Using A Dichotomous Key to Identify Mammal Skulls

Objectives

1. To learn how a dichotomous key works, and to appreciate its utility and necessity.

2. To learn how to use skull and dentition characteristics to key out mammal specimens.

3. To appreciate the diversity of skulls and dentition in mammals as ecologically important traits for different feeding strategies in mammals, and to increase general knowledge of mammals.

General Introduction

Dichotomous keys are very important tools in biology. In order to study biodiversity, it is necessary to be able to identify and classify individual organisms. In addition to the general utility of dichotomous keys for classifying difficult to distinguish organisms, from bacteria and fungi to insects and marine invertebrates, there are various uses specific to the study of vertebrates. Vertebrates, especially mammals, often appear to be easy to identify and classify. So, why and where would one need to use a key in classifying mammals?

It turns out that even mammals are not always easy to distinguish; there is a lot more variety than we are accustomed to seeing in North America, even if we include zoological parks. For example, while in N.A. we have only one species of opossum that is fairly easy to recognize, in South and Central America there are at least 70 species in the opossum family! These and other living mammals can usually be distinguished by their outward physical features such as body shape and size and pelage coloration. However, there are times when we need to identify an animal based only on skeletal features, a generally reliable set of characteristics. For example, paleontologists naturally need to key out fossils based only on skeletal features. Mammalogists studying the feeding habits of owls can analyze the skeletal remains of prey items that are found in the regurgitated 'owl pellets' to discover which species the owls are taking. Similarly, researchers studying the feeding habits of various other predators can use skeletal and fur remains that are found in fecal samples to identify prey animals. Wildlife rangers can use keys to identify remains of animals that are suspected of being taken illegally and use the information for forensics purposes. These are just a few examples of how various scientists and practioners use keys for identifying mammals.

You will find that the terminology in the keys is difficult and unfamiliar. Many users of keys are not highly familiar with the terminology used. Each user needs to be able and willing to research terms that are unfamiliar, for example by looking them up in a technical dictionary. There will be glossaries of terms available in several places for this laboratory.

Using Dichotomous Keys

To allow scientists to identify organisms, taxonomists develop dichotomous keys to facilitate identification. Here’s a simple example of a dichotomous key to the five kingdoms (before the advent of domains, etc.).

1a. Organisms lacking cell nuclei . . . . .Monera (Bacteria & Archaeabacteria)
1b. Organisms with cell nuclei 2

2a. Unicellular or tissue-level organisms . . . .Protista
2b. Complex, multicellular organisms 3

3a. Organisms autotrophic .Metaphyta (Plantae)
3b. Organisms heterotrophic. 4

4a. Organisms absorb food . . . . Fungi
4b. Organisms ingest food . . . . Metazoa (Animalia)

The key is arranged in couplets; at each stage, there are only two possible choices. Choices will either provide you with a taxonomic grouping to which your organism belongs or will direct you to the next couplet to be assessed. It is possible and useful to make a list of the path you take from the first couplet to your final identification. For example, if my unidentified organism was a button mushroom. My list would look like this: 1b; 2b; 3b; 4a (Fungi). This way if you take a wrong turn at a couplet you can more easily retrace your steps and find your mistake, something that is more likely when using a more complex key.

Mammalian Feeding Diversity: Skulls and Teeth

Mammals have diverse feeding habits that are reflected in their teeth and jaw structures. They have specialized teeth for performing different functions, such as canines for grasping and holding onto prey and broad molars for crushing or grinding plant material. The structure of a mammal's teeth as a whole can provide clues to its diet. Biologists can often use these traits to characterize a mammal as a carnivore, herbivore, or omnivore. These categories are artificially created by humans, however, and a species may not fit neatly into a particular category.

Describing the variations in skull morphology and dentition exhibited by mammals requires a specialized vocabulary. A few of the terms are introduced here and by your lab instructor. You will be expected to look up many more specific terms in the glossaries available in the lab. For example, most vertebrates possess homodont teeth (same size/shape teeth). These are relatively uniform in shape and size. Most mammals have heterodont teeth (different size/shape teeth) that can differ greatly in morphology. In mammals with heterodont teeth, there are generally four types of teeth -- incisors, canines, premolars, and molars.

How do you think the different tooth types divide the work involved in feeding, such as collecting and masticating food?

Different species of mammals have different numbers of each tooth type. This information is reflected in a dental formula, which describes the number of each type of tooth on one half of the upper and lower jaws. Dental formulas are a highly useful trait for identification of mammals.

For example, a mammal with three upper and lower incisors (on each half of the jaw), one upper and lower canine, three upper premolars and four lower premolars, and three upper and lower molars would have the dental formula: I3/3, C1/1, PM3/4, M3/3

Note that in the dental formula the first number corresponds to the upper tooth while the second number corresponds to the lower tooth.

What is the human dental formula? (Don't forget wisdom teeth!)

Materials, per pair of students:
Assortment of skulls from three difficulty categories
Ruler
Hand lens
Key to New England Mammal Skulls
Glossaries of Skull terms
Patience

Diversity Within the Orders of Living Mammals

Table 1. Number of species found within the orders of living mammals. Shaded rows indicate orders that have no representative species in New England.

Orders of Mammals	Representative Species	Number of Species	Occurrence in New England
Monotremata	Monotremes (e.g., duck-billed platypus, kiwi)	3	No
Marsupiala	Opossum	255	Yes
Edentata = Xenarthra	Anteater, sloth, armadillo	36	No
Pholidota	Pangolin	7	No
Rodentia	Rat, mouse, lemming, muskrat, beaver, squirrel, chipmunk, woodchuck, porcupine	1702	Yes
Lagomorpha	Rabbit, hare	58	Yes
Macroscelidea	Elephant shrew	15	No
Scandentia	Tree shrew	18	No
Primata	Lemur, monkey, ape	181	No
Dermoptera	Flying lemur	2	No
Chiroptera	Bat	951	Yes
Insectivora	Shrew, mole	345	Yes
Pinnipedia	Seal	33	Yes
Carnivora	Fisher, wolf, bear, weasel, marten, mink, skunk, raccoon, fox, lynx, bobcat	231	Yes
Tubulidentata	Aardvark	1	No
Cetacea	Whale, dolphin, porpoise, narwhal	76	Yes
Artiodactyla	Deer, moose, elk, bison, goat, sheep, boar	187	Yes
Sirenia	Manatee, dugong	4	No
Proboscidae	Elephant	2	No
Hyracoidea	Hyrax	11	No
Perissodactyla	Horse, rhino, tapir	16	No

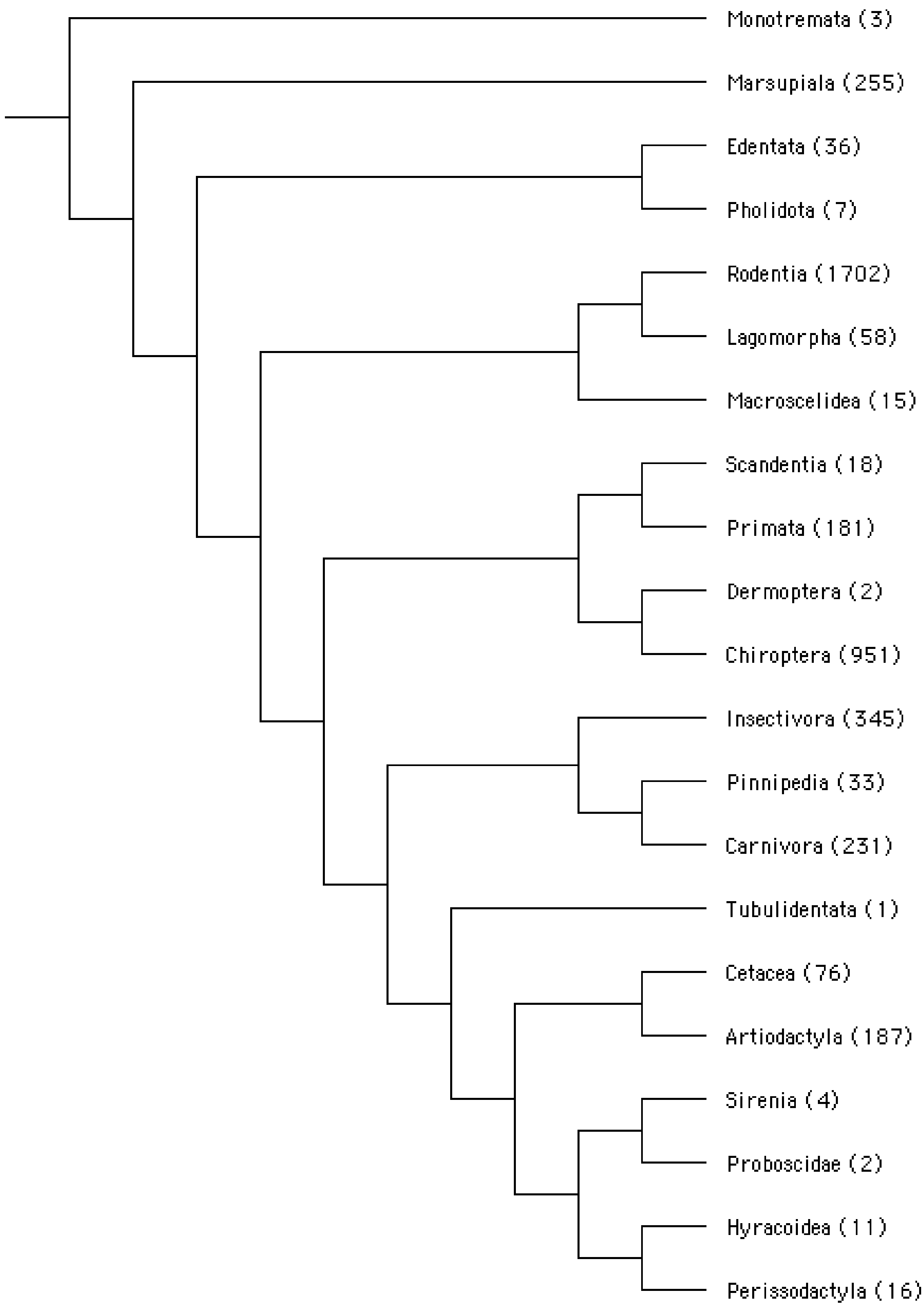

Fig. 1 Cladogram showing phylogenetic relationships among the orders of living mammals.

Directions for Exercise

There are several "mystery" skulls for you to identify using the key provided. The key is divided into parts. The first part allows you to identify the skull to mammalian Order. The second part consists of a series of keys, one for each mammalian Order.

The skulls have been divided into those that are relatively easy to identify and those that are more difficult. Each pair of students must identify at least two skulls from each category. Be sure to keep a record of the path you follow through the key, referring to the top line of each couplet as "a" and the bottom line as "b". This is important for you and for your instructor; if you do not have a record of the path taken, it is difficult to retrace your steps when resolving misidentifications!

This should be a fun exercise; don't let the difficulty of the terminology frustrate you. Use the glossary and figures provided and talk to your partner and others in lab. If a particular definition is still unclear be sure to ask your lab instructor or teaching assistant for pointers or assistance with identifying skull features.

Skull ID _______

Key path followed:

Common Name of Animal ______________________________

Skull ID _______

Key path followed:

Common Name of Animal ______________________________

Skull ID _______

Key path followed:

Common Name of Animal ______________________________
