrial; use lower procumbent incisors to stab and subdue prey  
Size: 14-41 g; 19-28 cm  
Reproduction: unknown  
Lifespan: unknown  
Other notes: family groups have been trapped together, suggesting both male and female parental care of young

### **Cohort Australidelphia**

The Australidelphia consist of the remaining five orders of marsupials. With the exception of *Dromiciops australis*, all australidelphians are found in the Australian biogeographic region. This group represents the vast majority of extant marsupial diversity. Particularly fascinating are the several examples of uncanny morphological convergence between australidelphian marsupials and placental mammals that occupy similar niches on other continents. As you study the specimens representing these orders, look for examples of convergence. How has natural selection shaped the features of evolutionarily distinct species to allow them to exploit similar habitats?

*Note - the term “possum” is appropriately used in reference to some australidelphian marsupials, whereas “opossum” refers to New World marsupials*

### **Order Microbiotheria, Family Microbiotheriidae**

Distinguishing characters: greatly enlarged tympanic bullae relative to other marsupials; prehensile tail; marsupium present; primitive 5/4 1/1 3/3 4/4 dental formula  
Number of species: 1  
Representative species: monito del monte, *Dromiciops australis*  
Geographic distribution: central Chile (Neotropical region)  
Diet: insectivorous, but also some vegetation  
Habitat: wet, montane forests; stands of Chilean bamboo  
Behavior: nocturnal; arboreal

Size: 170-260 mm  
Reproduction: 1 litter of 1-4 young per year  
Lifespan: unknown  
Other notes: stores fat in the tail (incrassate); hibernates during winter and lives off of fat reserves; it is reported to be considered bad luck to find a monito del monte in one's home

### **Order Notoryctemorphia, Family Notoryctidae**

Distinguishing characters: horny rostral shield; 3<sup>rd</sup> and 4<sup>th</sup> digits of forefeet have enormously enlarged claws; vestigial eyes lack lens and pupil – not visible externally; no pinnae (external ears); marsupium opens backward; five posterior cervical vertebrae are fused; dental formula 4-3/3 1/1 2/3 4/4

Number of species: 2

Representative species: southern marsupial mole, *Notoryctes typhlops*

Geographic distribution: central and western Australia

Diet: insectivorous, primarily invertebrate larvae

Habitat: sandy desert soils

Behavior: solitary; active day and night; “swim” through sandy soil as deep as 2.5m without leaving tunnels; often walks above ground also

Size: 100-200mm

Reproduction: poorly known; females construct deep, permanent burrows for bearing young

Lifespan: unknown

Other notes: “swim” through sand using large claws on forefeet; sense vibrations through the sand to locate prey

- Convergence – The marsupial moles exhibit strong convergence with the two other major groups of mole-like mammals, which are both eutherian. They are most similar in form to the golden moles (family Chrysochloridae), but also share many similarities with the “true” moles (family Talpidae). Compare the pictures of the notoryctids to the mounted talpid mole. Note the many superficial similarities (e.g., no pinnae, reduced/absent external eyes, enlarged forefeet and claws).

### **Order Dasyuromorphia, Family Myrmecobiidae**

Distinguishing characters: didactylous; bushy tail; marsupium absent; long slender tongue; reduced palatal vacuities; teeth small, but greater number than any other terrestrial mammal (up to 52); dental formula 4/3 1/1 3/3 4-5/5-6

Number of species: 1

Representative species: numbat, *Myrmecobius fasciatus*

Geographic distribution: southern Australia

Diet: insectivorous; primarily ants and termites

Habitat: dry eucalyptus forests with plenty of downed logs

Behavior: diurnal; often observed basking in the sun

Size: 300-550 mm; 280-600 g

Reproduction: 1 litter of 2-4 offspring per year  
Lifespan: unknown  
Other notes: long, sticky tongue can extend to 100mm outside of mouth

- Convergence – Many different mammalian lineages exploit ants and termites as a major food source. Several of these groups have evolved very similar traits as adaptations to this lifestyle (e.g., long, sticky tongues, large salivary glands, reduced dentition). Compare the numbat skull to those of pangolin, anteater, and armadillo, which all share a similar diet. Note that all exhibit some elongation of the skull and simplification or loss of teeth. Why do you think these characteristics might be advantageous for an animal that feeds primarily on termites or ants?

### **Order Dasyuromorphia, Family Dasyuridae**

Distinguishing characters: didactylous; tail usually furry, but not prehensile; skull is similar in appearance to didelphids, but incisors differ (4/3 rather than 5/4); canines well-developed and with sharp edge; marsupium often absent; dental formula 4/3 1/1 2-3/2-3 4/4

Number of species: 69

Representative species: Tasmanian devil, *Sarcophilus harrisii*

Geographic distribution: Australia, New Guinea, Tasmania, and Normandy Islands

Diet: primarily carnivorous or insectivorous

Habitat: wide range of habitats, from desert to forest to mountain

Behavior: varies broadly depending on size and diet; mostly terrestrial, but some arboreal; small dasyurids fill the niche of eutherian shrews, hunting invertebrates at night; larger cat-like dasyurids (quolls) run down prey with speed

Size: 5 g – 8 kg

Reproduction: varies widely

Lifespan: varies widely

Other notes: several examples of convergence in Dasyuridae, e.g. Tasmanian devil and hyena, quoll and cat

- Convergence – Some carnivorous mammals have evolved extraordinarily powerful jaws. This impressive bite allows them to crush bone and shear through tough hides and sinews. The Tasmanian devil and the placental hyenas are two such animals. Compare the skulls of these animals. Note the broad, sturdy construction of the crania, large sagittal crests to which the jaw-closing muscles attach, and robust cheek teeth.

### **Order Peramelemorphia, Family Peramelidae**

Distinguishing characters: syndactylous; elongated rostrum; marsupium opens backward; crown of incisors flattened; canine widely spaced from incisors and premolars; relatively flat cranium; dental formula 4-5/3 1/1 3/3 4/4

Number of species: 18

Representative species: long-nosed bandicoot, *Perameles nasuta*

Geographic distribution: Australia, Tasmania, and New Guinea

Diet: primarily insectivorous

Habitat: wide range of habitats; arid to forest  
 Behavior: nocturnal  
 Size: 200 g – 2 kg  
 Reproduction: chorioallantoic placenta, but not as invasive as in eutherians (see lecture notes)  
 Lifespan: unknown  
 Other notes: long limbs are adapted to running or hopping

- Look for syndactyly in the available specimen. What other order has syndactylous toes?

### **Order Diprotodontia, Family Phascolarctidae**

Distinguishing characters: syndactylous; schizodactylous; diprotodont; large, bulbous nose; marsupium opens to rear; angular process of dentary is not strongly inflected medially; large diastema on upper and lower jaw; dental formula 3/1 1/0 1/1 4/4

Number of species: 1

Representative species: koala, *Phascolarctos cinereus*

Geographic distribution: eastern Australia

Diet: eucalyptus leaves, stems, flowers, bark; microbes aid in digestion; prefer only 5 of 350 eucalyptus species (will eat up to 20)

Habitat: eucalyptus forest

Behavior: mostly solitary; arboreal; sedentary; major activities include eating and sleeping

Size: 8-12 kg

Reproduction: 1 litter of 1-2 offspring per year; embryo forms a placenta

Lifespan: 10 years in the wild; >20 years in captivity

Other notes: poor quality diet makes conservation of energy critical – koalas may remain inactive for 20 hours a day; males produce harsh bellowing calls during breeding season

### **Order Diprotodontia, Family Vombatidae**

Distinguishing characters: syndactylous; diprotodont; pouch opens backward; all teeth are open-rooted; enamel restricted to anterior side of incisors (as in rodents); dental formula 1/1 0/0 1/1 4/4

Number of species: 3

Representative species: common wombat, *Vombatus ursinus*

Geographic distribution: Australia and Tasmania

Diet: herbivorous

Habitat: montane and semiarid

Behavior: nocturnal; solitary; burrowing - builds extensive tunnel systems

Size: 700-1200 mm; up to 40 kg

Reproduction: single offspring litters; embryos form a simple placenta

Lifespan: 5 years in the wild; over 26 years recorded in captivity

Other notes: remarkable convergence with rodents (e.g., marmot)

- Convergence – Wombats have evolved to occupy the same niche as some rodents, and they exhibit some striking similarities to that eutherian group. Most impressive is the fact that like rodents, the enamel is restricted to only the anterior surface of their ever-growing incisors, which are kept sharp by constant gnawing. Compare the wombat skull to those of the rodents at this station. Aside from their incisors, what other similarities can you identify?

**Order Diprotodontia, Family Pseudocheiridae**

- Distinguishing characters: syndactylous; diprotodont; prehensile tail; pouch opens to front; selenodont upper molars; dental formula  $3/2 \ 1/0 \ 3/3 \ 4/4$
- Number of species: 17
- Representative species: common ringtail possum, *Pseudocheirus peregrinus*
- Geographic distribution: Australia, Tasmania, and New Guinea
- Diet: herbivorous
- Habitat: temperate and tropical forests
- Behavior: nocturnal; arboreal; territorial, but can be solitary or in groups
- Size: 0.5 – 2 kg
- Reproduction: up to 4 litters per year with 1-4 offspring per litter
- Lifespan: 3-6 years
- Other notes: microbial fermentation is an important part of digestion, and at least the common ringtail practices coprophagy (ingestion of feces)

**Order Diprotodontia, Family Acrobatidae**

- Distinguishing characters: syndactylous; diprotodont; bunodont molars; dorso-ventrally flattened tail; membrane between elbows and knees; eyes are binocular (focus forward); tongue has brush-like tip; dental formula  $3/2 \ 1/0 \ 2-3/3 \ 3/3$
- Number of species: 2
- Representative species: feather-tailed glider, *Acrobates pygmaeus*
- Geographic distribution: mainland Australia
- Diet: arthropods, nectar
- Habitat: wide range from forest canopy to terrestrial
- Behavior: nocturnal; may nest in groups; uses membrane for gliding
- Size: 10-50 g
- Reproduction: 2 litters of ~4 young per year
- Lifespan: unknown
- Other notes: brush tip on tongue may be an adaptation for soaking up nectar; can glide over 20 meters; convergent with flying squirrels

- Convergence – Though only one group of mammals is capable of true flight (any ideas?), several mammals have the ability to glide using patagia (flaps of skin that run between the limbs and body). Acrobatid marsupials exhibit several characteristics common to many gliding mammals. Compare the *Acrobates* specimen to that of *Glaucomys sabrinus*, one of our local flying squirrels. Note the similar patagia. Unfortunately, this *Acrobates* specimen has lost its tail. Tails are often important to gliding mammals, because they act to balance and steer the animal along its path. What characteristic of the tail of *Glaucomys* might help the animal during a glide?

## **Order Diprotodontia, Family Macropodidae**

- Distinguishing characters: syndactylous; diprotodont; large diastema; large masseteric fossa; relatively long and slender skull; hallux (big toe) missing; square, selenodont or lophodont molars; 3 upper incisors blade-like; dental formula 3/1 1-0/0 2/2 4/4
- Number of species: 65
- Representative species: red kangaroo, *Macropus rufus*
- Geographic distribution: Australia, New Guinea, and associated islands
- Diet: herbivorous; rely on intestinal microbes to aid in digestion
- Habitat: varies widely - arid scrub, montane, forest
- Behavior: mostly terrestrial, but some arboreal
- Size: 500 g – 90 kg
- Reproduction: females may simultaneously support young from 3 different litters (uterus, pouch, and post-pouch)
- Lifespan: varies
- Other notes: ecological equivalents to artiodactyls (e.g. antelope, deer) resulting in similar cranial morphology and dentition; highly specialized for bipedal jumping – unique among large mammals; elastic tendons in the hind feet store energy during jumping; kangaroos can attain speeds of up to 70 km/hr

- Convergence – Kangaroos and their relatives fill an ecological niche that is occupied by ungulates (horses, deer, cattle, etc.) outside of Australia. Not surprisingly, these groups exhibit similar cranial and dental features. Compare the deer and horse skulls to that of the kangaroo. Note the similarities in overall form, with particular emphasis on the dentition. For example, all are selenodont, with grinding cheek teeth separated from the nipping incisors by a large diastema.

### **Station 6 – Practical practice**

I've set up some specimens with questions on cards at this station. Use the questions to test your knowledge. Try to answer them without referring to your notes, but if you're stumped go ahead and look. If all else fails, the answers are on the back of the card. Please remember to put the cards down question side up for the next person!

### **Station 7 – Dentition review from Lab 1**

Refer to your lab handout from last week to review the material at this station.