

## Mammalian Ark Kinds

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### Abstract

Based on the methods outlined in *Determining the Ark Kinds* (Lightner, Hennigan, Purdom, and Hodge 2011), information on the class Mammalia was evaluated in an attempt to get a realistic estimate of what mammalian kinds would have been represented on the Ark. Examining information on extant species (those alive today), it was estimated that they represent 137 created kinds. Given the number of extinct mammalian families known from the fossil record, the actual number on the Ark could easily have been well over 300. This estimate is very low compared with those in the past. In evaluating the information, a number of important creationist research questions have been discussed. As further research is undertaken to address these, our knowledge of created kinds will be significantly advanced.

**Keywords:** Ark, baraminology, kinds, mammals

### Introduction

Mammals belong to the taxonomic class Mammalia. Nowak (1999) lists them in 28 orders that include 146 families and over 4,800 species. They are distinctive in several traits. They possess mammary glands that enable the female to suckle her young. They possess hair, though in cetaceans this is generally confined to early stages of development. Circulating red blood cells lack a nucleus. Additionally, the lower jaw is a single bone on each side that attaches directly to the skull. Like birds, mammals are homeothermic (warm-blooded) and have a four chambered heart with complete double circulation.

In school I was taught that taxonomy is a scientific discipline that, among other things, gave each animal species in the world a unique binomial name. Unlike common names which can vary from region to region, scientific names were to remain constant so any scientist in any country could use the name and it would be easily recognized by any other scientist anywhere else. Unfortunately, taxonomy has fallen short of this ideal. It is not uncommon to find species for which the genus name has changed over time and according to author. Many times subspecies are elevated to the rank of species; other times the reverse situation occurs. Further, at higher levels taxonomy is in flux. This is because, driven by the secular worldview, taxonomists are interested in classifying life according to its supposed evolutionary history. Often similarity based on morphology doesn't correlate with genetic similarity, causing some rather surprising associations (Nishihara, Hasagawa, and Okada 2006). For the purpose of this analysis, the taxonomic structure used in Wilson and Reeder's (2005) *Mammal Species of the World* is used.

To further complicate matters, many species classified as mammals are known only from the fossil record. It is impossible to identify in such specimens many of the important features that have historically defined mammals, as soft tissue is nearly always absent. Even the skeletal remains can be fragmentary, making their placement difficult and severely limiting our understanding of how they appeared in life (McKenna and Bell 1997). For this reason, fossil data will only be addressed to a limited degree in this paper.

Since hybrid information is so important to help identify biblical kinds, *Mammalian Hybrids* (Gray 1972) was used extensively. However, any hybrids she listed as "presumed" or "alleged" are generally disregarded. Since her work is far from complete, considerable effort was made to identify other hybrids in the literature. Where possible, papers summarizing findings were referenced, from which someone can trace the information back to its original source if they desire. Tables summarizing hybrid data are included at the end of this paper in the appendices.

What follows is an initial attempt, using currently available information, to identify all the created kinds of mammals that would have been represented on the Ark. Since cetaceans (whales, dolphins, porpoises) and sirenians (dugong and manatees) spend their entire lives in the water, these two orders of mammals are not considered. Previous creationist work is helpful in some taxa. A discussion of the strategy for identifying kinds as well as relevant terminology used in creationist work was outlined in a previous paper (Lightner et al. 2011). It is hoped that this work will provide a strong basis for future creation research that will bring even greater clarity to our understanding of created kinds.

## Order Monotremata

Monotremes are unusual mammals that lay eggs instead of giving birth to live young. They have a number of other unusual features as well. The structure of the eye and the presence of certain bones in the skull resemble anatomic features of reptiles. Additionally, they have distinct coracoid bones and an interclavicle in their pectoral (shoulder) girdle, resembling that of reptiles. Some features of their ribs and vertebrae are also considered more reptile-like.

Monotremes have three body systems, the digestive, urinary, and reproductive, that all end in a common chamber called the cloaca. This is the basis for the name of this order, which literally means “one hole.” In the male, the penis is in the ventral wall of the cloaca and is divided at the tip into paired canals that are only for conveying sperm. In the female, each oviduct opens separately into the cloaca. After fertilization in the oviduct, the egg is covered with albumin and a flexible, sticky, leathery shell before it is laid (Nowak 1999).

Monotremes suckle their young after they hatch. Like marsupials, monotremes have eupubic (marsupium) bones associated with the pelvis. Monotremes maintain a lower body temperature than most mammals (30–32°C; 86–90°F). There is evidence that they have electroreceptors in their snout that aid in acquiring food (Nowak 1999; Pasitschniak-Arts and Marinelli 1998). Young monotremes have teeth, but they don't cut through the gums and true functional teeth are not present in the adults of extant species. Adult males possess horny spurs on their ankles (Nowak 1999).

### **Tachyglossidae (Echidna kind)**

**Size:** smaller adult around 40–45 cm long (nose to rump; male larger than female). Eats bugs and worms, likes to dig; might hibernate.<sup>1</sup>

Echidnas are also known as spiny anteaters. In addition to their fur, they are covered on the back and



**Fig. 1.** Short-beaked echidna. Source: Encyclopedia of Life <http://www.eol.org/>.



**Fig. 2.** Western long-beaked echidna. Source: Zoo Institutes <http://zooinstitutes.com>.

sides by barbless spines. They have broad feet with three to five strong, curved claws which they effectively use for digging. They are divided into two genera: *Tachyglossus* is the short-nosed echidna; *Zaglossus* is the long-nosed echidna. Some authors list multiple species, particularly in the latter genus. Though there is no hybrid data available, the whole family forms a strong cognitum. *Tachyglossus* is smaller, has longer spines, and generally lays only one egg which it incubates in the temporary pouch that forms at the appropriate time. In contrast, *Zaglossus* is larger with shorter spines, and may incubate and suckle four to six young at a time in its temporary pouch.

Echidnas have been reported to become torpid if food supply dwindles and, in some instances, may hibernate through the winter (Nowak 1999). This leaves open the possibility that the pair on the Ark may have slept through much of the voyage, thus reducing their need for food. Interestingly, in those cases where hibernation has been documented, the females are ready to mate at the end of this period (Nowak 1999).

### **Ornithorhynchidae (Platypus kind)**

**Size:** head and body 30 cm; tail 10 cm; male larger than female. Caging requirements: Male has venomous spurs on hind feet; cage separate from other species.



**Fig. 3.** Duck-billed platypus. Source: Wild Watch Australia <http://www.wildwatch.com.au>.

<sup>1</sup> This is an estimate of the size for the individuals on the Ark using the range reported in the Nowak source.

The only extant member of this family is the duck-billed platypus, *Ornithorhynchus anatinus*. Its bill, though superficially similar to a duck's, is covered with soft, hairless skin. The body is streamlined as in other semi-aquatic mammals (for example, otters and beavers) and it has webbing on the feet. The tail is somewhat like a beaver's, but is covered with fur; it is used in fat storage. The spurs on the hind feet of the males are connected with venom glands and can be used for defense if necessary (Nowak 1999; Pasitschniak-Arts and Marinelli 1998).

There are several fossil specimens that have been placed in this family. They are quite fragmentary, but one is of particular interest. *Obdurodon dicksoni* exhibits well developed functional teeth. In *O. anatinus*, teeth are only found in juveniles; flattened horny plates are present in adults and used in mastication. This suggests that originally this kind may have had teeth, but this trait is largely lost in the present day platypus.

Some may question the need of putting a semi-aquatic creature on the Ark. Who really wants to bring a creature with venomous spurs on the Ark? Besides, extant platypuses aren't exactly known for doing particularly well in captivity (Pasitschniak-Arts and Marinelli 1998). While a platypus may spend half its day in the water, it lives in a burrow. Times of resting on land appear essential to its well being. It seems unlikely that months of swimming in Flood waters would be conducive to the survival of this created kind. Therefore we will assume it was on the Ark.

## Marsupials

At one time marsupials were considered an order. However, currently extant marsupials are usually placed in seven different orders which include about 20 families. There are five more orders of marsupial or marsupial-like animals known only from the fossil record, which comprise 37 families (Nowak 2005a). Only orders that include at least one extant species will be considered here. Currently, there are still areas of marsupial taxonomy where considerable controversy exists.

Although the kangaroo is probably the most familiar marsupial, several orders of marsupials have a rodent-like to ferret-like appearance. In fact, even some marsupials in the same order as kangaroos exhibit a very rodent-like face (for example, *Potorous longipes*, long-footed Potoroo). This, along with the fact that marsupials are generally less familiar, makes it more difficult to identify cognita in many cases. Further, only the family Macropodidae, which includes kangaroos and wallabies, has significant hybrid data (Close and Lowry 1990). For these reasons the kinds identified here should be considered only a rough estimate and more research in this group is highly encouraged.

## Order Didelphimorphia

### Didelphidae (Opossum kind)

**Size:** head and body 16–20cm; tail 19–33cm

Opossums are marsupials that live in the Americas. Generally, they comprise a single family with two subfamilies (Wilson and Reeder 2005), though it has been suggested that they should be divided into four distinct families (Nowak 2005a). The main difference noted between the two subfamilies involves specific details of the ankle bones. Several other details differ as well, but none that obviously affect the overall cognition.

Most opossums have a long, scaly, nearly naked prehensile tail. However, some forms have a shorter tail and/or one that is hairier. Hair is most likely to be abundant at the base of the tail and/or along its dorsal surface (Nowak 1999).

It is interesting to note that the bushy-tailed Opossum (*Glironia venusta*) was at one time placed in one subfamily (Didelphinae). Later, based on some dental and supposed basicranial similarities, it was placed, along with several other genera (*Caluromys*, *Caluromysiops*), in what is now a separate order (Microbiotheriidae, which contains *Dromiciops*). Later, the basicranial similarities were disputed and the dental similarities were considered to be from convergent evolution. Now the bushy-tailed Opossum is in the other subfamily (Caluromyinae) of Didelphidae (Marshall 1978).



**Fig 4.** Common opossum. Source: Wikipedia <http://www.en.wikipedia.org>.

## Order Paucituberculata

### Caenolestidae (Shrew-opossum kind)

**Size:** total body length female 17cm; male 20cm; tail about 40% of total length

Though fossil evidence suggests this order was once more widespread with seven recognized families, extant species are confined to a single family. These marsupials are small and shrew-like in appearance with a long conical head and small eyes. They have a limited range in South America. This order is

diagnosed by some finer details of the molars and wrist bones, which do not significantly affect the overall cognitum. They lack a pouch, a trait shared by some opossums as well as some members of other marsupial orders (Nowak 2005a).

Shrew-opossums are considered here as a separate kind for several reasons. Available pictures of extant species can be distinguished from opossums by head shape and eye size. Since these features are variable within many of the rodent-like marsupials, these criteria could reasonably be challenged. A second reason is that combining them would involve combining two groups that currently occupy the status of order (though previously they had been placed below this). To avoid underestimating Ark kinds, it was decided to list the shrew-opossum as a separate kind.

The Chilean shrew opossum (*Rhyncholestes raphanurus*) differs from others in this family in that it seasonally stores fat in its tail. This trait appears in some species from other marsupial orders and is associated in several small mammals with extended torpor (Patterson and Gallardo 1987). It is interesting to note that the Flood began on the seventeenth day of the second month (Genesis 7:11), which would correspond to about the beginning of November.<sup>2</sup> If we assume that seasons prior to the Flood were similar to those today (Genesis 1:14-15; 8:21-22), then animals prone to hibernate in the Northern Hemisphere could have easily built up the body reserves for this prior to entering the Ark. Further, some animals are able to enter shorter periods of torpor which is not necessarily related to winter hibernation. Such abilities would not only reduce their food requirement, it would likely reduce the stress of the voyage on them significantly.



Fig. 5. Shrew-opossum. Source: Mammalsrus <http://www.mammalsrus.com>.

#### Order Microbiotheria

##### **Microbiotheriidae (Little-monkey opossum kind)**

**Size:** total length 19.5 cm; head and body 8.5+cm; tail 9+cm

This family is represented by a single living species known as monito del monte (little monkey

of the mountain), *Dromiciops australis*, which lives in a limited range in South America. It is a good climber, rodent-like in appearance, and was previously classified in the family Didelphidae with other American opossums. It was reclassified into the otherwise extinct family Microbiotheriidae, which for a while was retained under the same order (Didelphimorphia). Later work suggested this order was more closely related to Australian marsupials. Based on limb bone analysis, one researcher placed them as a suborder next to Dasyuromorphia, which includes some rodent-like Australian marsupials. Another argued that they are separate from all other marsupials. They are unique among extant marsupials in that they have a basicaudal cloaca like monotremes and several cranial/dental traits found in some placental mammals (Nowak 2005a).

El monito del monte also stores fat in the basal portion of its tail in preparation for hibernation. It is known to be able to double its body weight in a week in this way. It has also been observed to enter periods of torpor on a daily basis, even when food is readily available (Nowak 2005a). As previously mentioned, these traits could have been useful on the Ark as this decreased metabolic activity would have reduced the required food intake and likely reduced the stress on the animal during its year on the Ark.



Fig. 6. El Monito del Monte opossum. Source: Learn Animals <http://www.learnanimals.com>.

#### Order Notoryctemorphia

##### **Notoryctemorphia (Marsupial mole kind)**

**Size:** head and body 9+cm; tail (short cylindrical, stumpy, hard, leathery, terminates in horny knob) 1.2cm

The marsupial mole consists of one extant species, *Notoryctes typhiops*. Its appearance is different from other marsupials, but it bears a striking resemblance to golden moles (Afrosoricida; Chrysochloridae) in

<sup>2</sup> Originally, Tishri was the first month of the year. It was at the time of the Exodus, many years after the Flood, that the first month changed to the spring month of Abib (Nisan), (Exodus 12:1).

overall morphology, burrowing habits, fur textures, and external features of the brain. Not only is its appearance unique compared to other marsupials, but studies involving serology, karyotype, and DNA data have failed to show significant similarity with other marsupials (Nowak 2005a).

Since there are a number of marsupials that bear an uncanny resemblance to placental animals, some have suggested that perhaps they belong to the same kind as their placental counterparts. If this were so, these mammals would have been created with the ability to switch between two modes of reproduction. This would be analogous to some reptiles that can vary between egg laying and live birth (Adams et al. 2007; Arrayago, Bea, and Heulin 1996).



**Fig. 7.** Marsupial mole. Source: Alice Springs Desert Park <http://www.alicespringsdesertpark.com.au>.

Similar to placentals, marsupials have an early forming yolk sac placenta through which nourishment is absorbed from the mother's uterus. In some marsupials (Phascolarctidae; Vombatidae; Peremelemorphia) a second chorioallantoic placenta forms and allows more intimate exchange between mother and developing embryo (Nowak 2005a). These factors would seem to suggest that switching mode of reproduction might be possible in mammals.

To evaluate this possibility further, a Blastn test was performed on the mitochondrial DNA (mtDNA) sequence for this species<sup>3</sup> and two species of golden moles (*Chrysochloris asiatica*<sup>4</sup> and *Eremitalpa granti*<sup>5</sup>) whose mtDNA sequences are found in the NCBI nucleotide database. The mtDNA of other marsupials showed the highest percent identity to the marsupial mole sequence; the sequences to the golden moles were not listed among the hits. When the golden mole sequences were queried, the other golden mole sequences were at the top of the list, followed by sequences from the pig (*Sus scrofa*); the marsupial

mole was not on the list of hits for the golden mole sequences. These results do not support the conjecture that marsupial moles and golden moles are members of the same created kind.

### Order Dasyuromorphia

The members of this order had been placed in a single family, Dasyuridae, until around 1960. Since then, several species have been placed in separate families within this order. The many species that remain in Dasyuridae are mostly rodent-like, bearing a strong superficial resemblance to the American marsupials of Didelphimorphia. However, they differ in the number of upper and lower incisors. Members of Dasyuromorphia also lack a cecum and never have a prehensile tail (Nowak 2005a).

### Thylacinidae

#### *Thylacinus cynocephalus* (Tasmanian wolf kind)

**Size:** head and body length 85cm; tail 38cm; shoulder height 35cm.

The Tasmanian wolf, *Thylacinus cynocephalus*, is the most unique appearing member of its order, bearing a striking superficial resemblance to a dog. However, its mtDNA is similar to other marsupials, especially those in Dasyuromorphia, but is not similar to the mtDNA of any canids. Analysis of its skeletal proportions indicates that it is very much like a large dasyurid. It does not have specialized pursuit adaptations like those found in wolves (Nowak 2005a). This single species, which became extinct in the last century, naturally falls into a class by itself using the cognitum.



**Fig. 8.** The Tasmanian wolf. Source: Jumpgate <http://www.jump-gate.com>.

<sup>3</sup> [http://www.ncbi.nlm.nih.gov/nuccore/NC\\_006522.1](http://www.ncbi.nlm.nih.gov/nuccore/NC_006522.1)

<sup>4</sup> [http://www.ncbi.nlm.nih.gov/nuccore/NC\\_004920.1](http://www.ncbi.nlm.nih.gov/nuccore/NC_004920.1) and <http://www.ncbi.nlm.nih.gov/nuccore/AJ428944.1>

<sup>5</sup> [http://www.ncbi.nlm.nih.gov/nuccore/NC\\_010304.1](http://www.ncbi.nlm.nih.gov/nuccore/NC_010304.1) and <http://www.ncbi.nlm.nih.gov/nuccore/AM904729.1>

The blastn test was run on each sequence individually using default parameters.

### **Myrmecobiidae (Banded anteater kind)**

**Size:** body length 17.5 cm; tail length 13 cm.

The banded anteater (*Myrmecobius fasciatus*), also known as the numbat, is unique among marsupials in that it is diurnal and uses its long tongue to eat termites. It was once classed as a subfamily within Dasyuridae. Apart from its color pattern, it seems to fit in the same cognitum as other dasyurids. Its karyotype (2n=14) is similar, but this same pattern is seen in other marsupial orders as well. It is distinctive from dasyurids in its serology, though to a degree more commonly found at the subfamily level. Major reasons for placing it in a separate family are distinctive dental and basicranial features (Archer and Kirsch 1977). They are considered a separate kind here because they do have some distinctive features and we have chosen to prefer splitting to lumping, especially above the family level.

There are several things worth noting here. First, Archer and Kirsch (1977) attribute much of the increase in marsupial families to the fact that the marsupial designation is now above the level of the order. This has provided more “room” and many subfamilies have been promoted to the family level. Second, they note that changes in morphology, serology, and karyology often don’t keep pace with each other. So, while the banded anteater has a karyotype like dasyurids, and the serology only differed as would be expected on the subfamily level, the separate family placement was based on some unique characteristics of the molars and basicranium.



**Fig. 9.** Banded anteater. Source: Red Orbit <http://www.redorbit.com>.

Creationists can also find it challenging to interpret differences in morphology, serology, and karyology. For example, even if we assume that each created kind originally had a uniform karyotype, there is not a uniform karyotype within all created kinds today. Animals can have similar or identical morphology, even belonging to the same species, and have different karyotypes (Lightner 2006a). Perhaps

the most extreme documented example is in the South American marsh rat, *Holochilus brasiliensis*, where 26 distinct karyotypes were observed in the 42 animals tested (Nachman and Myers 1989). So clearly animals with differing karyotypes can belong to the same created kind. On the other hand, what are we to make of similar karyotypes? Within different marsupial orders are individuals with a very similar karyotype (2n=14). Many of these animals have a rodent-like morphology, making it a challenge to see clear divisions when looking at the live animal without supporting laboratory data. Might this be a hint that the level of the kind may be higher and include several orders of marsupials? At the same time, there is no biblical reason why God could not have created several marsupial kinds with essentially identical karyotypes. This highlights the need for considerable creationist research to address these types of questions.

### **Dasyuridae (Marsupial mouse kind)**

**Size:** body length 12 cm; tail length ~12 cm.

Dasyuridae is divided into two subfamilies, each of which is composed of two tribes. There are a total of 69 species placed in 20 genera within this family (Wilson and Reeder 2005). Many look similar to mice, though the quolls (*Dasyurus* species) tend to be larger with some having a body shape similar to that of the banded anteater. From an appearance standpoint, the most unique member of this family is the Tasmanian devil, *Sarcophilus harrisii*. The head and body of this creature look like that of a small bear (Nowak 2005a). It would be tempting to split the Tasmanian devil out on the basis of the cognitum, but taxonomically it fits well in the tribe Dasyurini, along with the quolls and several other genera (Wilson and Reeder 2005). For



**Fig. 10.** Spotted tail quoll. Source: Australian Geographic <http://www.australiangeographic.com.au>.



**Fig 11.** Marsupial mouse. Source: Australian Animal Learning Zone <http://www.australiananimallearningzone.com>.

this reason, the kind is considered to be at the level of the family.

Here again there are important questions that can be raised. Taxonomists have reason to believe the Tasmanian devil is closely related to the quolls, despite its bulkier body build. Are the unusual features of the Tasmanian devil from variation within a kind? It has been assumed so here since other members of the same tribe (*Dasyurini*) look similar to members of the other tribe (*Phascogalini*) within this family. When two taxonomic categories are bridged, all members of both categories are assumed to be in the same kind. On the other hand, what differences distinguish one created kind from another? Since Scripture never tells us specifically, we are left to conjecture in most cases.

Some progress has been made on these questions by examining variation in kinds identified by hybrid data. We know that domestic dogs vary tremendously in size, color, and muzzle shape. Wild animals vary in size and color as well. What types of cranial and dental variation are found in created kinds? Are there certain features that are distinct and tend to not change? Do some changes within created kinds result in certain members that look a bit like other kinds? Considerably more research is necessary to better answer these questions. In marsupials, the family *Macropodidae* has documented intergeneric hybrids. This should provide an excellent place to start assessing morphologic, serologic, and genetic variation within marsupials linked by hybrid data.

### **Order Peramelemorphia (Bandicoot kind)**

**Size:** head and body 20 cm; tail 7–10 cm.

In bandicoots the second and third digits are syndactylous, bound together by skin so only the tops of the joints and nails are separate. It works somewhat like a single digit and the animals will use

it for grooming. This is also a feature of *Diprotodontia*, and previously animals in this order were placed at a lower rank in an order beside those of *Diprotodontia*. However, the teeth of bandicoots are polyprotodont, having more than one pair of lower incisors, much like members of *Dasyuromorphia*. For this reason, these animals were placed in their own order. Bandicoots are interesting in that they form a chorioallantoic placenta in addition to the yolk sac placenta. The only other marsupials known to form this type of placenta are koalas and wombats, both from the order *Diprotodontia*. However, these placentas are not as well developed as in placental mammals as marsupials have a comparatively short gestation time (Nowak 2005a).



**Fig. 12.** Long-nosed bandicoot. Source: Australian Wildlife <http://www.australianwildlife.org>.

This mix of characteristics can be interpreted several ways in the Creation model. It could be interpreted as indicating that the level of the kind is above the level of the order for at least some of the marsupials. Since many marsupials are rodent-like and the average student of nature probably would not be able to, by looking at pictures, place them in separate groups that match their current taxonomic position; this possibility is worthy of further investigation. It should be pointed out, however, that this would place the Tasmanian wolf in with some very rodent-like animals. In contrast, it could be taken as evidence that these animals were created separately with a mix of features so they would clearly be distinct from other groups. Since bandicoots do have some distinctive features, including a long pointed muzzle and hind limbs longer than forelimbs, they will be considered here to be a separate kind.

There has been considerable disagreement over how the 18 species in this order should be grouped into families (Wilson and Reeder 2005). Aplin, Helgen, and Lunde (2010) give a relatively detailed account of this history. In 1990, based on morphologic details, it was proposed that two families are appropriate: *Peroryctidae* and *Peramelidae*. Some genetic and serologic studies that followed supported this. Later studies resulted

in placing the members of Peroryctidae as a distinct subfamily within Peramelidae. Also, two genera were removed from Peramelidae to form the families Thylacomyidae (*Macrotis* spp.) and Chaeropodidae (for recently extinct *Chaeropus*). Aplin, Helgen, and Lunde (2010) point out that future studies to resolve these taxonomic issues should include, among other things, a more complete consideration of extant species. Because of the controversy over family status and the cognitum being unhelpful in dividing this order, the level of the kind was placed at the level of the order.

### Order Diprotodontia

The name for this order comes from a dental characteristic of its members, namely two large lower incisors that point forward. Usually there are no other incisors or canine teeth in the lower jaw, but if they appear they are small. This leaves a gap between the incisors and cheek teeth. As mentioned previously, they are syndactylous as are members of Peramelemorphia (Nowak 2005a). It is the largest of the marsupial orders with 143 recognized species in 39 families (Wilson and Reeder 2005).

#### Phascolarctidae (Koala kind)

**Size:** head and body 60 cm.

The koala, *Phascolarctos cinereus*, was once placed in the family Phalangeridae with the Australian possums and cuscuses. It has since been moved into its own family and is now believed to be more closely related to wombats. Although there is only one species, it is distinctive enough to be easily recognized by most people and will be considered a created kind here.



**Fig. 13.** Koala. Wikipedia <http://www.en.wikipedia.org>.

#### Vombatidae (Wombat kind)

**Size:** head and body 70 cm; tail 2.5 cm

There are three species of wombats which are placed in two genera. Like the koala, they lack the long obvious tail characteristic of most diprotodonts. They have a stocky bear-like body. Their teeth are similar to those of rodents in that they are rootless and ever growing. They also chew with rapid side-to-side movements like rodents. Since they have these unique features they are considered a separate created kind here.



**Fig. 14.** Southern hairy-nosed wombat. Source: Go Australia <http://www.goaustralia.about.com>.

#### Burramyidae (Pygmy possum kind)

At one time the members of Burramyidae were included in the family Phalangeridae (Nowak 2005a). Based on serology, Burramyidae was placed as a separate family (Kirsch 1977). In that study, the genus *Acrobates* grouped within Burramyidae, but subsequent study has placed it in a separate family, Acrobatidae (Nowak 2005a). Acrobatidae is in a separate superfamily (Petauroidea) from Burramyidae and Phalangeridae (Phalangerodea; Wilson and Reeder 2005).



**Fig. 15.** Mountain pygmy possum. Source: Australian Government, Department of Sustainability, Environment, Water, Population and Communities <http://www.environment.gov.au>.

Despite these shifts, the current family arrangement appears fairly well accepted. There certainly is not the degree of upheaval at the family level seen in bandicoots (order Peramelemorphia). There is, however, still considerable disagreement in how the current families are related to each other (Meredith, Westerman, and Springer 2009; Munemasa et al. 2006). One possible reason for this ambiguity is that the families are not related. However, the frequent use of possum in the common name for species in many of these families betrays the fact that there is a natural cognitum above the family level. Here the kind is tentatively placed at the family level to avoid underestimating the number of kinds on the Ark, but these issues should be looked at in more detail.

The small, mouse-like members of this family are nocturnal. Many inhabit trees, most have been observed to undergo torpor for variable lengths of time, and at least one, *Cercartetus nana*, undergoes full hibernation in the winter after storing considerable body fat, especially in the base of its tail (Nowak 2005a). It is interesting to note that studies on *Cercartetus nana*, the Eastern pygmy possum, have shown that torpor can be observed independent of season, time of day, and ambient temperature. Its body temperature drops to several degrees above ambient temperature. The duration of this period of torpor tended to increase with a drop in ambient temperature. In one experiment, a record 367 day hibernation period was recorded. The animal used 1/40th the energy normally used while awake (Harris 2008). This is not meant to imply that all marsupials slept through the entire voyage on the Ark, but some period of torpor seems reasonably likely for a number of these animals.



**Fig. 16.** Eastern pygmy possum. Source: Burke Museum <http://www.collections.burkemuseum.org>.

#### **Phalangeridae (Possum kind)**

**Size:** head and body 42cm; tail ~38–40cm

At one time this family included members of what are now considered separate families. The koala (Phascolarctidae) has been moved to a different suborder (Vombatiformes) beside the wombat. As mentioned, Burramyidae is now a separate family in the same superfamily (Phalangerodea). Members of Pseudocheiridae, Petauridae, Tarsipedidae,

and Acrobatidae are in a separate superfamily (Petauroidea) in the same suborder (Phalangeriformes; Nowak 2005a; Wilson and Reeder 2005).

Currently six genera remain in Phalangeridae. Taxonomists have recognized diagnostic features for this family, including several dental and several cranial features (Nowak 2005a). Most are not features that would be readily noticed by the average student of nature. Documented hybridization has occurred between *Trichosurus arnhemensis* and *T. vulpecula*, two of the more common species in the family (Close and Lowry 1990; Wilson and Reeder 2005). Since this is not an intergeneric hybrid, it is not listed in the hybrid tables.



**Fig. 17.** Brushtail possum. Source: Department of Environment and Heritage Protection <http://www.ehp.qld.gov.au>.

#### **Pseudocheiridae (Ring-tailed/Greater gliding possum kind)**

**Size:** head and body 32cm; tail ~33–36cm

When the members of this family were first removed from Phalangeridae, they were placed at the subfamily level in Petauridae. Based on later studies they were elevated to the family status (Nowak 2005a). There are 17 species which are placed in six genera (Wilson and Reeder 2005). All species are arboreal, and one genus contains a single species (*Petauroides volans*) which has the ability to glide. The patagium, or fold of skin used for gliding, extends from the elbow to the leg. In contrast to flying squirrels and the lesser gliding possum, the greater gliding possum glides with its elbows pointed outward and forearms pointed inward (Nowak 2005a).



**Fig. 18.** Greater gliding possum. Source: F.A.U.N.A. <http://www.fauna.com.au>.

**Petauridae (Gliding and striped possum kind)****Size:** head and body 22 cm; tail ~25–31 cm

Currently this family consists of 11 species placed in three genera. As with the previous family, all species are arboreal. One genus (*Petaurus*) has six species of lesser gliding possums (Nowak 2005a; Wilson and Reeder 2005). The patagium extends from the outside of the forearm to the ankle. As in the flying squirrel (*Glaucomys*), gliding is done with all limbs extended (Nowak 2005a). A hybrid has been documented between *Petaurus breviceps* and *P. norfolcensis* (Close and Lowry 1990). Since this is not an intergeneric hybrid, it is not listed in the hybrid tables.



**Fig. 19.** Sugarglider. Source: Burke Museum <http://collections.burkemuseum.org>.

**Tarsipedidae (Honey possum kind)****Size:** head and body 7 cm; tail ~7.5–8.5 cm

The honey possum, *Tarsipes rostratus*, is the only known member of this family. It is unique among the small, mouse-like Australian marsupials in its coloration and long snout. It uses its long tongue to feed on nectar and pollen from flowers. At one time it too was placed in the family Phalangeridae, but difference in morphology and serology were grounds for removing it. Other such studies identified some similarities between it and members of Acrobatidae (Nowak 2005a).



**Fig. 20.** Honey possum. Source: It's Nature <http://www.itsnature.org>.

**Acrobatidae (Feather-tailed possum kind)****Size:** head and body 9 cm; tail ~10–11 cm

This family consists of two species placed in separate genera, *Distoechurus* and *Acrobates*. At one time these species were placed in Phalangeridae, but based on serologic evidence they were removed with the family Burramyidae. Later they were considered to have affinity with Petauridae, but more recent serologic and morphologic studies suggest they have more similarity to Tarsipedidae (Nowak 2005a).



**Fig. 21.** Feathertail glider. Source: F.A.U.N.A. <http://www.fauna.com.au>.

**Hypsiprymodontidae (Musky rat-kangaroo kind)****Size:** head and body 21 cm; tail ~13 cm

The last three marsupial families are in the suborder Macropodiformes. The name means “big feet” which refers to the elongated hind foot. There is a strong cognitum at this level because of this trait. In addition to being evident in pictures of these animals, it is reflected in the name kangaroo which appears as rat-kangaroo for these first two families, reflecting the smaller size of their members. It would seem far more natural to place the level of the kind here, but I have resisted doing so for several reasons. First, it is at the suborder level, which is already fairly high. This first family is the most unique and also bears some resemblance to other rodent-like marsupials when noticing features such as head shape and overall body proportions. Further, these animals are less familiar to me which would increase the likelihood of me lumping them together inappropriately. For this project, we agreed to prefer splitting to lumping, especially above the family level, to avoid underestimating the Ark kinds.

The musky rat-kangaroo (*Hypsiprymnodon moschatus*), the only extant member of this family, is the smallest of the rat-kangaroos and differs from others in this suborder in that it retains the first digit of the hind foot, which is well developed, and its tail is naked and scaly. Its limbs are more equally proportioned than those of other rat-kangaroos (Nowak 2005a). It was separated taxonomically from the other rat-kangaroos, initially at the subfamily level, based on having a simple stomach and blade-like premolars

(Hume 1999). The stomach has been described as more similar to that of a brushtail possum (*Trichosurus* spp; Phalangeridae) than of other rat-kangaroos (Potoroidae). The stomach does have deep grooves on either side of the esophageal opening, which seems to partially divide it. Given the foregoing discussion, it is considered a distinct kind here.

Based on overall external morphology, there is not a strong division between the musky rat-kangaroo and the rat-kangaroos of the family Potoroidae, a fact also betrayed in the common names. This highlights a need for further creation research. In addition to research delineating the variability of dental and skull characteristics within created kinds, within-kind variability of the digestive tract needs to be evaluated. This issue is important in other mammalian orders too. Can a monogastric (simple stomached) creature develop a complex stomach if foregut fermentation becomes a viable adaptive strategy? If so, to what degree? Does adaptation occur in the reverse direction (complex stomach toward simple)? Within marsupials both the Potoroidae and Macropodidae are foregut fermenters with a complex stomach. What about various forms of hindgut fermentation, is there within-kind variation here as well? If so, to what extent? Among marsupials hindgut fermentation is found in the wombat (Vombatidae) and arboreal folivores (tree-dwelling leaf eaters) in the families Phalangeridae, Pseudocheiridae, and Phascolarctidae (Hume 1999).



**Fig. 22.** Musky rat-kangaroo. Source: Wikipedia <http://www.en.wikipedia.org>.

### **Potoroidae (Rat kangaroo kind)**

**Size:** head and body 28 cm; tail ~25 cm

This family includes 10 species placed in four genera (Wilson and Reeder 2005). Like members of Macropodidae, the tails are furred, first digit of the hind foot is absent, and they have a complex stomach. Skulls vary from short and broad to long and narrow. They are unique among the families of this suborder in that the parietal and alisphenoid bones of the skull are separated by the wide contact of the squamosal bone with the frontal bone (Nowak 2005a).



**Fig. 23.** Potoroo. Source: Carnivora Forum <http://www.carnivoraforum.com>.

### **Macropodidae (Kangaroo kind)**

**Size:** head and body 100 cm; tail varies, but shorter than head and body; females slightly smaller

This family includes 65 species placed in 11 genera (Wilson and Reeder 2005). This family is also characterized by a complex stomach. Hybrid data clearly connect three genera (*Macropus*, *Thylogale*, *Wallabia*; Gray 1972; VanGelder 1977). The genus *Setonix*, which consists of a single species, is reputed to have crossed with a species of *Macropus* at the Perth Zoo, though it has not been published and verified (Close and Lowry 1990). Hybrids within the genus *Petrogale*, which is considered closely related to *Thylogale*, are interesting because despite differing karyotypes, some hybrid females were at least partially fertile (Close and Bell 1997).

The kind is again placed at the level of the family since these species group well together. Over half the genera of this family do not currently have hybrid data recorded. Some of this may be due to the fact that they are not housed together affording them the opportunity to interbreed. On the other hand, perhaps they are unable to do so. Either way, the hybrid data that we do have provides us with valuable information. According to current baraminological understanding, this is definitive evidence they are from a common created kind. Variability among these species in morphology, serology, karyology, etc. can be examined in detail to give us a better understanding of which characteristics vary within kinds, and how they vary. With regard to morphology, Hume (1999, p.352) describes variation in body size, diet, dentition, and foregut morphology between various macropods, including some identified above as having hybrid data. Further detailed investigation may prove useful in identifying the level of the kind in other marsupial orders where the family level does not match a strong cognitum.



**Fig. 24.** Kangaroos. Source: G Magazine <http://www.gmagazine.com.au>.

## EUTHERIANS

### Order Afrosoricida

This order includes two families in separate suborders, the tenrecs (Tenrecidae) and the golden moles (Chrysochloridae; Wilson and Reeder 2005). At one time these small mammals were placed in the order Insectivora, alongside the families which contain true shrews, moles, and hedgehogs. Molecular evidence showed that these two families were similar to each other and more similar to animals of other African orders, including aardvarks (Tubulidentata) and elephants (Proboscidea), than to other members of Insectivora (Stanhope et al. 1998). Thus they were placed together in a separate order.

#### *Tenrecidae* (Tenrec kind)

**Size:** head and body 14cm; tail ~10cm

The members of this family vary in body sizes and shapes and many bear a striking superficial resemblance to members of other taxa. Many are shrew-like (*Microgale* spp. and *Geogale aurita*), some are mole-like and adapted for burrowing (*Oryzoryctes* spp.), and several are like hedgehogs (*Setifer setosus* and *Echinops telfairi*) except that their quills are barbed. While most species are limited to Madagascar, the otter shrews (*Potamogale velox* and *Micropotamogale* spp.) are semi-aquatic and found in other regions of Africa (Nowak 1999; Symonds 2005). Some species of tenrecs store fat in their tail and are known to undergo torpor (Marshall and Eisenberg 1996; Nowak 1999).

Although molecular evidence suggests Tenrecidae are not related to true shrews (Soricidae), moles (Talpidae), or hedgehogs (Erinaceidae), their

grouping as a family seems fairly consistent. They are currently divided into three subfamilies, two of which are quite diverse morphologically. One genus, *Microgale*, displays considerable karyotypic diversity (Gilbert et al. 2007).

Based on available photos and descriptions, no clearly discernible cognata below the family level were identified that were consistent with current taxonomic placement. For example, the otter shrews (Potamogalinae) have similarities with the web-footed tenrec (Oryzricinae) in body proportions and habitat. Further, members of the genus *Microgale* (Oryzricinae) are very similar in appearance to *Tenrec ecaudatus* (Tenrecinae) except that the latter species lacks a tail (Nowak 1999). This enigmatic group has posed some serious challenges for taxonomists, and it highlights important questions that creationists will need to address as well.

If these creatures are indeed a distinct kind, why do they have so many similarities to other kinds? Did one kind undergo post-Flood diversification so they now resemble one or more other kinds of animals? Which morphological features are most important in inferring created kind status? Which features tend to vary within a created kind? Further, it could also be asked if the molecular data is really as informative as it is assumed to be. Are the molecular differences that resulted in removal of Tenrecidae from Insectivora really indicative that they are from a separate kind? To answer this latter question we need more information on molecular variability within created kinds.

Wood (2008a) analyzed a dataset compiled to evaluate Tenrecidae phylogeny. It included cranial, dental and postcranial characters from all ten extant tenrecid genera and 25 outgroup taxa. The tenrecids formed a group united by significant, positive baraminic distance correlation (BDC). Some tenrecids were positively correlated with some outgroup taxa. Another group united by significant, positive BDC included such diverse taxa as marsupials and carnivores. Interestingly, the baraminic distance



**Fig. 25.** Tenrec. Source: Animal Hearing <http://www.animalhearing.wikispaces.com>.

between two marsupial genera *Macropus* (kangaroos and wallabies) and *Didelphis* (opposums) was greater (0.333) than the distance between *Didelphis* and the African palm civet *Nandinia*, a carnivore (0.222). Given that all three genera are likely unrelated, this is not necessarily a surprise for a creationist. However, because of the odd patterns in the results, Wood conservatively suggested that the tenrecids may be a monobaramin, but cautioned that such a conclusion might be dubious.

Recently a paper was published examining placentation in one member of each of the subfamilies of Tenrecidae as well as members of other taxa that had once been part of Insectivora (Carter and Enders 2010). Though it would be advantageous to have information on more members of this family, it does highlight the fact that this is another important anatomical area that needs evaluation. How much variation can there be in placentation within a created kind? Are there aspects of placentation that may be helpful in distinguishing between created kinds?

#### ***Chrysochloridae* (Golden mole kind)**

**Size:** head and body 15 cm; no visible tail

Golden moles are much less variable phenotypically than members of Tenrecidae, but they still raise similar questions given their resemblance to other mammalian taxa. Like Tenrecidae, they have a cloaca, which is relatively rare for eutherians. They superficially resemble moles (*Talpidae*), but lack a tail and have tough skin with thick fur that appears to have a metallic luster, from which the family name is derived. They appear to have several unique features for a mammal: three, rather than two, long bones in the forearm and a hyoid-dentary jaw articulation (Symonds 2005; Nowak 1999). Karyotypic diversity appears to be relatively low (Gilbert et al. 2006). Their resemblance to the marsupial mole has already been discussed.



**Fig. 26.** Cape golden mole. Source: Biodiversity Explorer <http://www.biodiversityexplorer.org>.



**Fig. 27.** Elephant shrew. Source: Tree of Life Project <http://www.tolweb.org>.

#### **Order Macroscelidea**

##### ***Macroscelididae* (Elephant shrew kind)**

**Size:** head and body 20 cm; tail ~18 cm

Elephant shrews were also at one time in the order Insectivora, but were removed after more detailed study. These small mouse- to rat-sized creatures have a long flexible proboscis from which they derive their common names. The hind legs are longer than the forelegs, allowing them to hop when moving rapidly (Nowak 1999). There is a strong cognitum at the family level.

One species in this family, the golden-rumped elephant shrew (*Rhynchocyan chrysopygus*), has some relatively unique features that bring up some important issues. The largest of the elephant shrews, its back is rounded (convex) with the rump higher than the shoulders. This gives it an overall body form that has been compared to a miniature duiker or dik-dik, ruminants in the same family as cattle (*Bovidae*). Further, unlike most elephant shrews, *Rhynchocyan* have upper incisors that are rudimentary or absent. Ruminants, which include *Bovidae* and several other families, are characterized by the absence of upper incisors. Finally, *Rhynchocyan chrysopygus* has been described as having very ungulate-like anti-predatory behavior (Rathbun 1979).

There are numerous other anatomic details that clearly distinguish elephant shrews from ruminants, but the superficial similarities of some members of these two groups hint that creationists will have to deal with the pesky problem of convergence. In other words, creatures descended from completely different created kinds appear to have developed similarities as they have adapted to fill the earth. This is likely to make discerning created kinds more of a challenge, and may have contributed to some of the taxonomic challenges that have been described so far.

## Order Tubulidentata

### *Orycteropodidae* (Aardvark kind)

**Size:** head and body 130 cm; tail ~60 cm

There is only one extant species of this order, *Orycteropus afer*. The name aardvark means “earth pig” in Afrikaans. This is an apt description for this medium-sized mammal that has a stocky body with a short neck and arched back. It is a powerful digger and lives in burrows. It has a long snout, large ears, and a long muscular tail (Nowak 1999; Shoshani, Goldman and Thewissen 1988).

This order and the previous two orders (Afrosoricida and Macroscelidea) are now placed in the supraorder Afrotheria along with the following two orders (Hyracoidea and Proboscidea) and sea cows (Sirenia; Wilson and Reeder 2005). The molecular similarities observed in these animals are intriguing given that all but the aquatic sea cows are found primarily in Africa. There is the possibility that some convergent evolution has taken place as these creatures have adapted to living in a similar region of the world. More information on within kind variability on a molecular level is needed to explore this possibility.



**Fig. 28.** Aardvark. Source: Animals—National Geographic <http://animals.nationalgeographic.com>.

## Order Hyracoidea

### *Procaviidae* (Hyrax kind)

**Size:** head and body 45 cm; tail ~20 cm

Extant species are similar in size and external appearance to rodents and lagomorphs, though some extinct forms were much larger. The soles of the feet have unique naked pads with a central portion that retracts to form a suction cup. This region is kept moist by glandular secretions and allows for excellent traction. The three extant genera form a strong cognitum. While currently evolutionists believe these creatures are most closely related to elephants and sea cows, some have argued that they are closer to odd-toed ungulates (*Perissodactyla*) based on morphology and

fossil evidence (Nowak 1999). Given the morphologic discontinuity between these creatures and their proposed evolutionary relatives, the level of the kind seems to naturally fall here. Extinct members of this order show more variability and a second family is recognized (Nowak 1999; McKenna and Bell 1997). These latter factors should be considered in future research on this group.



**Fig. 29.** Hyrax. Source: A–Z Animals <http://www.a-z-animals.com>.

## Order Proboscidea

### *Elephantidae* (Elephant kind)

Three extant species in two genera are recognized (Wilson and Reeder 2005). Both Asian and African elephants have five toes on each foot, but they vary in the number of digits that have hooves (nails). Both generally have five on the front feet, but Asiatic elephants vary from four to five on the hind feet. African elephants have only three nails on the hind feet (Nowak 1999).

Elephants have some unusual features compared to other large domestic animals. They have a lower normal body temperature (35.9°C; Benedict and Lee 1936) and the testes remain in the abdomen of the males. The females have a pair of mammary glands just behind the front legs (Nowak 1999), rather than near the rear legs.

There is hybrid data connecting the African elephant genus with the Asian elephant. Creationists have recognized the extinct mammoths and mastodons as members of this kind as well (Oard 2004; Sarfati 2000).

## Order Cingulata

### *Dasypodidae* (Armadillo kind)

Armadillos are unique mammals with skin that is modified to contain a double-layered covering of horn and bone over the more exposed areas of the animal, serving like armor (Nowak 1999). Wilson and Reeder (2005) recognize 21 extant species in



**Fig. 30.** Elephant. The elephant kind includes African and Asian elephants. Source: Animals—National Geographic <http://animals.nationalgeographic.com>.

nine genera. They had been placed in two subfamilies with one containing only the genus *Chlamyphorus*, and the remaining genera in the other. More recently it was divided into three subfamilies, with the genus *Dasyopus* in one, and several genera in each of the other two.

Wood (2008a) analyzed a dataset containing craniodental characters from various members of this order with two members of the order Pilosa as an outgroup. Most of the species were from extant or extinct genera within one of the three subfamilies, namely Euphractinae (McKenna and Bell 1997). There was significant, positive BDC and high bootstrapping values within Euphractinae. One species of a second subfamily, *Dasyopus* of Dasyopodinae, showed significant positive BDC with this group, though the



**Fig. 31.** Armadillo. Source: NBC News <http://www.msnbc.msn.com>.

bootstrap values were lower. A second member of Dasyopodinae, *Stegotherium*, showed negative BDC with most of the group (all except *Dasyopus*). The one species from the third subfamily, *Priodontes* of Tolypeutinae, didn't show significant positive or negative BDC with other taxa.

Unsurprisingly, the outgroup taxa from the order Pilosa showed significant negative BDC with most of the other taxa. What is surprising is that one fossil taxa that is normally placed in a separate superfamily within Cingulata (McKenna and Bell 1997), *Vassallia*, had significant positive BDC with most of the Euphractinae, and significant negative BDC with the outgroup. This is a bit unexpected given that it appears closer to members of Euphractinae than some of the other taxa which are classified in the same family as Euphractinae! For a more detailed evaluation of this dataset, the reader is referred to Wood (2008a).

From a cognitum perspective, the genus *Chlamyphorus* appears most unique. It is rather unsurprising that at one time it was placed in its own subfamily. However, this is not where it is generally placed today and the statistical baraminology analysis shows it fits well in its current placement in Euphractinae. Thus it seems the kind naturally falls at the family level, with some suggestion that extinct

taxa from other families in this order may be included as well.

There is some rather interesting variation among extant members of Cingulata. The snout varies considerably in length and though most species have 7–9 teeth in each half jaw, the giant armadillo *Priodontes* may have more than 40. The forefeet have three, four, or five digits with powerful claws that make armadillos excellent diggers. The hind feet consistently have five digits with claws (Nowak 1999). The nine banded armadillo, *Dasybus novemcinctus*, is described as having a simplex uterus like humans and primates (McBee and Baker 1982). The six banded armadillo, *Euphractus sexcinctus*, is said to have a bicornate uterus (Redford and Wetzel 1985), the type found in cattle.

### Order Pilosa

This order and the previous one (Cingulata) belong to the superorder Xenarthra. Previously, Xenarthra was considered an order and sloths, anteaters, and armadillos were placed in three separate superfamilies. Xenarthra are distinguished from all other mammals by their xenarthrous vertebrae which have secondary articulations between them in the lumbar region. The ischium (bone of the pelvis) also articulates with the sacrum. All living members are found in the Americas and lack incisors and canines (Nowak 1999).

Xenarthra are also united in having long, sharp, strong claws on their digits. The females have a common urinary and genital duct. The males retain the testes in the abdomen between the bladder and the rectum. These shared features are not exclusive to this group.

Despite their distinctive morphology, studies place the anteaters and sloths closer to each other than to the armadillo (Nowak 1999). Thus they are now placed together in the order Pilosa (Wilson and Reeder 2005).

#### Suborder Folivora (Sloth kind)

Sloths are very distinctive creatures. There are two extant genera, both of which are arboreal (Nowak 1999; Wilson and Reeder 2005). They move very slowly and spend most of their lives hanging upside-down from a tree limb. The digits are syndactylus, being bound together by skin. There are three long, sharp claws that extend from each hindfoot. Depending on the genus, there are two (*Choloepus*) or three (*Bradypus*) claws on the forefeet. The forelimbs are longer than the hindlimbs, a trait more pronounced in *Bradypus* (Nowak 1999).

The hair on sloths is directed dorsally, which helps direct water off their body as they hang inverted on a tree limb (Nowak 1999). Depending on the genus,

the hairs have deep longitudinal grooves (*Choloepus*) or irregular transverse cracks (*Bradypus*) that allow for the invasion of various microorganisms and small invertebrates. Most notable is green algae, which give the animal a greenish coloration that serves as camouflage. It also appears that the algae can be involved in a symbiotic relationship with the sloth (Suutari et al. 2010).

At one time both genera were placed in a single family, Bradypodidae. Currently *Choloepus* is placed in Megalonychidae, which previously contained only fossil species. Bradypodidae is now considered more closely related to the long-extinct family Megatheriidae (Nowak 1999). Despite the recent taxonomic splitting into multiple families, the strong cognitum suggests they are descendants from a single created kind.



Fig. 32. Two-toed sloth. Source: Animals—National Geographic <http://animals.nationalgeographic.com>.

#### Suborder Vermilingua (Anteater kind)

There are three extant genera and four species of anteaters. They have been placed in a single family, Myrmecophagidae (Nowak 1999). However, Wilson and Reeder (2005) place the silky anteater, *Cyclopes didactylus*, in a separate family, Cyclopedidae. Anteaters have elongated, tapered snouts, long, sticky tongues and tubular mouths (Nowak 1999). Despite the recent splitting into two families, there is a strong enough cognitum to suggest they are a single created kind.



Fig. 33. Giant anteater. Source: News Watch—National Geographic <http://newswatch.nationalgeographic.com>.

### Order Scandentia (Tree Shrew kind)

Scandentia was considered a single family (Tupaiaidae) order with five extant genera and 16 species of tree shrews. Superficially, tree shrews look like long-snouted squirrels. All but one species, *Ptilocercus*, lack the long whiskers characteristic of squirrels. Tree shrews have large upper incisors that are separated and canine-like, while their canines are small and resemble premolars. *Ptilocercus*, known as the pen-tailed tree shrew, has a dark naked tail except for the end which contains whitish hairs on opposite sides. Its name comes from the fact that the tail resembles an old-fashioned quill pen (Nowak 1999). More recently the single species of *Ptilocercus* is often placed in a separate family, Ptilocercidae, within this order (Wilson and Reeder 2005).

Taxonomic placement of tree shrews in relation to other mammals has been difficult. At times tree shrews were grouped with the elephant shrew (Macroscelididae) either in the insectivore suborder Menotyphla or together in a separate order. Tree shrews have several primate-like features and have been grouped with lemurs as primates. Recent studies suggest the tree shrews have no immediate relationship with elephant shrews. Evolutionists have proposed this order is more closely related to Primates, Chiroptera, and Dermoptera (Nowak 1999). Given the difficulty in defining how tree shrews relate to other mammals and the fact that they have remained grouped together in all the shifting so they are currently placed in their own order suggests that tree shrews are a distinct created kind.



**Fig. 34.** Tree shrew. Source: Cascadia Community College <http://www.cascadia.edu>.

### Order Dermoptera

#### *Cynocephalidae* (Colugo kind)

Colugos have a more extensive gliding membrane than other mammals using this means of locomotion, such as the gliding possums (Diprotodontia) or flying

squirrels (Rodentia). The membrane is attached to the neck and extends along the limbs to the tips of the fingers, toes, and tail. There are two extant species which have been difficult to place in relation to other mammals. It has been considered a suborder of Insectivora. Others consider it more closely related to Chiroptera (bats). Sometimes it is considered more closely related to primates, which is suggested by the common name flying lemur (Nowak 1999). Given this uncertainty and the fact that this family is now placed in its own order, it seems natural to consider them a distinct kind.



**Fig. 35.** Sunda colugo. Source: National Geographic News <http://news.nationalgeographic.com>.

### Order Primates

Primates are comprised of 15 families which are divided into two suborders: Strepsirrhini (lemurs and lorises; 7 families) and Haplorrhini (monkeys and apes; 8 families). Humans are classified in the latter group (Wilson and Reeder 2005), but will not be included here because we were created separately from all the other animals (Genesis 1).

Primates generally have stereoscopic vision, grasping hands and feet with nails rather than claws, and superior levels of muscular coordination and dexterity. Strepsirrhini are distinguished from Haplorrhini primarily by cranial and dental differences. For example, a typical Strepsirrhini skull has large orbits, reduced braincase, and more highly developed olfactory and auditory regions of the skull than a monkey of comparable size (Nowak 1999).

#### *Cheirogaleidae* (Dwarf/mouse lemur kind)

Cheirogaleidae, the first of four families of lemurs (Infraorder: Lemurformes), is comprised of five genera and 21 species. All lemurs and the aye-aye (Daubentoniidae) naturally occur only on the island of Madagascar. Dwarf and mouse lemurs were at one time placed in the family Lemuridae, but have some distinctive unifying features so they are now considered a separate family (Nowak 1999; Wilson and Reeder 2005).



**Fig. 36.** Fat-tailed dwarf lemur. Source: BBC <http://www.bbc.co.uk>.

### **Lemuridae**

True lemurs are comprised of five genera and 19 species (Wilson and Reeder 2005). There is considerable interspecific hybrid data within the genus *Eulemur* (which were previously placed in *Lemur*), both in captivity (zoos) and in the wild (Delmore, Louis, and Johnson 2011; Gray 1972; Pastorini et al. 2009; Wyner et al. 2002).



**Fig. 37.** True lemurs. Source: BBC <http://www.bbc.co.uk>.

### **Lepilemuridae (Sportive Lemur kind)**

This family is comprised of a single genus with eight species. There are other extinct genera attributed to this family as well. Nowak (1999) refers to this family as Megaladapidae, but Wilson and Reeder (2005) claim the name Lepilemuridae takes precedence. This family has been placed by some as a subfamily in Lemuridae, but evidence suggests they are similar to Indriidae (Wilson and Reeder 2005).



**Fig. 38.** Holland's sportive lemur. Source: Planet' Mammifères <http://www.planet-mammifères.org>.

### **Indriidae (Indri/Sifaka/Woolly Lemur kind)**

There are three genera and 11 species in this family (Wilson and Reeder 2005). They are unusual in their locomotion. For example, when on the ground they progress by a series of hops (Nowak 1999). Though there is considerable diversity in these first four families of lemurs, it is questionable if the level of the kind is actually the family. In Old World monkeys (Cercopithecidae) there is an amazing amount of phenotypic diversity even though many genera are united by hybrid data. Here intergeneric hybrid data is lacking, but significant morphological similarity is evident, which is also reflected by the inclusion of these four families in the infraorder Lemuriformes. Therefore, further research to better address the baraminic status of lemurs is strongly encouraged.



**Fig. 39.** Moore's woolly lemur. Source: Planet' Mammifères <http://www.planet-mammifères.org>.

### **Daubentoniidae (Aye-aye kind)**

The aye-aye, though often called a lemur in the broad sense, is so distinctive it is now placed in its own family, and infraorder (Chiromyiformes)! Its incisors are similar to rodents in that they are chisel shaped, continually grow and have enamel on the front. They have long fingers, with the third finger being particularly so (Nowak 1999; Wilson and Reeder 2005).



**Fig. 40.** Aye-aye. Source: Animals—National Geographic <http://animals.nationalgeographic.com>.

**Lorisidae (Loris kind)**

There are five genera and nine species of lorises and pottos (Wilson and Reeder 2005). Their small ears are inconspicuous in their furred round head. All four limbs are nearly equal in size. All digits have nails except the second digit of the hindlimb, which has a claw. The tail is short or absent. Males do not have a baculum (a bone in the penis) (Nowak 1999).



**Fig. 41.** Slender loris. Source: It's Nature <http://www.itsnature.org>.

**Galagidae (Bushbaby kind)**

There are three genera and 19 species of bushbabies (Wilson and Reeder 2005). They had been placed as a subfamily beside the lorises and pottos. Their bodies are more slender and the hindlimbs are much longer than the forelimbs. The tail is generally longer than the head and body put together, and is usually bushy. Males do have a baculum (Nowak 1999).

Wood (2008a) analyzed a craniodental character set that included 13 species from this family plus additional species from the families Lorisidae and Cheirogaleoidea as outgroups. Based on the analysis it appears the level of the kind could be at the family level, but Wood kept his conclusions tentative because the characters were not holistic.



**Fig. 42.** Senegal bushbaby. Source: Kids Britannica <http://www.kids.britannica.com>.

**Tarsiidae (Tarsier kind)**

There is a single genus with seven species of tarsiers. Its name comes from the elongated tarsal (ankle) region. The digits are long and have rounded pads at the tips that enable the animal to grasp almost any surface. The tarsier typically moves by hopping much like a frog. This family is the first of those placed in the Haplorrhini suborder, though some have argued they are more similar to the Strepsirrhini above (Nowak 1999; Wilson and Reeder 2005).



**Fig. 43.** Tarsier. Source: Burke Museum <http://www.collections.burkemuseum.org>.

**Cebidae (Marmoset/tamarin/capuchin/squirrel monkey kind)**

This family is comprised of six genera and 56 species. At one time tamarins and marmosets were placed together in a separate family, and the members of Aotidae, Pitheciidae, and Atelidae were included here (Wilson and Reeder 2005). There is interspecific hybrid data within half the current genera, but no intergeneric data (Gray 1972).



**Fig. 44.** White-headed capuchin. Source: Wikipedia <http://www.en.wikipedia.org>.

**Aotidae (Night monkey kind)**

There is a single genus with eight species of night monkeys. These nocturnal animals have short, dense, soft, semi-woolly fur and inhabit forests of the New World. Though this genus had traditionally been placed in Cebidae, in 1989 it was suggested they should have a full family status (Nowak 1999; Wilson and Reeder 2005).



**Fig. 45.** Panamanian night monkey. Source: Wikipedia <http://www.en.wikipedia.org>.

**Pitheciidae (Titi monkey/saki/uakari kind)**

This family is comprised of four genera and 40 species. These diurnal, arboreal animals inhabit South American forests (Wilson and Reeder 2005). They share a common dental morphology which enables them to eat hard, heavily protected fruits (Dewey 2007).



**Fig. 46.** Red-bellied titi. Source: Burke Museum <http://www.collections.burkemuseum.org>.

**Atelidae (Howler/prehensile tailed monkey kind)**

This family is comprised of five genera and 24 species. These animals have a prehensile tail, which can grasp and hold objects such as tree limbs. In some genera the underside of these tails are naked in the terminal portion (Nowak 1999; Wilson and Reeder 2005).



**Fig. 47.** Geoffroy's spider monkey. Source: Wikipedia <http://www.en.wikipedia.org>.

**Cercopithecidae (Old world monkey kind)**

There are 21 genera and 132 species of Old World monkeys (Wilson and Reeder 2005). This family has an amazing amount of phenotypic diversity and abundant intergeneric hybrid data. This includes crosses connecting mangabeys (*Cercocebus*), macaques (*Macaca*), mandrills, (*Mandrillus*), guenons (*Cercopithecus*), and baboons (*Papio*; VanGelder 1977).

Though all the intergeneric hybrids are within only one of the two subfamilies, previous creationist research has suggested that the entire family is from a single created kind (Hartwig-Scherer 1993). This has some powerful implications for the design of creatures that allows for such impressive variability to develop within created kinds (Lightner 2009).



**Fig. 48.** Southern pig-tailed macaque. Source: Wikipedia <http://www.en.wikipedia.org>.

### **Hylobatidae (Gibbon kind)**

There are four genera and 14 species in this family. Some authors had placed them in Pongidae, but various lines of evidence are used to support their position as a separate, but related family. At one time a single genus, *Hylobates*, was recognized. The elevation of subgenera to genera has resulted in the current four that are recognized (Nowak 1999; Wilson and Reeder 2005). There have been interspecific hybrids within this family (Gray 1972).



**Fig. 49.** Lar gibbons. Source: Wikipedia <http://www.en.wikipedia.org>.

### **Pongidae (Great ape kind)**

Wilson and Reeder (2005) place the great apes in Hominidae with humans, but given the significant differences between us and apes compared to some of the differences between other families, this seems ludicrous. Therefore, the older designation Pongidae is used here. There are three genera and six species in this family, which includes the gorilla, chimpanzee, and orangutan. Hybrids have been documented between the two species of orangutans (Gray 1972).

### **Order Rodentia**

Rodents are the largest order of living mammals with 33 families and over 2,200 species. There are a number of features that unite them. While large chisel-like teeth are found in other orders, in rodents these are retained deciduous second incisors rather than permanent first incisors (Wilson and Reeder 2005). These incisors grow throughout the lifetime of the animal. Enamel is present on the front resulting in the outer surface being harder than the inner. This causes them to be self-sharpening (Nowak 1999).

Rodents lack canines and anterior premolars. This leaves a diastema or space between the incisors and cheek teeth. There is considerable variation in the morphology of the cheek teeth, and these differences are often the basis for classification. There are generally five digits on the forefoot, though the first may be small or absent. Hindfeet may have three to five digits. The stomach may vary from simple to complex. In most cases males have a baculum (Nowak 1999).

There has been considerable controversy over suborder classification. It was popular to classify rodents according to the attachments of the masseter muscle and the morphology of the zygomatic arch. Three basic groups were Sciuromorpha (squirrel form), Myomorpha (mouse form), and Hystricomorpha (porcupine form). The problem was that these were generalizations and there are some species that have a different morphology than the others they are closely related to. Later it was suggested that they be classified according to mandibular (jaw) morphology. The two suborders were Sciurognathi and Hystricognathi. Others have proposed from five to 16 suborders. Wilson and Reeder (2005), after a fairly in depth discussion of this topic, identify five suborders: Sciuromorpha, Castorimorpha, Myomorpha, Anomaluromorpha, and Hystricomorpha.

Rodents are more familiar to most people than many of the other small mammals. I have kept albino and hooded rats as pets (*Rattus norvegicus*) and observed them closely. I have also watched eastern fox squirrels (*Sciurus niger*) that live by my house. My observations of the many similarities in how these two species appear, move, sit, and eat, make it so I naturally group them into a single cognitum. There are some obvious differences in skull shape, but I have seen more dramatic examples of skull differences in domestic dogs. Likewise, differences in coloration are common within created kinds. Squirrels have a beautifully haired tail, while the rat has a naked tail. However, differences in tail pelage exist between other creatures presumably in the same created kind, such as opossums (Didelphidae). There is an obvious behavioral difference in tail carriage, but again this can vary within a kind (for example, Arabian horses).

Given the characteristics that unite this order and the controversy in suborder classification, one could argue that the obvious cognitum is at the level of the order. Given my personal observations of squirrels and rats, which usually are placed in different suborders (except on the dual suborder scheme where they are both in Sciurognathi), I find this suggestion appealing. However, for the purposes of this project the order is too high for such a diverse group without considerably more evidence. For this reason the level of the kind will be considered to be at the level of the family.

### **Aplodontiidae (Sewellel kind)**

The single extant species in this family, *Aplodontia rufa*, looks like a medium-sized muskrat with a very short, well-furred tail. It is commonly referred to as a sewellel or mountain beaver, though the latter name isn't accurate. It has some unusual characteristics and has been placed in several different families

historically. It was placed in Sciuridae for about half a century and now is considered a possible sister taxon (Carraway and Verts 1993; Nowak 1999; Wilson and Reeder 2005).



**Fig. 50.** Mountain beaver. Source: Vancouver Island University <http://www.viu.ca>.

### **Sciuridae (Squirrel kind)**

This family contains 51 genera and 278 species. It includes squirrels, chipmunks, marmots and prairie dogs. They are united by several dental and cranial characteristics. Some members of the family undergo hibernation. The taxonomy within the family has been controversial (Nowak 1999; Wilson and Reeder 2005). Recent molecular evidence has resulted in more shifting. For example, flying squirrels are now considered to have come from tree squirrels and are no longer viewed as a separate lineage worthy of the rank of subfamily (Steppan, Storz, and Hoffmann 2004).

While there are documented interspecific hybrids, they are between species in the same genus. In ground squirrels, *Spermophilus*, there is considerable evidence of interspecific hybridization at contact zones (Cothran and Honeycutt 1984, Ermakov et al. 2002, Goodwin 1998, Hafner 1992, Spiridonova et al. 2006, Tsvirka, Chelomina, and Korablev 2006). Gray (1972) uses the genus name *Citellus* for this genus, though that designation is now considered invalid. There is also evidence for interspecific hybridization in *Tamiasciurus* and *Marmota* in contact zones (Brandler, Nikol'sky, and Kolesnikov 2010; Chavez, Saltzberg, and Kenagy 2011).



**Fig. 51.** Black tree squirrel. Source: Animal Galleries <http://www.animalgalleries.org>.

### **Gliridae (Dormouse kind)**

There are nine genera and 28 species of dormice. The family name Myoxidae was commonly used, but is now considered invalid. There has been considerable research and controversy on how this family is related to other rodent families (Wilson and Reeder 2005). They appear much like furry-tailed mice. There are a few members considered to be in this family that other authors place in different families (Nowak 1999).

In other taxa where controversy is noted in how one taxon related to others I suggested perhaps they were not related to those other taxa. In this paper dormice are considered a separate kind, consistent with that conclusion. However, it should be noted they fit well in the strong rodent cognitum and many of the characters being considered involve subtle details of internal anatomy. Further, there is some controversy over which creatures are included in the family. Therefore, it would be worth investigating in more detail.



**Fig. 52.** African dormouse. Source: Wikipedia <http://www.en.wikipedia.org>.

### **Castoridae (Beaver kind)**

There is one genus with two species of extant beavers. They live on different continents and differ in cranial features and chromosome number (Wilson and Reeder 2005). They are among the largest rodents with dense fur, webbed hindfeet, and a broad, scaly, paddle-like tail which suit their semi-aquatic lifestyle. They are well known for their habit of building dams in streams (Nowak 1999).



**Fig. 53.** North American beaver. Source: Kansas Department of Wildlife, Parks and Tourism <http://www.kdwppt.state.ks.us>.

**Heteromyidae (Pocket mouse/kangaroo rat kind)**

This family contains six genera with 60 species. Some authors have considered them a subfamily under Geomyidae, though they are more commonly classified as a distinct family. Like Geomyidae they have external fur-lined cheek pouches. While skull morphology varies within the family, it has a thin papery consistency. External morphology varies as well. Kangaroo rats and mice have long powerful hindlegs for bipedal jumping. Other members tend to move quadrupedally, though they may assume a bipedal stance while foraging (Nowak 1999; Wilson and Reeder 2005).



**Fig. 54.** Giant kangaroo rat. Source: College of Behavioral and Social Sciences—San Francisco State University <http://www.sfsu.edu>.

**Geomyidae (Pocket gopher kind)**

This family is comprised of six genera with 40 species (Wilson and Reeder 2005). Like Heteromyidae they have fur-lined cheek pouches that extend from the facial region back to the shoulders. Their massive skulls are more modified for fossorial (underground) life (Nowak 1999). Hybridization has been documented in contact zones within the genera *Thomomys* and *Geomys* (Gray 1972; Harrison 1993). Further, there is considerable karyotypic diversity within *Geomys* which has been investigated using banding techniques (Smolen and Bickham 1995). There is considerable literature available on *Geomys* in particular that should be profitable to analyze from a creationist perspective for a better understanding of speciation (Burt and Dowler 1999; Harrison 1993).



**Fig. 55.** Pocket gopher. Source: Wild Nature Images <http://www.wildnatureimages.org>.

**Dipodidae (Birch mouse/jumping mouse/ jerboa kind)**

Dipodidae is comprised of 16 genera and 51 species. Though at times they have been divided into two families, there is strong agreement that they are closely related to each other. The masseter muscle travels through the infraorbital foramen, which is morphologically similar to members of Hystricognathi. However, for a variety of reasons they are considered more closely related to members of Myomorpha. Some species gain weight in the fall and then become dormant for six to eight months (Nowak 1999; Wilson and Reeder 2005).



**Fig. 56.** Lesser jerboa. Source: Bahrain Bird Report <http://www.hawar-islands.com>.

**Platacanthomyidae (Malabar spiny dormouse/ pygmy dormouse kind)**

Platacanthomyidae is comprised of two genera and two species. At one time they had been placed in Gliridae, which explains why dormouse is in their common names. They have some molar similarities with dormice, but in other cranial and dental details they have been considered more closely related to members of the following five families (Wilson and Reeder 2005). Nowak (1999) lists them within the family Muridae.



**Fig. 57.** Malabar spiny dormouse. Source: Wikipedia <http://www.en.wikipedia.org>.

### **Spalacidae (Blind mole rat/African mole rats/zokor/bamboo rat kind)**

Spalacidae is comprised of six genera and 36 species. All possess extreme specializations in morphology, physiology, and behavior suitable for their fossorial (digging and subterranean) lifestyle. Many believe these similar adaptations are from convergence. This is apparent when considering that these genera have often been placed in different families. For example, *Myospalax* is often placed in Muridae, but has been considered by others to be part of Cricetidae. Other lines of evidence seem to support the unity of this group (Wilson and Reeder 2005).



**Fig. 58.** Demon African mole rat. Source: The Field Museum <http://www.fieldmuseum.org>.

### **Calomyscidae (Calomyscus kind)**

This family is comprised of a single genus, *Calomyscus*, and eight species. Often called mouse-like hamsters, their name actually means “beautiful mouse.” They have variously been placed in Muridae and Cricetidae, but molecular evidence seems to support their placement as a separate family. There is considerable karyotype diversity within *Calomyscus*, but little evidence that it creates significant reproductive barriers (Wilson and Reeder 2005).



**Fig. 59.** Mouse-like hamster. Source: ZOO Bojnice <http://www.zoobojnice.sk>.

### **Nesomyidae (African and malagasy endemic rat/mouse kind)**

This family consists of 21 genera with 61 species. It has been recognized since 1899, though its contents have varied by author. Questions still remain about the validity of the family. They do fit clearly within Muroidea, which includes the three previous and two following families (Wilson and Reeder 2005). The ambiguity in where to place various genera within the superfamily Muroidea suggests that the level of the kind could easily be at this higher level. However, for the purposes of this paper the default to the family level is deemed best, at least until more information is examined in more detail.



**Fig. 60.** Lesser hamster-rat. Source: The Field Museum <http://www.fieldmuseum.org>.

### **Cricetidae (New world rat/vole/hamster kind)**

Wilson and Reeder (2005) recognize 130 genera and 681 species in this family. For over a century there has been debate over which subfamilies should be in Cricetidae and which subfamilies should be in Muridae. Given this controversy, one might consider placing the level of the kind at the level of the subfamily for these rodents. After all, there are so many species! Wilson and Reeder (2005) recognize six subfamilies. While the hamsters (Cricetinae) seem strongly united, other subfamilies are not as clearly so. Further, the cognitum is clearly above this level as mouse-like members are in various families within Muroidea, and even in other superfamilies. Further, species with the common name dormouse can be found in two suborders: Sciuromorpha and Myomorpha (see Platacanthomyidae above).

There have been a number of documented hybrids within several different genera in this family (Gray 1972). Hybrids between North American deer mice, *Peromyscus maniculatus*, and oldfield mice, *Peromyscus polionotus*, are particularly interesting. When the female is a deer mouse, hybrids are viable and fertile but are significantly growth retarded. The reverse cross results in overgrowth and other abnormalities. Generally the hybrid will die by midgestation. If it survives to term, it will generally result in the death of the mother since it is too large to pass through the birth canal. Studies of these hybrids have provided information about imprinted genes and the role they might play in speciation (Duselis and Vrana 2010; Wiley et al. 2008).



**Fig. 61.** Meadow vole. Source: Wikipedia <http://www.en.wikipedia.org>.

**Muridae (Old world mouse/rat/gerbil/whistling rat kind)**

Muridae is comprised of 150 genera and 730 species. Historically, they have been classified primarily by details of dentition, though other cranial traits are sometimes used. Wilson and Reeder (2005) give a fairly detailed account of the different placement of genera and subfamilies within Muridae. Many of the taxa they currently place there had been considered to belong to other families in Muroidea by previous authors. They also discuss examples where molecular data have changed which genera are grouped together in the same subfamily. Given this discussion, it is likely there will be future shifting within the superfamily Muroidea as more molecular data accumulates.

Gray (1972) reports numerous interspecific hybrids in Muridae, though most are intrageneric. Van Gelder (1977) discusses the few intergeneric hybrids and the difficulty of placing some of the species involved into a genus. Based on this discussion he doesn't identify any clear intergeneric hybrids, suggesting further study to confirm the presence of possible intergeneric hybrids. Some interspecific hybrids within *Mus* are interesting in that they exhibit similar embryo dysgenesis as in *Peromyscus*, but with some differences in the underlying basis for these growth abnormalities (Brown, Piccuillo, and O'Neill 2012; Zechner et al. 2004).



**Fig. 62.** Black rat. Source: Wikipedia <http://www.en.wikipedia.org>.

**Anomaluridae (Scaly-tailed squirrel kind)**

This family consists of three genera and seven species (Wilson and Reeder 2005). Superficially they resemble squirrels. All but one genus have gliding membranes which are similar to those of flying squirrels. They differ from squirrels in several details involving the teeth, skull, and internal anatomy. The systematic position of this family is uncertain (Nowak 1999). Wilson and Reeder (2005) place them in the suborder Anomaluromorpha, which also includes Pedetidae.



**Fig. 63.** Scaly-tailed flying squirrel. Source: Encyclopedia of Life <http://www.eol.org>.

**Pedetidae (Springhare kind)**

Pedetidae is comprised of a single genus with two species. Its taxonomic position has been uncertain because it shares both hystricognathic and sciurognathic characters. Several authors have suggested placing them in a separate superfamily under Sciuromorpha. Others have argued that they are a separate lineage that diverged early, and that hystricognathic characters are from convergent evolution (Wilson and Reeder 2005).



**Fig. 64.** Springhare. Source: Encyclopedia of Life <http://www.eol.org>.

**Ctenodactylidae (Gundi kind)**

This family is comprised of four genera and five species. This family has also been difficult to place taxonomically (Wilson and Reeder 2005). Superficially they look like guinea pigs (*Cavia*) with their thickset, compact body (Nowak 1999). Wilson and Reeder (2005) place it in a separate infraorder in the suborder Hystricomorpha.



**Fig. 65.** Gundi. Source: Wikipedia <http://www.en.wikipedia.org>.

#### ***Bathyergidae (Blesmole/mole rat kind)***

This family is comprised of five genera and 16 species (Wilson and Reeder 2005). As the common name implies, these are fossorial animals. Similar to other such mammals, they have a stocky head and body, short tails and limbs, and tiny eyes and ears. Some species dig mostly with their claws, while others rely more on their incisors (Nowak 1999).



**Fig. 66.** Naked mole rate. Source: Wikipedia <http://www.en.wikipedia.org>.

#### ***Hystricidae (Old World porcupine kind)***

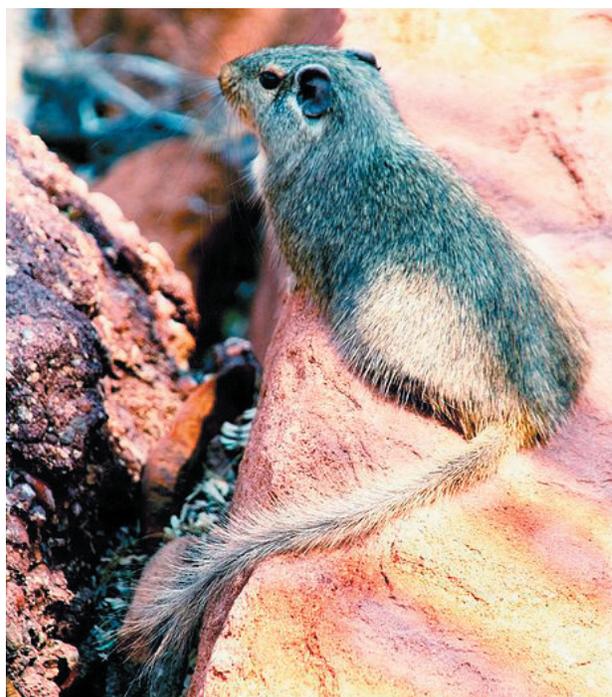
Old World porcupines are comprised of three genera and 11 species (Wilson and Reeder 2005). These large heavy-set rodents have relatively short tails. Their head, body, and sometimes the tail are covered with spines or quills, which are sharp, stiff, thick hairs (Nowak 1999). Gray (1972) list several interspecific hybrids within the genus *Hystrix*.



**Fig. 67.** Brush-tailed porcupine. Source: Wikipedia <http://www.en.wikipedia.org>.

#### ***Petromuridae (Dassie rat kind)***

This family consists of a single species. The Dassie rat looks similar to a squirrel. It has long, black whiskers and hair on the tail. It blends in when it lies flattened on a rock. Its ribs are so flexible it can be pressed almost flat without injury. Its skull is also flattened allowing these animals to squeeze into narrow crevices (Nowak 1999; Wilson and Reeder 2005).



**Fig. 68.** Dassie rat. Source: Wikipedia <http://www.en.wikipedia.org>.

#### ***Thryonomyidae (Cane rat kind)***

There is one genus with two species of cane rats. They are large and heavy-set animals. They have short rounded ears and spiny pelage. Despite their appearance they are fast and agile. They are also good swimmers (Nowak 1999; Wilson and Reeder 2005).



**Fig. 69.** Greater cane rat. Source: Netscype Geographic <http://www.mammals.netscype.com>.

**Erethizontidae (New World porcupine kind)**

New World porcupines are comprised of five genera and 16 species. Like their Old World counterparts, they are relatively large, heavy-set rodents. Some hairs are modified to form short, sharp spines with overlapping barbs. The spines are embedded individually into the skin musculature, rather than laterally in groups of four to six as in Old World porcupines (Nowak 1999; Wilson and Reeder 2005).



**Fig. 70.** North American porcupine. Source: BioLib <http://www.biolib.cz>.

**Chinchillidae (Chinchilla/viscacha kind)**

This family includes three genera and seven species (Wilson and Reeder 2005). Their head, ears, and eyes are relatively large. The hindlimbs are muscular and much longer than the forelimbs. The hindfeet are elongated. The tail is bushy (Nowak 1999). Gray (1972) reports hybrid data between the short-tailed and long-tailed chinchillas.



**Fig. 71.** Standard chinchilla. Source: Wikipedia <http://www.en.wikipedia.org>.

**Dinomyidae (Pacarana kind)**

This family contains one endangered species and a number of large extinct species (Wilson and Reeder 2005). It is similar in size and coloration to pacas (Cuniculidae) though its body is stockier and it has an obvious tail. It looks something like a huge guinea pig (Caviidae). It has a broad head and short, rounded ears (Nowak 1999).



**Fig. 72.** Pacarana. Source: Animais <http://animais.culturamix.com>.

**Caviidae (Cavy kind)**

This family is comprised of six genera and 18 species. It includes the guinea pig with its short ears and short legs as well as the mara with long, rabbit-like legs and large ears. The capybara, which also has long legs, has at times been placed in this family, but other authors have placed them in a separate family. Based on recent molecular evidence, the capybara is included here (Nowak 1999; Wilson and Reeder 2005). Gray (1972) lists interspecific hybrids within the genus *Cavia*.



**Fig. 73.** Mara. Source: Wikipedia <http://www.en.wikipedia.org>.

### **Dasyproctidae (Acouchi/Agouti kind)**

This family is comprised of two genera and 13 species. Some authors have included the following family, Cuniculidae, in with this one. However, molecular data is considered strong support for their designation as a separate family in the same subfamily, Caviioidea (Wilson and Reeder 2005). Nowak (1999) describes agoutis as having a “piglike body and rabbitlike head.” They have long legs and are adapted for running. Gray (1972) lists hybrids within the genus *Dasyprocta*.



**Fig. 74.** Red-rumped agouti. Source: BioLib <http://www.biolib.cz>.

### **Cuniculidae (Paca kind)**

This family consists of a single genus with two species (Wilson and Reeder 2005). It is a bit confusing that pacas have the genus name *Agouti*, while agouti is the common name used for some members of the previous family. Pacas are similar in appearance in general body form and dentition to members of Dasyproctidae (Nowak 1999).



**Fig. 75.** Lowland paca. Source: Wikipedia <http://www.en.wikipedia.org>.

### **Ctenomyidae (Tuco-tuco kind)**

The single genus, *Ctenomys*, includes 60 species. Though they are fairly uniform in morphology, they vary tremendously in chromosome number ( $2n=10-70$ ). This family has been in a state of flux, and though progress has been made, is still in need of revision. Tuco-tucos are considered closely related to *Octodontomys* and it has been debated whether they should be a subfamily within Octodontidae or placed in a separate family as they are here. They are adapted to fossorial life, which is why they are more commonly considered a separate family (Wilson and Reeder 2005).



**Fig. 76.** Social tuco-tuco. Source: Projects in Scientific Computing <http://www.psc.edu>.

### **Octodontidae (Degu/rock rat/viscacha rat kind)**

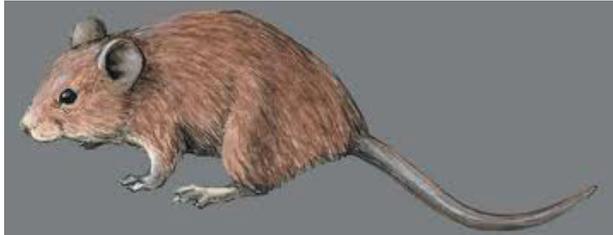
This family is comprised of eight genera with 13 species. They also vary in chromosome number (38–102; Wilson and Reeder 2005). Two species have been identified as tetraploids, including the red viscacha rat (*Tympanoctomys barrerae*) with 102 chromosomes (Gallardo et al. 2004). Tetraploidy is a condition where an organism carries four copies of each chromosome rather than the normal two (diploid). It is more common in plants and had been observed to be lethal when it occurred in mammals. After this surprising discovery, a number of studies have attempted to evaluate the origin and significance of tetraploidy in these species (Bacquet et al. 2008; Gallardo et al. 2004; Suárez-Villota et al. 2012).



**Fig. 77.** Degu. Source: BioLib <http://www.biolib.cz>.

**Abrocomidae (Chinchilla rat kind)**

This family is comprised of two genera and ten species. Their appearance is similar to the chinchilla and some authors have considered them closely related. Other authors have placed them within Echimyidae or Octodontidae. Still others have placed them as a separate family, which seems to be supported by molecular data (Nowak 1999; Wilson and Reeder 2005).



**Fig. 78.** Bolivian chinchilla rat. Source: Animal Diversity Web—University of Michigan <http://animaldiversity.ummz.umich.edu>.

**Echimyidae (Spiny rat kind)**

This family is comprised of 21 genera and 90 species. It is the most diverse family of the infraorder Hystricognathi, which includes the families Bathyergidae through Heptaxodontidae. While some important revisions have been made, more are needed (Wilson and Reeder 2005).



**Fig. 79.** Spiny rat. Source: Ecology Asia <http://www.ecologyasia.com>.

**Myocastoridae (Coypu kind)**

This family is comprised of a single extant species. They have been variously placed in Capromyidae, Echimyidae, or a separate family as they are here. They appear to be closely related to *Capromys* (Capromyidae). Some authors have considered both myocastorids and capromyids as subfamilies within Echimyidae based on the retention of deciduous premolars, however this is controversial (Wilson and Reeder 2005).



**Fig. 80.** Nutria. Source: Northrup Photography <http://www.northrup.org>.

**Capromyidae (West Indian hutia kind)**

This family is comprised of eight genera and 20 species. At least one author had placed the West Indian spiny rats (Heteropsomyinae) in this family, but Wilson and Reeder (2005) retain that group under Echimyidae.



**Fig. 81.** *Capromys pilorides*. Source: Wikipedia <http://www.en.wikipedia.org>.

**Heptaxodontidae (Giant hutia kind)**

This family is comprised of four genera each containing a single species, but all appear to be recently extinct. This family is often placed near Chinchillidae based on similar laminar plates of molariform teeth. However, one genus, *Quemisia*, has similar dental morphology to members of Capromyidae. It appears all dental morphology seen in this family can be derived from that seen in Capromyidae, which is the basis for placing them next to that family (Wilson and Reeder 2005).



**Fig. 82.** Demarest's hutia. It is a larger member of Capromyidae, but no pictures exist for Heptaxodontidae because they are all extinct. Source: Wikipedia <http://www.en.wikipedia.org>.

**Order Lagomorpha**

At one time rabbits, hares, and pikas were considered rodents, but it soon became clear that they have distinctive features. While they also have continuously growing incisors, they are born with three pairs rather than one. By adulthood they have

only two pairs with the smaller peg-like second pair directly behind the first. Additionally, they have enamel on both sides of these teeth rather than on just the front. Lagomorphs also have the testes in front of the penis like marsupials, but unlike most other mammals. They lack a baculum (Nowak 1999).

The relationship between lagomorphs and rodents has been debated for well over a century. Based on morphology it is easy to argue for a close relationship. Molecular data does not support this. Based on structural features and serology it has been suggested that lagomorphs are more closely related to even-toed ungulates (Artiodactyla). Another suggestion is that they are closely allied with elephant shrews (Macroscelidea; Nowak 1999).

Given the taxonomic disputes, it seems reasonable to conclude that lagomorphs were created distinct from rodents. The next question is whether these “hare form” creatures represent more than one kind. The fact that they have remained united during much taxonomic shifting might be evidence that they are a single kind. However, it is not difficult to distinguish extant members according to their families, so the level of the kind will be placed at the level of the family.

### **Ochotonidae (Pika kind)**

Pikas are comprised of only one extant genus which includes 30 species (Wilson and Reeder 2005). They are comparatively small with rounded ears and short legs. They tend to escape predators by dropping into a crevice. They have no obvious tail. This family is usually more generalized, but they do not appear any earlier in the fossil record than Leporidae (Nowak 1999).



**Fig. 83.** American pika. Source: Britannica Online Encyclopedia <http://www.britannica.com>.

### **Leporidae (Rabbit kind)**

There are currently 11 genera and 61 species recognized in this family (Wilson and Reeder 2005). They have long ears, long legs, and a short tail. Hind legs are longer than forelimbs and most are well adapted to saltatorial locomotion. All feet have five digits, though the first one is very small (Nowak 1999).

Taxonomy within this family is controversial. Originally all species were classified as *Lepus* except *Pentalagus* (Wilson and Reeder 2005). Technically, hares are considered to be those currently remaining in *Lepus*, though common names often don't reflect this distinction. Hares are usually larger than rabbits and have a few distinguishing features of the skull. Their young are born covered with fur and with their eyes open; they can run within a few minutes of being born. In contrast, rabbits are born naked, blind and helpless in the security of a fur lined nest (Nowak 1999).

There have been reports of intergeneric hybrids within this family, but laboratory attempts to form such hybrids have ended in failure. Interestingly, when domestic rabbits (*Oryctolagus cuniculus*) were inseminated with cotton-tail rabbit sperm (*Sylvilagus* species) about a third of the ova were fertilized, but development failure was evident by the blastocyst stage. When snowshoe hare sperm (*Lepus americanus*) was used, a fertilization rate of 96% was obtained. Though most deteriorated by the blastocyst stage, one advanced beyond this and implanted (Chang, Marston, and Hunt 1964; Gray 1972). If we consider development to the advanced blastocyst stage evidence of true hybridization (Lightner et al. 2011), then the domestic rabbit and snowshoe hare have well documented hybrid data to support they are from a single kind.

Wood (2008a) analyzed a dataset with craniomandibular characters from six genera in Leporidae, one extant and one extinct species in Ochotonidae, and several other extinct species that were considered either stem lagomorph or non-lagomorph species. The BDC analysis showed four neat groups with: Leporidae, Ochotonidae, and two with the remaining three extinct species. There was significant positive correlation with bootstrap values over 90% between all members within each group. There was significant negative correlation between the group containing two extinct species and Leporidae. Wood concluded Leporidae represented a monobaramin. He was hesitant to conclude it was a holobaramin because the dataset only included craniomandibular characters, and thus wasn't holistic, and because only two representatives from Ochotonidae were included. He also mentions that in the study this dataset comes from, the author had concluded that Leporidae and Ochotonidae were monophyletic.

Based on the cognitum and the other foregoing information, it seems quite clear the level of the kind is at least at the level of the family. Although members of each extant family are readily distinguishable, there are still some hints that the level of the kind could be higher.

**Order Erinaceomorpha; Erinaceidae**  
**Erinaceinae (Hedgehog kind)**  
**Galericinae (Gymnure kind)**

Hedgehogs and gymnures were once placed in the now defunct order Insectivora, but were later moved to occupy their own order. They have an elongate and blunt snout, well developed eyes, a hairy tail, walk on the soles of their feet, and the lower leg bones (tibia and fibula) are fused. Hedgehogs have barbless spines on their back and sides. Although they had been considered closely related to shrews and moles (Soricomorpha), they tend to have distant positions in phylogenetic trees (Nowak 1999, Wilson and Reeder 2005). Based on this information, it seems natural to consider the family a created kind.

However, Wood (2008a) investigated this family using a dataset of craniodental characters from both subfamilies. It included fossil representatives from each subfamily and two outgroups. Unfortunately, the outgroups do not represent individual specimens, but only characters that are considered plesiomorphic for those taxa (Frost, Wozencraft, and Hoffman 1991). In other words, traits were selected which appear in those groups (Tenrecoidea and Soricidea) that are considered to be ancestral when all of these taxa are assumed to share common ancestry.

When Wood (2008a) used statistical baraminology techniques on this dataset, the subfamily Erinaceinae, with the exception of one fossil species, clustered neatly showing significant, positive BDC with bootstrap values over 90%. There was also significant, negative correlation with members of Galericinae (aka Hylomyinae) and the outgroups. Given these results and the fact that barbless spines clearly distinguish the two groups, the level of the created kind is more conservatively placed at the level of the subfamily.

**Order Soricomorpha**

There is some evidence that the “shrew-form” mammals, consisting of shrews (Soricidae), moles (Talpidae), solenodons (Solenodontidae) and the presumed recently extinct nesophontid insectivores (Nesophontidae) may form a united group. However, different studies have given conflicting phylogenies (Wilson and Reeder 2005), suggesting it would be wise to conservatively place the kind lower, at the level of the family.

**Solenodontidae (Solenodon kind)**

Solenodons resemble large, stout shrews. There is a single genus with only two known extant species limited to Cuba and Hispaniola. They have a long, bare-tipped cartilaginous snout supported at the base by a small round bone. There are five claw-bearing digits on each foot. The claws on the front feet are longer and more curved than those on the hind feet (Nowak 1999).



**Fig. 84.** Cuban solenodon. Source: Red Orbit <http://www.redorbit.com>.

**Soricidae (Shrew kind)**

Shrews are small, short-legged and mouse-like animals which are fairly difficult to distinguish at the species level. They are, however, fairly easy to distinguish from mice in that they have a long, narrow snout with a continuous row of teeth and five digits on each foot. This is in contrast to the mouse which has a shorter snout and an obvious gap between incisors and molars. Mice also have only four digits on their front feet (Reid 2006). There is some evidence of interspecific hybridization within the genus *Blarina* (Benedict 1999) and within the genus *Sorex* (Gray 1972).



**Fig. 85.** Southern short-tailed shrew. Source: Wikipedia <http://www.wikipedia.org>.

**Talpidae (Mole kind)**

Moles tend to be larger than shrews and are adapted to burrowing and living underground. They have a long tubular snout which extends beyond the margin of the lower lip. Their legs are short and the feet have five digits (Nowak 1999).

The subfamily systematics of moles has been controversial (Wilson and Reeder 2005). Wood (2008a) analyzed a dataset of myological characters from 11 genera of moles and two outgroup genera (*Blarina*, a shrew, and *Ateleurix*, a hedgehog). The BDC revealed four neat groupings. Three contained three to four genera of moles. The fourth group included the eleventh mole genus and the two outgroup genera! Along with providing a more detailed explanation of the results, Wood considers the results inconclusive.



**Fig. 86.** European mole. Source: Wikipedia <http://www.en.wikipedia.org>.

### Order Chiroptera

Bats are the only mammal capable of powered flight. There is a very strong cognitum at the level of the order as bats are readily distinguishable from all other mammals. They have thin, elastic wing membranes that extend from their sides and are stretched over the elongated digits of their forelimbs. Many species use echolocation to navigate in flight. Of all the families investigated so far, at least some members have this ability. Striking variation is apparent in the heads of bats. While some have faces reminiscent of other mammals, such as mice or dogs, many have a more bizarre appearance. Many species have a nose leaf or other facial ornamentation associated with emitting or augmenting echolocation sounds. Ears are often specialized in ways that improve receiving the sound (Nowak 1999).

Currently there 18 recognized families which comprise over 1,000 bat species. Traditionally bats have been divided into two suborders: Megachiroptera, comprised of a single large family (Pteropodidae, the Old World fruit bats), and Microchiroptera, containing the remaining families. Based on morphologic studies, Microchiroptera was divided into two infraorders: Yinochiroptera and Yangochiroptera. More recent molecular data suggests that Yinochiroptera is more closely associated with Megachiroptera. Thus, because of conflict between morphological and molecular data, the higher level classification of Chiroptera is in flux.

Many bats hibernate and/or enter periods of torpor as they rest during the day. The metabolic rate drops considerably. During hibernation the oxygen consumption level drops to about 1/100th of the normal rate for an active bat. While sleeping during the day many bats experience a drop in body temperature which reverses as they awaken (Wilson and Reeder 2005).

The obvious cognitum is taxonomically high, at the level of the order, and taxonomic groupings below are controversial. One creationary study has briefly examined the variation in different traits within this order, which also seemed to hint at the unity of the

order (Moeller 2004). Some evidence of hybridization on the intrageneric level exists, but none was found that linked different families (Larsen, Marchán-Rivadeneira, and Baker 2010). Due to the tremendous diversity in this order and the lack of interfamilial hybrid data, the family is used here for the level of the kind to avoid possibly underestimating the number of kinds.

### *Pteropodidae* (Old World fruit bat kind)

Old world fruit bats are a diverse group with 186 species placed in 42 genera (Wilson and Reeder 2005). It includes the largest bats, with a few species having wingspans of five and a half feet (1.7 m). Only one genus, *Rousettus*, is known to use echolocation. Members of this family have large, well developed eyes and most find food by smell (Nowak 1999).



**Fig. 87.** Spectacled flying fox. Source: Wikipedia <http://www.en.wikipedia.org>.

### *Rhinolophidae* (Horseshoe bat kind)

Horseshoe bats comprise one genus with 77 species (Wilson and Reeder 2005). They have an unusual nose-leaf expansion that is composed of three portions. The lower portion is horseshoe shaped, covers the upper lip, surrounds the nostrils, and has a notch on its lower edge. Above the nostrils is a lancet, an erect, pointed structure attached only at its base. The third portion is the sella. It is located between the horseshoe and lancet and projects forward (Nowak 1999).



**Fig. 88.** Lesser horseshoe bat. Source: Wikipedia <http://www.en.wikipedia.org>.

**Hipposideridae (Old world leaf-nosed bat kind)**

These bats comprise nine genera with a total of 81 species (Wilson and Reeder 2005). Some authors have treated this group as a subfamily of Rhinolophidae, but now they are generally placed separately. While they have an elaborate nose leaf, they lack a sella, the median projection of the nose leaf. They have only two bones in each toe, whereas members of Rhinolophidae have three bones in all but the first toe (which has two). They also differ in that they lack the lower small premolar. While both families have a high degree of fusion in the elements of the shoulder girdle, it is much greater in Hipposideridae. The pelvic girdle is similar in the two families except that Hipposideridae has an extra bridge of bone in the front (Nowak 1999).



**Fig. 89.** Sundevall's leaf-nosed bat. Source: Wikipedia <http://www.en.wikipedia.org>.

**Megadermatidae (False vampire bat kind)**

This family with four genera and five species have large, basally united ears, a divided tragus (covering of the ear canal), and a long, erect nose leaf. The genera differ from each other in size, as well as dental and skull characteristics (Nowak 1999).



**Fig. 90.** Yellow-winged bat. Source: The Field Museum <http://www.fieldmuseum.org>.

**Rhinopomatidae (Mouse-tailed bat kind)**

This monogeneric family is comprised of four species. Bats in this family have tails nearly as long as the head and body combined. The tail is very pronounced due to the short, narrow tail membrane. They are generally found in treeless arid regions. Considerable fat accumulates subcutaneously in the autumn and is used during the winter. While true hibernation has not been documented, extended torpor has been observed during the winter (Nowak 1999).



**Fig. 91.** Greater mouse-tailed bat. Source: mammal watching around the world <http://www.mammalwatching.com>.

**Craseonycteridae (Hog-nosed bat kind)**

This single species was discovered in 1973. It is tiny, about the size of a bumble bee, and tailless. It has a number of other unusual features as well, including a somewhat pig-like snout. It appears to be restricted to a small range in Thailand (Nowak 1999).



**Fig. 92.** Small hog-nosed bat. Source: FactZoo <http://www.factzoo.com>.

**Emballonuridae (Sac-winged bat kind)**

This family is more diverse with 13 genera and 51 species. These bats lack a nose leaf, but many species have glandular wing sacs that open on the upper surface of the wing. The sacs are larger and better developed in males. They secrete a red substance with a strong odor (Nowak 1999).



**Fig. 93.** Thomas's sac-winged bat. Source: Consejo Belize <http://www.consejo.bz>.

### ***Nycteridae (Slit-face bat kind)***

This monogeneric family is comprised of 16 species. The muzzle is divided by a longitudinal furrow. The nostrils are at the rostral end of the groove. The furrow is bordered and concealed by nose leaves. Posteriorly it expands into a deep pit in the forehead. The skull is characterized by a deep concavity between the orbits. In addition to these characteristics that are related to their common names, several other distinctive traits appear in this family as well. There are no fossils that have been assigned to this family (Nowak 1999).



**Fig. 94.** Egyptian slit-faced bat. Source: mammalwatching around the world <http://www.mammalwatching.com>.

### ***Myzopodidae (Old World sucker-footed bat kind)***

This monogeneric family is comprised of a single species (Wilson and Reeder 2005). Both Myzopodidae and Thyropteridae have suction disks. However, the anatomical and histological differences in the organs between the two families suggest that they have different origins. In Myzopodidae the adhesive disks are attached directly on the wrists and ankles. There are glands on the surface the disks which may function to aid in adhesion. The bats probably use these disks to hold to smooth surfaces (Nowak 1999).



**Fig. 95.** Madagascan sucker-footed bat. Source: It's Nature <http://www.itsnature.org>.

### ***Mystacinidae (New Zealand short-tailed bat kind)***

This monogeneric family is comprised of two species. They are unique in that modification of the wings allows for quadrapedal locomotion in addition to

flight. They are known to burrow and roost in hollow trees. In some situations they will undergo daily torpor; extended torpor has been observed during cold periods to conserve energy. Unlike the other New Zealand bat, *Chalinobus* (family Vespertilionidae), they do not hibernate for extended periods of time (Carter and Riskin 2006; Nowak 1999).

The taxonomic placement of these species has long been controversial. They have been placed in seven different families and four different superfamilies over the years (Carter and Riskin 2006). One could propose that this suggests they are a unique kind, as they have been identified here. However, the cognitum is very strong at the level of the order, so perhaps the similarities are from being related to these other bats. If so, it does have implications for how creatures diversify over time. The widely promoted nice, neat branching tree appears to be overly simplistic.



**Fig. 96.** New Zealand lesser short-tailed bat. Source: Scientific American <http://www.scientificamerican.com>.

### ***Phyllostomidae (American leaf-nosed bat kind)***

Leaf-nosed bats are a diverse family comprised of 55 genera and 160 species (Wilson and Reeder 2005). They include vampire bats (Desmodontinae), which had previously been grouped as a separate family (Nowak 1999). Other members are adapted to feed on fruit, nectar, and insects. Wood (2008a) reported an analysis of this family with 57 taxa, some of which

were outgroups from within the same superfamily (Noctilionoidea). Wood points out that based on these results alone, there is no evidence of discontinuity between Phyllostomidae and Mormoopidae, suggesting both are part of a monobaramin. Thus the level of the created kind would be above the family level.



**Fig. 97.** Californian leaf-nosed bat. Source: Bureau of Land Management <http://www.blm.gov>.

**Mormoopidae (Leaf chinned bat kind)**

This family of two genera and ten species was once placed as a subfamily in Phyllostomidae. However, they do not possess the nose leaf. Instead, they have leaf-like flaps of skin on the chin. When navigating by echolocation, they open their mouth widely to form a megaphone (Reid 2006). Their eyes are small and inconspicuous compared to Phyllostomidae (Nowak 1999).

Wood (2008a) analyzed a dataset that contained characters from both genera of Mormoopidae, two genera of Phyllostomidae, two species from Nictilionidae (all three families being in the superfamily Noctilionoidea), two species of Mystacinidae, and one from Emballonuridae. The bats grouped neatly according to their families, with positive BDC within each group. Except for some species within Mormoopidae, the bootstraps were >90%. There was significant negative BDC between members of Mormoopidae and the three species outside the Noctilionoidea superfamily. However, there was no significant negative correlation within Noctilionoidea. To me this seems to indicate a lack of discontinuity within Noctilionoidea and more evidence suggesting that the level of the kind is above the family level. While Wood acknowledged this possibility, he was more comfortable suggesting that Mormoopidae was most likely a holobaramin.



**Fig. 98.** Parnell's mustached bat. Source: NHPTV <http://www.nhptv.org>.

**Noctilionidae (Bulldog bat kind)**

This is another monogeneric family with two species. Its common name comes from its unusual facial features. They are sometimes known as fisherman bats because fish make up part of their diet (Nowak 1999).



**Fig. 99.** Greater bulldog bat. Source: Washington Slagbaai National Park <http://www.washingtonparkbonaire.org>.

**Furipteridae (Smoky bat kind)**

This family is comprised of two genera each containing a single species. The placement of these bats within Chiroptera has been controversial. They are generally placed near Natalidae and Thyropteridae, which they resemble in overall appearance. They have been referred to as thumbless bats, but they actually do have a small thumb included in the wing membrane. They have unusual cranial features giving them an elevated crown and truncated snout. There is no fossil record for this family (Nowak 1999).



**Fig. 100.** Thumbless bat. Source: Battime <http://www.battime.tumblr.com>.

**Thyropteridae (New world sucker-footed bat kind)**

This monogeneric family contains three species. They differ from their Old World counterpart, Myzopodidae, in that the suction disks are on short stalks and at the base of a well-developed thumb claw. They have a somewhat elevated crown and their third and fourth toes are joined as in the smoky bat (Furipteridae). Two of the three species are widely distributed. There are no fossils representing this family (Nowak 1999).



**Fig. 101.** Spix's disk-winged bat. Source: Bats Images <http://www.batsimages.com>.

### **Natalidae (Funnel-eared bat kind)**

Although many recent authors consider this family monogeneric, Wilson and Reeder (2005) list three genera and eight species. These bats are slim-bodied with long slender wings, legs, and tail. The large ears are separate and funnel shaped. The ear surface is covered with glandular papillae as in the genus *Kerivoula* in the family Vespertilionidae (Nowak 1999).



**Fig. 102.** Mexican funnel-eared bat. Source: NHPTV <http://www.nhptv.org>.

### **Molossidae (Free-tailed bat kind)**

This family is comprised of 16 genera and 100 species (Wilson and Reeder 2005). These bats are found in warmer parts of the world. They have a tail that extends far beyond the free edge of the narrow tail membrane. They have short hair with a velvet-like texture. In one genus (*Cheiromeles*) the hair is so short that the bat appears to be naked (Nowak 1999).



**Fig. 103.** Mexican free-tailed bat. Source: U.S. National Park Service <http://www.nps.gov>.

### **Vespertilionidae (Vesper bat kind)**

This diverse family is comprised of 48 genera and 407 species (Wilson and Reeder 2005). They have a worldwide distribution. Nearly all members feed on insects, though at least one species consumes fish. Most species lack a nose leaf. Some species are known to hibernate (Nowak 1999).



**Fig. 104.** Parti-coloured bat. Source: Max Planck Society <http://www.mpg.de>.

## **Order Pholidota**

### **Manidae (Pangolin kind)**

Pangolins, or scaly anteaters, were once classified with anteaters, sloths, and armadillos (suborder: Xenarthra). They have an elongate tapered body covered dorsally with overlapping scales. These scales are formed from fused hairs which continually grow from thick skin, compensating for wear on the outer edge. The posterior portion is movable and sharp. When pangolins are threatened, they can roll up in a ball to protect themselves.

Despite superficial similarities to members of Xenarthra, it is now believed that their similarities are the result of being adapted to a similar lifestyle. They have what may be the simplest mammalian skull with few projecting processes for muscle attachment. The elongate snout lacks teeth and a long tongue is used to capture ants and termites which are swallowed whole. The stomach consists of two chambers: the larger first chamber stores the food; the second muscular stomach grinds it. They also have powerful forelegs with large, robust claws to rip apart termite nests and dig burrows. They walk on their knuckles or wrists by curling their digging claws inward and backward (Heath 1992; Nowak 1999).

## **Order Carnivora**

Most members of the order Carnivora have a well-developed sense of smell, even compared to other mammals. They have large olfactory lobes of the brain and elaborate turbinal bones in the skull, which allow for a large surface area of nasal mucosa. They also have specialized teeth: long, sharp canine teeth and scissor-like cheek teeth known as carnassials. In other traits, this order is one of the most diverse (Nowak 2005b).

Three of the families within this order were previously placed in a separate order: Pinnipedia. True seals (Phocidae), fur seals and sea lions (Otariidae), and walrus (Odobenidae) spend nearly all their lives in the water (Nowak 2003). For this reason, there was no need to have them on the Ark. This leaves 12 families that need to be accounted for. Half of these are classified in the suborder Feliforma and the other half in Caniforma (Wilson and Reeder 2005).

**Felidae (Cat kind)**

There are 14 genera and 40 species of cats. There is a very strong cognitum at the family level, but the relationships within the family have been more controversial (Wilson and Reeder 2005). There is extensive hybrid data within this family, which has been the basis for suggesting that fewer genera should be recognized (Van Gelder 1977). There have been several different creationist studies on cats (Pendragon and Winkler 2011; Robinson and Cavanaugh 1998; Wood 2008a). Because of the extensive hybrid data that crosses the two recognized subfamilies and a strong cognitum, it is natural to place the level of the kind at the family.



**Fig. 105.** Jaguar. Source: Wikipedia <http://www.en.wikipedia.org>.

**Viverridae (Civet kind)**

This family is comprised of 15 genera and 35 species. These small to medium-sized carnivores have been difficult to classify. At one time members of Eupleridae, Nandiniidae, and Herpestidae were also included in this family (Nowak 2005b; Wilson and Reeder 2005). Wood (2008a) analyzed a dataset and found that members of Viverridae showed extensive, positive BDC with members of the families Eupleridae and Nandiniidae. One member of Eupleridae (*Cryptoprocta*) showed significant, positive correlation with others in that family including *Galidia*, which in turn was positively correlated with two members of Herpestidae. Given this, the level of the kind could easily be above the level of the family.



**Fig. 106.** African civet. Source: Wikipedia <http://www.en.wikipedia.org>.

**Eupleridae (Malagasy carnivore kind)**

There are seven genera and eight species of Malagasy carnivores. These animals have been difficult to place taxonomically since their discovery. They have been variously placed in Viverridae, Herpestidae, or separated into monotypic families. Several studies have suggested that they represent a single radiation, which is the basis for placing them together in a family (Wilson and Reeder 2005). There is not a strong cognitum at the level of the family, as is evidenced by the taxonomic difficulties and the use of the name civet and mongoose in the common name of animals from several different families. Though the kind may easily include the four families Viverridae, Eupleridae, Nandiniidae, and Herpestidae, it has been left at the family level for this paper to avoid possibly underestimating the number of kinds.



**Fig. 107.** Fossa. Source: Wikipedia <http://www.en.wikipedia.org>.

**Nandiniidae (Africa palm civet kind)**

This is a monotypic family, containing only the species *Nandinia binotata*. It was separated out based on a characteristic of the auditory bullae. Some molecular data are also used to support this placement (Wilson and Reeder 2005).



**Fig. 108.** African palm civet. Source: Wikipedia <http://www.en.wikipedia.org>.

### ***Herpestidae (Mongoose kind)***

There are 14 genera and 33 species in this family. They are similar in appearance to members of *Viverridae*, but they can be distinguished based on characteristics of the anal scent gland and various features of the skull, especially the basicranium (Nowak 2005b; Wilson and Reeder 2005).



**Fig. 109.** Dwarf mongoose. Source: Wikipedia <http://www.en.wikipedia.org>.

### ***Hyaenidae (Hyena/Aardwolf kind)***

*Hyaenidae* is comprised of three genera and four species. Hyenas have an unusual sloping profile because their hindlegs are shorter than their forelegs. They are able to cover long distances with an energy-efficient 'loping gallop' due to this trait. Although the genus name *Canis* was originally used for some species centuries ago when they were first named, this family is now considered to be more cat-like and is in the suborder *Feliforma* (Nowak 2005b; Wilson and Reeder 2005).



**Fig. 110.** Hyena. Source: Scientopia <http://scientopia.org>.

### ***Canidae (Dog kind)***

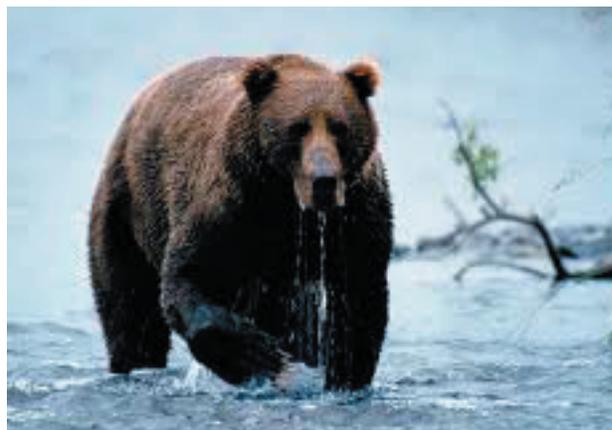
There are 13 genera and 35 species of canids (Wilson and Reeder 2005). There is considerable hybrid data, including a cross between a coyote and a red fox. This has led to the suggestion that fewer genera should be recognized because these animals are quite closely related (Van Gelder 1977). A number of creationist studies have been done, including a couple which examine diversity within the family (Lightner 2009; Pendragon 2011; previous baraminology studies summarized in Wood 2006). The strong cognitum and extensive hybrid data suggest the kind is likely at the level of the family.



**Fig. 111.** Bush dog. Source: Wikipedia <http://www.en.wikipedia.org>.

### ***Ursidae (Bear kind)***

There are five genera and eight species of bears. Some have questioned the inclusion of the giant panda in this family because it has some unique characteristics. However, morphological and molecular evidence support its inclusion here (Wilson and Reeder 2005). Hybrid data connect all species except the giant panda (Hennigan 2010). Based on the extensive hybrid data and strong cognitum, the family seems to correspond to a kind.



**Fig. 112.** Brown bear. Source: National Geographic <http://animals.nationalgeographic.com>.

**Mustelidae (Weasel/otter/badger kind)**

There are 22 genera and 59 species of mustelids. The skunks, Mephitidae, had once been placed as a subfamily within this family (Wilson and Reeder 2005). There are some documented intrageneric hybridizations in the genus *Mustela*, but alleged intergeneric hybrids seem questionable (Chang 1965; Chang 1968; Gray 1972; Lodé, Guiral, and Peltier 2005, Wu and Chang 1973). There is not a clear cognitum at the family, so further investigation would be beneficial for a better estimate of where the level of the kind falls.



**Fig. 113.** Long-tailed weasel. Source: NHPTV <http://www.nhptv.org>.

**Mephitidae (Skunk kind)**

The family has four genera with 12 species. In some taxonomies, these animals are still included as a subfamily under Mustelidae (Nowak 2005b; Wilson and Reeder 2005). As suggested by the taxonomical ambiguity, skunks group together nicely, but seem very similar to other mustelids in many respects. Though the level of the kind is placed tentatively at the family level, more research would be helpful.



**Fig. 114.** Striped skunk. Source: Wikipedia <http://www.en.wikipedia.org>.

**Procyonidae (Raccoon/coati kind)**

This family has four genera and 12 species. In some taxonomies the red panda is also included in this family. Procyonids often have a bear-like gait and are good climbers. They are omnivorous and, like bears, most species do not have the well-developed carnassial teeth (Nowak 2005b; Wilson and Reeder 2005).



**Fig. 115.** Common raccoon. Source: Wikipedia <http://www.en.wikipedia.org>.

**Ailuridae (Red panda kind)**

This monotypic family contains only the red panda, which has previously been placed in Procyonidae. These unique animals feed on bamboo like the giant panda. They have been somewhat of a challenge to classify and some have suggested that they are more closely related to bears than to procyonids (Nowak 2005b; Wilson and Reeder 2005).



**Fig. 116.** Rosso red panda. Source: Wikipedia <http://www.en.wikipedia.org>.

**Order Perissodactyla**

The animals in this order are often referred to as odd-toed ungulates. They carry weight on their central digit(s). The main axis of the foot passes through the third digit, which is the longest digit on all four feet. There are three distinct families. In modern horses, only the center digit is well developed and weight bearing. The tapir has four digits developed on the front feet, and three on the hind. In rhinos, three are present on all feet.

**Equidae (Horse kind)**

There is a single genus with eight species of equids (Wilson and Reeder 2005). There is considerable hybrid data connecting all extant species, so it is not surprising that creationists consider them from

a single kind (Gray 1972; Stein-Cadenbach 1993). What has been more controversial is the placement of three-toed fossils horses and hyracotherium. Using statistical methods it has been suggested all three are from a single created kind (Cavanaugh, Wood, and Wise 2003) although some bootstrapping values for positive correlation between these groups are low and there is significant negative BDC between modern horses and hyracotherium (Wood 2008b). A suggestion at the opposite end of the spectrum views even more than three kinds represented by these animals, with at least two different kinds of three-toed horses (Molén 2009).



**Fig. 117.** Wild horses. Source: Wikipedia <http://www.wikipedia.org>.

#### **Tapiridae (Tapir kind)**

There is a single genus with four species of tapirs (Wilson and Reeder 2005). These animals have a rounded back which tapers in front. The snout and upper lips project forward in a short, fleshy proboscis (Nowak 1999). Hybrids have been reported between the Baird's and South American tapirs (Anonymous n. d.). There is a natural cognitum at this level.



**Fig. 118.** Malayan tapir. Source: Tapir Specialist Group <http://www.tapirs.org>.

#### **Rhinocerotidae (Rhinoceros kind)**

There are four genera with five species of rhinoceros (Wilson and Reeder 2005). They have one or two horns which, unlike the horns of ruminants, are dermal in origin and made up of compressed fibrous keratin (Nowak 1999). This family forms a natural cognitum too. Hybridization has been reported between the white and the black rhinoceroses (Robinson et al. 2005).



**Fig. 119.** Black rhinoceros. Source: Wikipedia <http://www.en.wikipedia.org>.

#### **Order Artiodactyla**

Thesemammalsareknownastheeven-toedungulates. They usually have an even number of well-developed digits. The main axis of the body passes through the third and fourth digits, the two digits that support the weight of the body. Members of the superfamily Suoidea usually have a two chambered stomach, but do not chew their cud (ruminant). The hippopotamus has a three chambered non-ruminating stomach. Camelids have a three chambered ruminating stomach. All ruminants have a distinctive four chambered ruminating stomach, though the third chamber is poorly developed in the family Tragulidae (Nowak 1999).

#### **Superfamily Suoidea (Pig kind)**

There are two families (Suidae and Tayassuidae) with eight genera and 22 species in this superfamily (Wilson and Reeder 2005). Gray (1972) reports some fertile hybrids within the genus *Sus*, as well as an intergeneric cross between the Collard and White-lipped peccaries. The karyotypes of these two peccaries are surprisingly divergent (Bosma et al. 2004). Though no hybrids crossing the two families have been documented, all these animals have an unmistakable pig-like shape with the distinctive mobile, cartilaginous snout. Both families normally have a two chambered stomach, which is more complex in the peccaries. Peccaries also have a dorsal scent gland (Nowak 1999). Both pigs and peccaries carry a duplication of a gene (CYP19) which appears to be unique among mammals (Corbin et al. 2007).

The cognitum is very strong at the superfamily level. It is doubtful that an average biology student with some familiarity with pigs would divide this group in a way consistent with current family divisions. Therefore, it seems natural to place the level of the kind here.



**Fig. 120.** Bearded pig. Source: Wikipedia <http://www.en.wikipedia.org>.

### **Hippopotamidae (Hippopotamus kind)**

There are two species of hippopotamuses, each placed in their own genus. Though they differ greatly in size, they share common features including a broad snout with a large mouth, a stout rotund body and stocky legs. The nostrils are on the top of the snout and can be closed, allowing the hippo to remain submerged for a considerable length of time (Nowak 1999). Due to their distinctiveness compared to other animals in this order, it seems natural to place the level of the kind at the family level.



**Fig. 121.** African hippopotamus. Source: Wikipedia <http://www.en.wikipedia.org>.

### **Camelidae (Camel kind)**

There are three genera with four species of camelids (Wilson and Reeder 2005). Although they have a three chambered ruminating stomach, there are significant differences between it and the distinctive ruminant stomach (Alzola et al. 2004; Wang et al., 2000). There are remarkable anatomical and physiological similarities between Old World camels and the New World llamas and alpacas. All species are connected through hybrid data (Skidmore et al. 1999). Thus it seems natural to consider the family equivalent to the kind.



**Fig. 122.** Bactrian camel. Source: Wikipedia <http://www.en.wikipedia.org>.

### **Suborder Ruminantia**

Based on anatomical characteristics there is a strong cognitum at Ruminantia, which was considered the suborder level. True ruminants lack upper incisors, and most lack upper canines. Upper canines are present in Tragulidae, Moschidae, and some Cervidae, and in some cases they grow to become tusks. Ruminant cheek teeth have selenodont (crescent-shaped) ridges which are effective at grinding food with the side-to-side motion characteristic of these herbivores. All ruminants have a four chambered stomach, although the third chamber, the omasum, is poorly developed in Tragulidae (Huffman 2011). Each chamber has its own distinctive lining, and digestive glands are confined to the final chamber, the abomasum.

The metapodials (foot bones) are fused to form a cannon bone. In one taxon this fusion does not occur until after maturity. The navicular and cuboidal bones are fused. Only the third and fourth digits are well-developed (Huffman 2011). Many ruminants have cranial appendages: horns, antlers, pronghorns, or ossicones; each of which is specific to a particular family. There have been multiple hypotheses proposed to account for these in the evolutionary paradigm (Davis, Brakora, and Lee 2011). Unlike the evolutionary accounts, creationists are free to hypothesize that elaborate cranial appendages were the created state, and variations today may have results from various forms of loss (such as loss of the ability to shed).

The two largest families of ruminants are Cervidae and Bovidae. Nearly all Cervidae have antlers, though in many species it is only in the male. They also lack a gall bladder. Bovidae have horns rather than antlers; these are neither branched nor shed (Huffman 2011). There have been several claimed hybrids between deer (Cervidae) and cattle or sheep (Bovidae), but they have not been well documented enough to be deemed

reliable. Mating has been observed between members of these families (Gray 1972). There are species of deer (Cervidae) and antelope (Bovidae) that are not easily identifiable to family unless the cranial appendages are present. All this hints that one created kind could have given rise to all in Ruminantia. However, given the diversity of this group I will split them so as to avoid underestimating the number of kinds on the Ark.

### **Tragulidae (Mouse deer kind)**

There are three genera and eight species of mouse deer, or chevrotains (Wilson and Reeder 2005). These small ruminants have powerful hind quarters and forward-sloping shoulders. This appearance is reminiscent of agoutis (Rodentia: Dasyproctidae) and African duikers (Artiodactyla: Bovidae: Cephalophinae). Although they are sometimes said to have a three chambered stomach, they actually have four, though the omasum is poorly developed. Females have two pairs of mammary glands. They do not have antlers, but they do have upper canine teeth which form tusks in the males (Huffman 2011; Nowak 1999).



**Fig. 123.** Lesser mouse deer. Source: Wikipedia <http://www.en.wikipedia.org>.

### **Moschidae (Musk deer kind)**

There is a single genus with four species of musk deer (Wilson and Reeder 2005). Though musk deer were once considered a subfamily of Cervidae, they are now generally placed in a separate family. They also lack antlers, but have upper canines which develop into tusks in the males. They are named for the musk gland on the abdomen of the males which secretes a brownish wax-like substance. Unlike Cervidae they have a gall bladder. They also have only a single pair of mammary glands, whereas most Cervidae have two pairs (Nowak 1999).



**Fig. 124.** Siberian musk deer. Source: Wikipedia <http://www.en.wikipedia.org>.

### **Cervidae (Deer kind)**

There are 19 genera and 51 species of deer (Wilson and Reeder 2005). All but one genus (*Hydropotes*) have antlers, though they are generally only on the male. These are shed annually and then regrow (Nowak 1999). There is excellent hybrid data connecting two of the four subfamilies, Cervinae and Odocoileinae (Lightner 2006b). Recent shifting of subfamilies based on new studies has caused the remaining subfamilies, Muntiacinae and Hydropotinae, to be placed in (or near) Cervinae and Odocoileinae (aka Capreolinae) respectively (Huffman 2011). This seems strong evidence that all members of this family are related.



**Fig. 125.** Sika deer. Source: Red Orbit Wikipedia <http://www.redorbit.com>.

### **Antilocapridae (Pronghorn kind)**

The single extant species is the fastest of all hoofed creatures. Pronghorns have a mix of characteristics that are found in other ruminant families, so it has been hard to place taxonomically. Their horns are forked and consist of a permanent bony core covered by a keratinous sheath that is shed annually. Some considered them a subfamily within Bovidae, but others argue for a separate family more closely allied with Cervidae (Nowak 1999).

**Giraffidae (Giraffe kind)**

The two extant species, the giraffe and the okapi, are placed in separate genera (Wilson and Reeder 2005). These animals have long legs, neck, and tongue. Like Cervidae, they lack a gall bladder. The cranial appendages are called ossicones. They are present at birth as cartilaginous knobs which ossify as they grow. Eventually they become fused to the skull. In fossil giraffids the ossicones were sometime branched (Nowak 1999).



**Fig. 126.** Okapi. Source: Wikipedia <http://www.en.wikipedia.org>.



**Fig. 127.** Giraffe. Source: Wikipedia <http://www.en.wikipedia.org>.

**Bovidae****Aepycerotinae (Impala kind)**

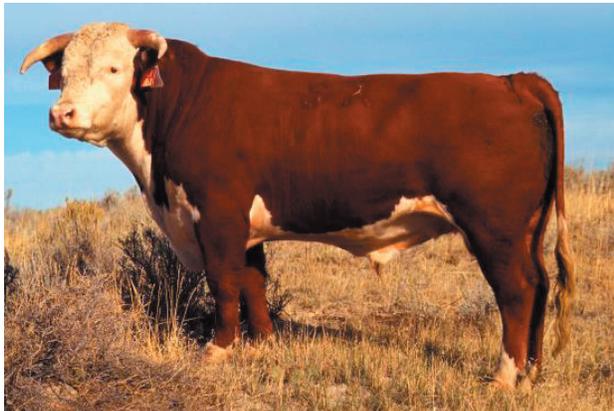
**Fig. 128.** Impala. Source: Wikipedia <http://www.en.wikipedia.org>.

**Alcelaphinae (Hartebeest kind)**

**Fig. 129.** Hartebeest. Source: African Wildlife Foundation <http://www.awf.org>.

**Antilopinae (Antelope kind)**

**Fig. 130.** Blackbuck antelope. Source: Wikipedia <http://www.en.wikipedia.org>.

**Bovinae (Cattle kind)**

**Fig. 131.** Hereford bull. Source: Wikipedia <http://www.en.wikipedia.org>.

**Caprinae (Tsoan kind)**

**Fig. 132.** Barbary sheep. Source: Tree of Life <http://www.tolweb.org>.

**Cephalophinae (Duiker kind)**

**Fig. 133.** Yellow-backed duiker. Source: Wikipedia <http://www.en.wikipedia.org>.

**Hippotraginae (Hippotragus antelope kind)**

**Fig. 134.** Sable bull antelope. Source: Wikipedia <http://www.en.wikipedia.org>.

**Reduncinae (Reedbuck kind)**

**Fig. 135.** Kob. Source: Wikipedia <http://www.en.wikipedia.org>.

There are 50 genera and 143 species in the family Bovidae (Wilson and Reeder 2005). Horns, which are characteristic of this family, consist of a bony core attached to the frontal bone and a hard keratinous sheath (Nowak 1999). There is considerable hybrid data within two subfamilies: Bovinae which includes cattle and Caprinae which includes sheep and goats. In fact, sheep and goats have been so commonly thought of together that the Bible has a single word that refers to a flock of sheep and/or goats: תְּשׂוּן (tsoan). While isolated reports of hybrids between the subfamilies Caprinae and Bovinae and between them and members of Cervidae exist, they are not well documented enough to be considered reliable (Lightner 2006c; Lightner 2007).

There is considerable diversity in this family. Most people would tend to think of sheep and goats as distinct from cattle. For these reasons it was decided to split the family and consider the subfamily the level of the kind. This probably over-estimates the number of kinds since antelope are found in more than one subfamily, but it is the simplest way to split until more information becomes available.

## Summary/Conclusions

It has often been stated that the level of the kind is approximately the level of the family. It can be above or below this level, but the family is a fairly good approximation. In this analysis, only twice was the level of the kind assigned to a rank below family. It was placed at the subfamily level for hedgehogs (*Erinaceinae*) and gymnures (*Galericinae*) because they could be fairly easily distinguished based on whether or not they had spines, at least in the photos that were available. However, given their many other morphological similarities, it could have easily been argued that the level of the kind was actually at the level of the family. It was placed at the subfamily level again in *Bovidae*, though again one could easily argue that the level of the kind is higher there too.

There were a number of times where the level of the kind did seem to naturally fall at the family level based on the cognitum and hybrid data. However, in a number of cases the kind appeared to be above this level. It seems to me a better rule of thumb is that the level of the kind is anywhere from the level of the family to the level of the order. In some cases, such as for some marsupials, it appears that it could even be above this level. This is because marsupials are no longer considered a single order.

Where considerable controversy exists over placement of a taxon, it has often been regarded as potentially informative. If it is at a higher taxonomic level and there is not a strong cognitum between the groups, it has been taken as support that the groups are unlikely to be related. This is particularly the case when the identity of those within the taxon is relatively non-controversial. When there is a strong cognitum and/or the controversy is below the level of the family, it has been suggested that the creatures are related, but within kind diversification doesn't fit the neat "tree of life" pattern often proposed by evolutionists. While this may in fact be the case, it is quite subjective and further confirmation is desirable.

In biology it is relatively easy to observe, measure, and identify similarities and differences. It is often much less straightforward to interpret the similarities and differences. Evolutionists often end up explaining similarities as convergence as they attempt to account for traits in their paradigm of universal common descent. While creationists recognize that similarities can be the result of a Creator reusing

design elements, and thus there is less need to invoke convergence or common descent as an explanation for similarities, this does not appear to eliminate the other two options completely. Since creationists have three possible explanations for similarity (common ancestry, common design feature, and convergence), we need to be all the more careful to investigate carefully before attributing similarities to one of the three causes.

Another issue is interpreting differences. When are differences significant enough that they indicate that the creatures in question are likely from distinct kinds? More thorough investigation into variability within known kinds can help in answering this question. It is known that color patterns and karyotype can be variable within a kind. Is there a limit to this? What about variability in dental anatomy, cranial morphology, GI tract morphology, and placentation? What factors influence morphologic variability? Environment? Genetics? Or both? As these types of questions get answered for kinds that are well defined by hybrid data, it should help us make more informed decisions about the level of the kind in situations where such data is lacking.

In this paper 137 kinds have been tentatively identified. If the fossil record is taken into consideration, this number could easily double. Beech (2012) listed terrestrial vertebrate families represented in the fossil record. In the list of mammals 210 to 218 families are not recognized here. This suggests that closer to 350 mammal kinds were on the Ark. The large number of extinct families may be partially from a tendency for paleontologists to be splitters. However, much of it reflects the fact that a large amount of the diversity previously found in mammals has been lost.

In this serious attempt to quantify the kinds represented on the Ark, the numbers which resulted are lower than many had anticipated. Previous work had estimated the genus as the level of the kind, knowing this would significantly overestimate the number, in order to emphasize that the Ark had sufficient room for its intended purpose (Woodmorappe 1996). In discussing the results of this study with other creationists, many are surprised at how incredibly spacious the accommodations on the Ark would have been. In any case, this work is a reminder we have a Creator who cares for His creation and, even in judgment, He provides a way of salvation to those who will trust in Him.

## Appendix 1. Mammalian hybrids—Macropodidae.

Sthenurinae			Macropodinae		
Genus	Species	Common Name	Genus	Species	Common Name
<i>Lagostrophus</i>	<i>fasciatus</i>	Banded Hair-wallaby	<i>Macropus</i>	<i>irma</i>	Western Brush Wallaby
Macropodinae			<i>Macropus</i>	<i>parma</i>	Parma Wallaby
Genus	Species	Common Name	<i>Macropus</i>	<i>parryi</i> (1)	Pretty-faced Wallaby
<i>Dendrolagus</i>	<i>bennettianus</i>	Bennett's Tree-kangaroo	<i>Macropus</i>	<i>robustus</i> (2)	Walleroo
<i>Dendrolagus</i>	<i>dorianus</i>	Doria's Tree-kangaroo	<i>Macropus</i>	<i>rufogriseus</i> (4)	Red-necked Wallaby
<i>Dendrolagus</i>	<i>goodfellowi</i>	Goodfellow's Tree-kangaroo	<i>Macropus</i>	<i>rufus</i> (1, 2)	Red Kangaroo
<i>Dendrolagus</i>	<i>inustus</i>	Grizzled Tree-kangaroo	<i>Onychogalea</i>	<i>fraenata</i>	Brindled Nail-tail Wallaby
<i>Dendrolagus</i>	<i>lumholtzi</i>	Lumholtz's Tree-kangaroo	<i>Onychogalea</i>	<i>lunata</i>	Crescent Nail-tail Wallaby
<i>Dendrolagus</i>	<i>matschiei</i>	Huon Tree-kangaroo	<i>Onychogalea</i>	<i>unguifera</i>	Northern Nail-tail Wallaby
<i>Dendrolagus</i>	<i>mbaiso</i>	Dingiso	<i>Petrogale</i>	<i>assimilis</i> (5)	Allied Rock-wallaby
<i>Dendrolagus</i>	<i>pulcherrimus</i>	Golden-mantled Tree-kangaroo	<i>Petrogale</i>	<i>brachyotis</i>	Short-eared Rock-wallaby
<i>Dendrolagus</i>	<i>scottae</i>	Tenkile	<i>Petrogale</i>	<i>burbidgei</i>	Monjon
<i>Dendrolagus</i>	<i>spadix</i>	Lowlands Tree-kangaroo	<i>Petrogale</i>	<i>coenensis</i>	Cape York Rock-wallaby
<i>Dendrolagus</i>	<i>stellarum</i>	Seri's Tree-kangaroo	<i>Petrogale</i>	<i>concinna</i>	Nabarlek
<i>Dendrolagus</i>	<i>ursinus</i>	Ursine Tree-kangaroo	<i>Petrogale</i>	<i>godmani</i>	Godman's Rock-wallaby
<i>Dorcopsis</i>	<i>atrata</i>	Black Dorcopsis	<i>Petrogale</i>	<i>herberti</i>	Herbert's Rock-wallaby
<i>Dorcopsis</i>	<i>hageni</i>	White-striped Dorcopsis	<i>Petrogale</i>	<i>inornata</i> (5)	Unadorned Rock-wallaby
<i>Dorcopsis</i>	<i>luctuosa</i>	Gray Dorcopsis	<i>Petrogale</i>	<i>lateralis</i>	Black-flanked Rock-wallaby
<i>Dorcopsis</i>	<i>muelleri</i>	Brown Dorcopsis	<i>Petrogale</i>	<i>mereeba</i> (5)	Mareeba Rock-wallaby
<i>Dorcopsis</i>	<i>macleayi</i>	Macleay's Dorcopsis	<i>Petrogale</i>	<i>penicillata</i>	Brush-tailed Rock-wallaby
<i>Dorcopsis</i>	<i>vanheurni</i>	Small Dorcopsis	<i>Petrogale</i>	<i>persephone</i>	Proserpine Rock-wallaby
<i>Lagorchestes</i>	<i>asomatus</i>	Lake Mackay Hare-wallaby	<i>Petrogale</i>	<i>purpureicollis</i>	Perple-necked Rock-wallaby
<i>Lagorchestes</i>	<i>conspicillatus</i>	Spectacled Hare-wallaby	<i>Petrogale</i>	<i>rothschildi</i>	Rothschild's Rock-wallaby
<i>Lagorchestes</i>	<i>hirsutus</i>	Rufous Hare-wallaby	<i>Petrogale</i>	<i>sharmani</i> (5)	Mt. Claro Rock-wallaby
<i>Lagorchestes</i>	<i>leporides</i>	Eastern Hare-wallaby	<i>Petrogale</i>	<i>xanthopus</i>	Yellow-footed Rock-wallaby
<i>Macropus</i>	<i>agilis</i> (3)	Agile Wallaby	<i>Setonix</i>	<i>brachyurus</i>	Quokka
<i>Macropus</i>	<i>antilopinus</i>	Antilopine Kangaroo	<i>Thylogale</i>	<i>billardierii</i>	Tasmanian Pademelon
<i>Macropus</i>	<i>bernardus</i>	Woodward's Wallaroo	<i>Thylogale</i>	<i>browni</i>	Brown's Pademelon
<i>Macropus</i>	<i>dorsalis</i>	Black-striped Wallaby	<i>Thylogale</i>	<i>brunii</i>	Dusky Pademelon
<i>Macropus</i>	<i>eugenii</i>	Tammar Wallaby	<i>Thylogale</i>	<i>calabyi</i>	Calaby's Pademelon
<i>Macropus</i>	<i>fuliginosus</i> (1, 2)	Western Grey Kangaroo	<i>Thylogale</i>	<i>lanatus</i>	Mountain Pademelon
<i>Macropus</i>	<i>giganteus</i> (1, 2)	Eastern Grey Kangaroo	<i>Thylogale</i>	<i>stigmatica</i> (4)	Red-legged Pademelon
<i>Macropus</i>	<i>greyi</i>	Toolache Wallaby	<i>Thylogale</i>	<i>thetis</i> (4)	Red-necked Pademelon
			<i>Wallabia</i>	<i>bicolor</i> (3)	Swamp Wallaby

(1) The Eastern Grey Kangaroo has crossed with the Western Grey Kangaroo, the Pretty-faced Wallaby, and the Red Kangaroo (Gray 1972, pp. 167–168).

(2) The Red Kangaroo, in addition to hybridizing the the Eastern (#1) and Western Grey Kangaroos, has hybridized with the Wallaroo (Gray 1972, p. 168).

(3) The Agile Wallaby has crossed with the Swamp Wallaby (VanGelder 1977, pp. 5–6). Mentioned in Gary (1972) with both under the genus name *Wallabia* (pp. 169–170).

(4) The Red-necked Pademelon has hybridized with the Red-legged Pademelon and the Red-necked Wallaby (Bennet's Wallaby in Gray) (Gray 1972, p. 169).

(5) Crosses have been produced between the Allied Rock-wallaby and the Unadorned, Mareeba, and Mt. Claro Rock-wallabies (Close et al. 1996). Each of these species differ in karyotype.

## Appendix 2. Mammalian hybrids—Elephantidae.

Genus	Species	Common Name
<i>Elephas</i>	<i>maximus</i> (1)	Asian Elephant
<i>Loxodonta</i>	<i>africana</i> (1)	African Bush Elephant
<i>Loxodonta</i>	<i>cyclotis</i>	African Forest Elephant

(1) An Asian elephant gave birth to a male calf, Motty, at Chester Zoo in England in 1978; the sire was an African elephant ([http://www.elephant.se/Motty\\_the\\_elephant\\_crossbreed.php?](http://www.elephant.se/Motty_the_elephant_crossbreed.php?))

For many years the African Bush and Forest Elephants were considered different subspecies of *L. africana*.

**Appendix 3.** Mammalian hybrids—Cercopithecidae.

<b>Cercopithecinae</b>		
<b>Genus</b>	<b>Species</b>	<b>Common Name</b>
<i>Allenopithecus</i>	<i>nigroviridis</i> (1)	Allen's Swamp Monkey
<i>Cercocebus</i>	6 species (2, 3)	Mangabeys
<i>Cercopithecus</i>	25 species (1, 4, 5)	various Monkeys and Guenons
<i>Chlorocebus</i>	6 species	various Monkeys and Vervet
<i>Erythrocebus</i>	<i>patas</i> (5)	Patas Monkey
<i>Lophocebus</i>	3 species	various Mangabeys
<i>Macaca</i>	21 species (2, 4)	Macaque
<i>Mandrillus</i>	2 species (3, 6)	Mandrills
<i>Miopithecus</i>	2 species	Talapoin
<i>Papio</i>	5 species (6, 7)	Baboon
<i>Theropithecus</i>	<i>gelada</i> (7)	Gelada
<b>Colobinae</b>		
<b>Genus</b>	<b>Species</b>	<b>Common Name</b>
<i>Colobus</i>	5 species	Colobuses
<i>Nasalis</i>	<i>larvatus</i>	Proboscis Monkey
<i>Ptilocolobus</i>	9 species	other Colobuses
<i>Presbytis</i>	10 species	Surilis and Langurs
<i>Procolobus</i>	<i>verus</i>	Olive Colobus
<i>Pygathrix</i>	3 species	Douc Langurs
<i>Rhinopithecus</i>	4 species	Snub-nosed Monkeys
<i>Semnopithecus</i>	7 species	Gray Langurs
<i>Simias</i>	<i>cancolor</i>	Simakobou
<i>Trachypithecus</i>	17 species	Lutungs, Leaf-monkeys, and other Langurs

- (1) *Allenopithecus nigroviridis* has crossed with *Cercopithecus aethiops* producing viable offspring (Van Gelder 1977).  
 (2) Two species of *Cercocebus* have each crossed with two species of *Macaca* (Van Gelder 1977).  
 (3) There are two reported cases of *Cercocebus* crossing with *Mandrillus*, resulting in live birth (Van Gelder 1977).  
 (4) Several species of *Cercopithecus* have been crossed successfully with several species of *Macaca* (Van Gelder 1977).  
 (5) A hybrid was produced between one species of *Cercopithecus* and *Erythrocebus patas* (Van Gelder 1977).  
 (6) Several species of *Mandrillus* have hybridized with various species from *Papio* (Van Gelder 1977).  
 (7) *Theropithecus gelada* has hybridized with *Papio* (Van Gelder 1977).

## Appendix 4. Mammal hybrids—Sciuridae.

Genus	Species	Common Name
<i>Ratufa</i>	4 species	Giant Squirrels
<i>Sciurillus</i>	<i>pusillus</i>	Neotropical Pygmy Squirrel
<i>Microsciurus</i>	4 species	Dwarf Squirrels
<i>Rheithrosciurus</i>	<i>macrotis</i>	Tufted Ground Squirrel or Groove-toothed Squirrel
<i>Sciurus</i>	28 species	Tree Squirrels
<i>Syntheosciurus</i>	<i>brochus</i>	Bang's Mountain Squirrel
<i>Tamiasciurus</i>	3 species (2)	Red Squirrels or Chickarees
<i>Aeretes</i>	<i>melanopterus</i>	Northern Chinese Flying Squirrel or Groove-toothed Flying Squirrel
<i>Aeromys</i>	2 species	Large Black Flying Squirrels
<i>Belomys</i>	<i>pearsonii</i>	Hairy-footed Flying Squirrel
<i>Biswamoyopterus</i>	<i>biswasi</i>	Namdapha Flying Squirrel
<i>Eoglaucomyus</i>	<i>fimbriatus</i>	Kashmir Flying Squirrel
<i>Eupetaurus</i>	<i>cinereus</i>	Woolly Flying Squirrel
<i>Glaucomyus</i>	2 species	New World Flying Squirrels
<i>Hylomys</i>	9 species	Arrow-tailed Flying Squirrels
<i>Iomys</i>	2 species	Horsfield's Flying Squirrels
<i>Petaurillus</i>	3 species	Pygmy Flying Squirrels
<i>Petaurista</i>	8 species	Giant Flying Squirrels
<i>Petinomys</i>	9 species	Dwarf Flying Squirrels
<i>Pteromys</i>	2 species	Old World Flying Squirrels
<i>Pteromyscus</i>	<i>pulverulentus</i>	Smoky Flying Squirrel
<i>Trogopterus</i>	<i>xanthipes</i>	Complex-toothed Flying Squirrels
<i>Callosciurus</i>	15 species	Beautiful Squirrels or Tricolored Squirrels
<i>Dremomys</i>	6 species	Red-cheeked Squirrels
<i>Exilisciurus</i>	3 species	Pygmy Squirrels
<i>Funambulus</i>	5 species	Asiatic Striped Palm Squirrels
<i>Glyphotes</i>	<i>simus</i>	Bornean Pygmy Squirrel or Sculptor Squirrel
<i>Hyosciurus</i>	2 species	Sulawesi Long-nosed Squirrels
<i>Lariscus</i>	4 species	Malaysian Striped Ground Squirrels
<i>Menetes</i>	<i>berdmorei</i>	Berdmore's or Multistriped Palm Squirrel
<i>Nannosciurus</i>	<i>melanotis</i>	Black-eared Squirrel
<i>Prosciurillus</i>	5 species	Sulawesi Dwarf Squirrels
<i>Rhinosciurus</i>	<i>laticaudatus</i>	Long-nosed Squirrel or Shrew-faced Squirrel
<i>Rubrisciurus</i>	<i>rubriventer</i>	Sulawesi Giant Squirrel
<i>Sundasciurus</i>	15 species	Sunda Tree Squirrels
<i>Tamiops</i>	4 species	Asiatic Striped Squirrel
<i>Atlantoxerus</i>	<i>getulus</i>	Barbary Groud Squirrel
<i>Spermophilopsis</i>	<i>leptodactylus</i>	Long-clawed Ground Squirrel
<i>Xerus</i>	4 species	African Ground Squirrels
<i>Epixerus</i>	<i>ebii</i>	African Palm Squirrels
<i>Funisciurus</i>	9 species	African Striped Squirrels or Rope Squirrels
<i>Heliosciurus</i>	6 species	Sun Squirrels
<i>Myosciurus</i>	<i>pumilio</i>	African Pygmy Squirrel
<i>Paraxerus</i>	11 species	African Bush Squirrels
<i>Protoxerus</i>	2 species	Oil Palm Squirrels
<i>Ammospermophilus</i>	5 species	Antelope Ground Squirrels
<i>Cynomys</i>	5 species	Prairie Dogs
<i>Marmota</i>	14 species (3)	Marmots
<i>Sciurotamias</i>	2 species	Rock Squirrels
<i>Spermophilus</i>	41 species (1)	Ground Squirrels or Susliks
<i>Tamias</i>	25 species	Chipmunks

(1) There is abundant evidence of interspecific hybridization among members of this genus in contact zones (Cothran and Honeycutt 1984; Ermakov et al. 2002; Goodwin 1998; Hafner 1992; Spiridonova et al. 2006; Tsvirka, Chelomina, and Korablev 2006). Gray (1972) has some listed under the (invalid) genus name *Citellus*.

(2) There is evidence of hybridization between *Tamiasciurus douglasii* and *T. hudsonicus* in a contact zone (Chavez, Saltzberg, and Kenagy 2011).

(3) There is evidence of hybridization between *Marmota baibacina* and *M. sibirica* in a contact zone (Brandler, Nikol'sky, and Kolesnikov 2010).

**Appendix 5.** Mammal hybrids—Geomyidae.

Genus	Species	Common Name
<i>Cratogeomys</i>	8 species	Yellow-faced and Mexican Pocket Gophers
<i>Geomys</i>	9 species (1)	Eastern Pocket Gophers
<i>Orthogeomys</i>	11 species	Taltuzas
<i>Pappogeomys</i>	2 species	Alcorn's and Buller's Pocket Gophers
<i>Thomomys</i>	8 species (2)	Western Pocket Gophers
<i>Zygoeomys</i>	<i>trichopus</i>	Michoacan Pocket Gopher

(1) Hybrids have been reported in contact zones between several different species in *Geomys* (Harrison 1993).

(2) Hybrids have been reported in contact zones between *Thomomys townsendii* x *T. umbrinus* (Gray 1972, pp. 63–64).

**Appendix 6.** Mammal hybrids—Leporidae.

Genus	Species	Common Name
<i>Brachylagus</i>	<i>idahoensis</i>	Pygmy Rabbit
<i>Bunolagus</i>	<i>monticularis</i>	Riverine Rabbit
<i>Caprolagus</i>	<i>hispidus</i>	Hispid Hare
<i>Lepus</i>	32 species (1, 2)	Common Hares and Jackrabbits
<i>Nesolagus</i>	2 species	Striped Rabbits
<i>Oryctolagus</i>	<i>cuniculus</i> (2)	European Rabbit
<i>Pentalagus</i>	<i>furnessi</i>	Amami Rabbit
<i>Poelagus</i>	<i>majorita</i>	Bunyoro Rabbit
<i>Pronolagus</i>	3 species	Red Rock Hares
<i>Romerolagus</i>	<i>diazi</i>	Volcano Rabbit
<i>Sylvilagus</i>	17 species	Cottontails

(1) Hybrids have been reported between *L. europæus* (European Hare) and *L. timidus* (Mountain Hare) (Gray 1972, pp. 90–91).

(2) Live hybrids are claimed between *Lepus* species and *O. cuniculus* (European rabbit), but not well documented. One well documented case of development past the blastocyst stage and implantation has been recorded (Chang, Marston and Hunt 1964; Gray 1972, pp. 91–92).

**Appendix 7.** Mammal hybrids—Felidae.

Felinae		
Genus	Species	Common Name
<i>Acinonyx</i>	<i>jubatus</i>	Cheetah
<i>Caracal</i>	<i>caracal</i>	Caracal
<i>Catopuma</i>	<i>badia</i>	Bay Cat
<i>Catopuma</i>	<i>temminckii</i>	Asian Golden Cat
<i>Felis</i>	<i>beiti</i>	Chinese Mountain Cat
<i>Felis</i>	<i>catus</i> (3)	Domestic Cat
<i>Felis</i>	<i>chaus</i> (3)	Jungle Cat
<i>Felis</i>	<i>manul</i>	Palla's Cat
<i>Felis</i>	<i>margarita</i>	Sand Cat
<i>Felis</i>	<i>nigripes</i>	Blackfooted Cat
<i>Felis</i>	<i>silvestris</i> (3)	Wildcat
<i>Leopardus</i>	9 species (4)	includes ocelot
<i>Leptailurus</i>	<i>serval</i>	Serval
<i>Lynx</i>	<i>canadensis</i>	Canadian Lynx
<i>Lynx</i>	<i>lynx</i>	Eurasian Lynx
<i>Lynx</i>	<i>pardinus</i>	Iberian Lynx
<i>Lynx</i>	<i>rufus</i> (3)	Bobcat

Felinae		
Genus	Species	Common Name
<i>Pardofelis</i>	<i>marmorata</i>	Marbled Cat
<i>Prionailurus</i>	<i>bengalensis</i> (3)	Leopard Cat
<i>Prionailurus</i>	<i>iriomotensis</i>	Iriomote Cat
<i>Prionailurus</i>	<i>planiceps</i>	Flat-headed Cat
<i>Prionailurus</i>	<i>rubiginosus</i>	Rusty-Spotted Cat
<i>Prionailurus</i>	<i>viverrinus</i>	Fishng Cat
<i>Profelis</i>	<i>aurata</i>	African Golden Cat
<i>Puma</i>	<i>concolor</i> (1, 4)	Cougar
<i>Puma</i>	<i>yagouarundi</i>	Jaguarundi

Pantherinae		
Genus	Species	Common name
<i>Neofelis</i>	<i>nebulosa</i>	Clouded Leopard
<i>Panthera</i>	<i>leo</i> (2)	Lion
<i>Panthera</i>	<i>onca</i>	Jaguar
<i>Panthera</i>	<i>pardus</i> (1, 2)	Leopard
<i>Panthera</i>	<i>tigris</i> (2)	Tiger
<i>Uncia</i>	<i>uncia</i>	Snow Leopard

(1) Reciprocal crossed have occurred between the Cougar and the Leopard (Gray 1972, pp. 37–38).

(2) Lions have crossed with both leopards and tigers (Gray 1972, pp. 39–40).

(3) The domestic cat is reported to have crossed with the Jungle Cat, European Wild Cat, Bobcat, and Leopard Cat (Gray 1972, pp. 35–37).

(4) The ocelot (*Leopardus pardalis*) has crosses with the Cougar (*Puma concolor*) (Dubost and Royère 1993).

**Appendix 8.** Mammal hybrids—Canidae.

Genus	Species	Common Name
<i>Atelocynus</i>	<i>microtis</i>	Short-eared Dog
<i>Canis</i>	<i>adustus</i>	Side-striped Jackal
<i>Canis</i>	<i>aureus</i> (1)	Golden Jackal
<i>Canis</i>	<i>latrans</i> (1, 4)	Coyote
<i>Canis</i>	<i>lupus</i> (1)	Wolf
<i>Canis</i>	<i>mesomelas</i>	Black-backed Jackal
<i>Canis</i>	<i>simensis</i>	Ethiopian Wolf
<i>Cerdocyon</i>	<i>thous</i>	Crab-eating Fox
<i>Chrysocyon</i>	<i>brachyurus</i>	Maned Wolf
<i>Cuon</i>	<i>alpinus</i>	Dhole
<i>Dusicyon</i>	<i>australis</i>	Falkland Islands Wolf
<i>Lycalopex</i>	<i>culpaeus</i>	Culpeo
<i>Lycalopex</i>	<i>fulvipes</i>	Darwin's Fox
<i>Lycalopex</i>	<i>griseus</i>	South American Gray Fox
<i>Lycalopex</i>	<i>gymnocercus</i>	Pampas Fox
<i>Lycalopex</i>	<i>sechurae</i>	Sechuran Fox
<i>Lycalopex</i>	<i>vetulus</i>	Hoary Fox
<i>Lycaon</i>	<i>pictus</i>	African wild dog

Genus	Species	Common Name
<i>Nyctereutes</i>	<i>procyonoides</i>	Raccoon dog
<i>Otocyon</i>	<i>megalotis</i>	Bat-eared Fox
<i>Speothos</i>	<i>venaticus</i>	Bush Dog
<i>Urocyon</i>	<i>cinereoargenteus</i>	Gray Fox
<i>Urocyon</i>	<i>littoralis</i>	Island Fox
<i>Vulpes</i>	<i>bengalensis</i>	Bengal Fox
<i>Vulpes</i>	<i>cana</i>	Blanford's Fox
<i>Vulpes</i>	<i>chama</i>	Cape Fox
<i>Vulpes</i>	<i>corsac</i>	Corsac Fox
<i>Vulpes</i>	<i>ferrilata</i>	Tibetan Sand Fox
<i>Vulpes</i>	<i>lagopus</i> (2)	Arctic Fox
<i>Vulpes</i>	<i>macrotis</i> (3)	Kit Fox
<i>Vulpes</i>	<i>pallida</i>	Pale Fox
<i>Vulpes</i>	<i>rueppellii</i>	Rüppell's Fox
<i>Vulpes</i>	<i>velox</i> (3)	Swift Fox
<i>Vulpes</i>	<i>vulpes</i> (2, 4)	Red Fox
<i>Vulpes</i>	<i>zerda</i>	Fennec Fox

(1) Well documented hybrids with domestic dogs (*Canis familiaris*) (Gray 1972, pp.46–47).

(2) The Arctic Fox has hybridized with both the Red Fox, and the color variant called the Silver Fox (formerly *Vulpes fulva*) (Gray 1972, pp. 44–45).

(3) Hybridization inferred from intermediate skull morphology found in region where species overlap (Rohwer and Kilgore 1973).

(4) A zoo hybrid documented in International Zoo Yearbook 15, Duplax-Hal (1975, p. 372). Further documentation in VanGelder (1977, p. 10).

**Appendix 9.** Mammal hybrids—Ursidae.

Genus	Species	Common Name
<i>Ailuropoda</i>	<i>melanoleuca</i>	Giant Panda
<i>Helarctos</i>	<i>malayanus</i> (1)	Sun Bear
<i>Melurus</i>	<i>ursinus</i> (1)	Sloth Bear
<i>Tremarctos</i>	<i>ornatus</i> (3)	Spectacled Bear
<i>Ursus</i>	<i>americanus</i> (2)	American Black Bear
<i>Ursus</i>	<i>arctos</i> (2)	Brown Bear
<i>Ursus</i>	<i>maritimus</i> (2)	Polar Bear
<i>Ursus</i>	<i>thibetanus</i> (1, 2, 3)	Asian Black Bear

(1) The Sun Bear has hybridized with both the Sloth Bear and the Asian Black Bear (Hennigan 2009).

(2) The Brown Bear has hybridized with the American Black Bear, Polar Bear, and Asian Black Bear (Hennigan 2009).

(3) The Asian Black Bear has hybridized with the Spectacled Bear (Hennigan 2009).

**Appendix 10.** Mammal hybrids—Equidae.

Genus	Species	Common Name
<i>Equus</i>	<i>asinus</i> (1)	Ass
<i>Equus</i>	<i>burchellii</i> (1)	Burchell's Zebra
<i>Equus</i>	<i>caballus</i> (1)	Horse
<i>Equus</i>	<i>grevyi</i> (1)	Grévy's Zebra
<i>Equus</i>	<i>hemionus</i> (1)	Onager
<i>Equus</i>	<i>kiang</i> (1)	Kiang
<i>Equus</i>	<i>quagga</i> (1?, 2)	Quagga
<i>Equus</i>	<i>zebra</i> (1, 2)	Mountain Zebra

(1) Crosses have been reported between the Ass and all other equine species. The cross between the Ass and the Quagga (now extinct) has been questioned (Gray 1972, pp.94–101).

(2) The Quagga has been involved other crosses that are not questionable according to Gray, including with the Mountain Zebra (Gray 1972, p. 112).

**Appendix 11.** Mammal hybrids—Tapiridae.

Genus	Species	Common Name
<i>Tapirus</i>	<i>bairdii</i> (1)	Baird's Tapir
<i>Tapirus</i>	<i>indicus</i>	Malayan Tapir
<i>Tapirus</i>	<i>pinchaque</i>	Mountain Tapir
<i>Tapirus</i>	<i>terrestris</i> (1)	South American Tapir

(1) Crosses have occurred between the Baird's and South American Tapirs at the San Francisco Zoo (Anonymous n.d.).

**Appendix 12.** Mammal hybrids—Rhinocerotidae.

Genus	Species	Common Name
<i>Ceratotherium</i>	<i>simum</i> (1)	White Rhinoceros
<i>Dicerorhinus</i>	<i>sumatrensis</i>	Sumatran Rhinoceros
<i>Diceros</i>	<i>bicornis</i> (1)	Black Rhinoceros
<i>Rhinoceros</i>	<i>sondaicus</i>	Javan Rhinoceros
<i>Rhinoceros</i>	<i>unicornis</i>	Indian Rhinoceros

(1) A hybrid between a white and a black rhinoceros has been confirmed (Robinson et al 2005).

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