Terrestrial Vertebrate Families on Noah's Ark

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Abstract

One of the central challenges faced by young-Earth creation researchers who believe the Bible to be the inerrant Word of God is defending the Biblical claim that two of every kind of *nephesh* animal was saved from the great flood on Noah's ark. Recently, *Answers in Genesis* became involved in the design and construction of a full-sized, authentic replica of Noah's ark. They have endeavored to be as accurate as possible in presenting the number of kinds that would have needed to be on the ark in order to have the diversity in species that we observe today. In order to expand creationist's understanding of the animal "kinds" and their relation to Noah's ark, this thesis 1) estimates a minimum number of 1438 animals, representing 719 terrestrial vertebrate families from Classes Mammalia, Aves, and Reptilia; and 2) describes many of the characteristics of those kinds which may have been on the ark. As a result, a better understanding of both the contents of Noah's ark and the meaning of the word *min* as it relates to the flood narrative are possible.

Terrestrial Vertebrate Families on Noah's Ark

The account of Noah's ark in Genesis 6-8 is one of the most widely known passages of Scripture. Children are taught the familiar tale of God's destruction of the earth with a global flood at a very young age in Sunday schools, and fanciful drawings of a small and often "cute" ark with human and animal heads popping out of the windows are a familiar sight to people of diverse beliefs and cultures. Much of the world calls this Biblical account a myth and instead believes the secular story of competition, survival, and extinction promoted through old-age geology and biological evolution. Moreover, skeptics assert that the ark is an impossible solution to the destruction of the world. Arguments are often repeated against the possibility of one boat carrying two of every terrestrial animal species alive today. Noah's ark, however, was a massive structure that had the ability to hold many different animals of different shapes and sizes, and the feat of carrying two of every terrestrial animal becomes more feasible when considering the taxonomic data that evolutionists and creationists alike have been collecting. By looking at the same data that evolutionists use to compare close "relatives" among species, a creationist and believer in the global flood can gain a more realistic number of animals that would have been needed on the ark.

Here I present data that have been collected from primary and secondary sources in a manner that will further the research on the number of animals that would have needed to be on the ark. The research was performed by using one of the most complete taxonomical records to date of both extinct and extant vertebrates that is found in the book *Vertebrate Paleontology and Evolution* by Robert Carroll (1988). While many discoveries have been made since the compilation of this record, the comprehensiveness of the listing was the best for the purpose of this research. This text, as well as other sources on mammals, birds, the dinosaurs, and other extant and extinct organisms, was used for an estimation of the number of terrestrial vertebrates that would have been housed on the ark, and to serve as a guideline for descriptions of the lesser-known extinct animals. First the background of this study (and past ark research) will be presented, and then the description of the groups of animals that were possibly on the ark along with the number of terrestrial families in each category will be discussed.

Statistics of the Ark and Flood

To preface the presentation of research results and an overview of the types of animals that would have been on the ark, the size and feasibility of the ark is an important foundational issue. In order to defend the possibility of an ark being built for a flood of global magnitude, Biblical apologists have taken the information that is found in the book of Genesis and translated the data into modern terminology. For example, according to the text in Genesis 6, the ark was 300 cubits in length, 50 cubits in width, and 30 cubits in height. Since this measurement system is no longer employed, the statistics must first be converted so that their meaning becomes clear. The Scriptural account provides the details in a manner that the people of the time were able to understand.

In order to provide contextual data for the research that was performed, a brief survey of the studies performed on the ark's specifications is needed. Whitcomb and Morris (1961) provide numerous detailed arguments for the accuracy of the Biblical account of the flood by looking into the size of the ark and the possibility of an ark of such proportions being built by a few people without modern technological aids. The text shows that there are several different modern lengths that can be attributed to the word cubit that is used in Genesis 6:15. The lengths noted range anywhere from 17.5 inches to 20.65 inches. Another study into the size of the ark has shown that other structures, such as Solomon's temple, that were made according to the specifications of God used the "long cubit" which is between 19.8 and 20.6 inches (Lovett & Hodge, 2010, p. 26). In order to avoid criticism alleging that the estimate of the size of the ark is too large, the calculations were done using the smaller cubit size of 17.5 inches (Whitcomb & Morris, 1961). The main concern for the animals that were to be put on the ark would have been the amount of room that they had in the form of surface area and volume. These measurements were estimated to be about 95,700 square feet for the surface area of the three decks, and a volume of approximately 1,396,000 cubic feet (1961). This massive floating structure would have been able to hold a very large number of animals.

Further recent research into the size and shape of the ark has shown that the ark was also very seaworthy despite its large size. In fact, the dimensions are very similar to modern cargo ships (Lovett & Hodge, 2010). The balance of the dimensions between stability, comfort, and strength insinuate that the dimensions are based on a well-engineered design rather than folklore. The ship would have been able to withstand high waves, and with a possible modification of a keel and wind sail, the ship could have oriented itself with the wind in order to hit the waves in a smoother fashion (2010). The ark was not a wooden box that would have been a danger to the inhabitants, but was a rather well built and safe sea vessel that may have been a precursor to other ancient ship designs.

Previous research suggests that the ark not only could have fit a large number of animals, but also that there would have been enough extra room to store the needed water and food that Noah's family needed for their own sustenance as well as that of the animals. Woodmorappe (1996) performed a feasibility study of Noah's Ark in which he performed detailed evaluations about whether the ark could have held and supported the ancestors of the variety of life we see today, as well as if such few animals could have repopulated the world. Many of the current creation researchers agree that both scriptural and biological evidence show the identity of the meaning of created kind to be somewhere around the family or subfamily level for most species (Jones, 1972; Scherer, 1993). This greatly narrows down the number of animals that would have needed to be on the ark. In fact, some believe the number to be as small as 2000 animals (Woodmorappe, 1996).

Woodmorappe (1996) also showed that even if the created kind is found to be equal with the genus level, there would still be enough room on the ark for every animal; especially if juveniles were used to save space. In fact, his generous estimate of 16,000 animals (8,000 pairs) was still feasible, although conditions would have been crowded and difficult for the inhabitants of the ark. Furthermore, even with the estimate of 16,000 animals, the space needed of the three floors of the ark would have only amounted to about 50% of the total space (1996). This leaves sufficient room for food and water storage as well as room for Noah and his family.

Duration of the Flood

Even with enough space on the ark, an extended period of time in those conditions would have been quite difficult. Furthermore, in order for animals that are semiaquatic to survive without needing the shelter of the ark, the duration would have needed to be within the correct time frame which would vary considerably among groups.

Studies have been performed into the duration of the flood, which provide information on the length of time that the occupants of the ark would have needed to be in the safe confines of the structure. The passage in Genesis 7-8 describes the amount of time, including the days of months, over which the flood occurred. The flood began on the seventeenth day of the second month of Noah's six-hundredth year of life and he left the ark on the twenty-seventh day of the second month of Noah's six-hundred and first year of life (Genesis 7:11 and 8:14, NASB). According to Snelling (2009), who uses Whitcomb and Morris (1961) as a model, a look into the biblical account of the flood shows that from the time the waters began to fall and the door of the ark was shut, to the time God told Noah it was safe to leave the ark, 371 days had elapsed. This time period, the text states, can be broken into two sections which can be simply summarized as the waters rising to remain at flood level, and the waters receding enough for the animals to be able to exit the ark. For the first 150 days, the waters rose and "prevailed" on the earth. For the following 221 days, the waters receded to the extent needed for the repopulation of the earth. After this, the process of diversification that was possible due to the animal kinds who were on the ark was able to begin, and the new earth was ready to sustain life once more.

Meaning of the Word *Min*

In order to look further into the number of kinds of animals that would have needed to be on the ark, and a description of these kinds, the meaning of the Hebrew word *min*, which is translated "kind," must first be understood. This research of semantics affects the creation-based biological approach termed baraminology, the study of the relationships of animals in terms of kinds, which finds its root words from *bara* (create) and *min* (kind). The meaning of *min* can be simply defined as kind, and some literal translations of the word can sometimes go as far as to say species. The term species was originally used because it is Latin for "kind." However, since species is a concept that was created by human reason in the 18th century, the word *min* cannot be defined by the word species. As Ernst Mayr said of the differing opinions of how a species is determined, "It may not be exaggeration if I say that there are probably as many species concepts as there are thinking systematists and students of speciation" (Mayr, 1942, p. 115). While Mayr attempted to create a systematic concept of species differentiation which is widely used today, an exact definition of species has been disputed since its inception and is not agreed upon by either evolutionists or creationists.

The word *min*, while seemingly quite simple in its direct translation, raises many questions about what we can define as a kind in modern terms. This has been disputed and discussed amongst theologians and creationists for some time. The context of the word *min* that will be looked at is taken from the passage in Genesis 6:18-21:

> **18** But I will establish My covenant with you; and you shall enter the ark—you and your sons and your wife, and your sons' wives with you. **19** And of every living thing of all flesh, you shall bring two of every *kind* into the ark, to keep *them* alive with you; they shall be male and female. **20** Of the birds after their kind, and of the animals after their kind, of every creeping thing of the ground after its kind, two of every *kind* will come to you to keep *them* alive. **21** As for you, take for yourself some of all food which is edible, and gather *it* to yourself; and it shall be for food for you and for them. (NASB)

The word *min*, which is found in this passage translated as the unitalicized "kind," is the same Hebrew word that is used in the creation account to describe how God created every fish, bird, and land animal "after their kinds." The diverse number of species that we observe today is a result of differentiation and microevolution among the animals that God selected to represent their created kinds on the ark, and those other organisms (primarily marine) which survived the Flood.

One of the simplest ways of attempting to define the word *min* is what is known as a *cognitum* (Sanders & Wise, 2003). A *cognitum* is a concept that is created by people in attempting to group things together logically and not necessarily scientifically. The basis of this approach is that God used the term *min* because of the simplicity of its meaning. The definition of *min* is simply how the average person or "proto-scientific" person typically categorizes animals logically (P. J. Williams, 1997, p. 344). Sometimes the cognitum is more broad or narrow than what would define a *min*, but people usually classify animals in their own minds based on observable similarities and differences (Lightner, Hennigan, Purdom, & Hodge, 2011). To some extent, a *cognitum* is used by all scientists who attempt to classify an animal. Before doing a statistical analysis, they use their cognitive abilities to determine to which species the organism should be compared.

Determining the Level(s) of Baramins

Ernst Mayr's Biological Species Concept, which defined a species based on their reproductive abilities to produce a fertile offspring between other members of the group (Mayr, 1942), is similar to the concept that is used by many to determine what taxonomic range is included in a baramin (created kind). One such way to determine members of a baramin is by observing and recording the ability of two species to reproduce even if the offspring is sterile (Lightner, et al., 2011). According to Frank Marsh's (1941) definition of a created kind, "Two organisms are members of a kind if their germ cells will join in true fertilization" (p. 169). Furthermore, Siegfried Scherer (1993) noted that if two organisms are unable to meet the criteria described by Marsh, but they are both found to interbreed with the same third organism, all three are logically part of the same kind. These ideas and definitions were compiled by Todd Wood, et al., (2003) in their work entitled "A Refined Baramin Concept." In this article, the researchers compiled theories that had been made pertaining to baraminological research and used the theories to refine the meaning of baramin by focusing solely on similarities and theoretical baramin constructs based on these similarities (Wood, Wise, Sanders, & Doran, 2003).

A significant separation of two species from mating for a long enough period of time could lead to significant changes in DNA which would lead to sterility upon reproduction. Species are not generally defined in this manner because most taxonomists are attempting to identify or separate animals into new and different species. In contrast, creationists desire to see which species were able to mate with other species within the last few thousand years. Examples of the types of animals that could be combined into a baramin but are not defined as a species include some very familiar and some quite unique animals. Probably the most familiar example is used by Lightner, et al. (2011) to describe the complexities of reproduction between species in discussing the cross between a horse and a donkey to produce a mule. The resulting hybrid mule is usually sterile, but the cross-breeding demonstrates that donkeys and horses may have belonged to a single species at one point, but have diverged as a result of mutations and geographical separations since the flood. This phenomenon is also observable between cows and buffalo (beefalos), lions and tigers (ligers), and even marine iguanas with land iguanas (Alberts, 2004). Furthermore, some animals are able to mate, but after conception the embryo is unable to survive past a certain point. This is demonstrated by the example of a sheep crossed with a goat. While they are able to fertilize an egg, the resultant life is not able to fully develop (Kelk, Gartley, Buckrell, & King, 1997). Observations such as these show that many species are probably derived from each other, and hence may be in the same baramin, yet they are separate from other baramins because of significant morphological or other differences.

The problem with this definition of species arises when considering the separation into species of fossilized remains that have no scientific historical documentation as to how they mated and what they were actually like. This raises several problems for the taxonomical classification of dinosaurs and other extinct organisms. Through direct observations, creationists are able to determine whether a horse and a donkey would be able to reproduce. This can and does happen to produce a mule as has been shown for many centuries. A comparison of the bone structures of a horse, a donkey, and a mule, without the knowledge that we have concerning their mating habits would result in a conclusion of perhaps three different species of animal. However, the observations that we have show us that the two species and their cross are quite similar, and descended from the same created kind.

Observations concerning the possibility and vitality of offspring between two species are not possible from the fossil record. This limits the evaluations of baramins that are now extinct, both in terms of the number of now-extinct baramins and the number of extinct animals that would be a part of baramins (both extant and extinct). Any character data that have been collected do not give researchers an understanding of the behaviors and fertilization abilities of the organisms. Comparisons between dinosaurs, for example, are based solely on fossil data, which can give scientists an idea of how closely they are related to each other (from similarities in skeletal structure, for example), but are inherently more limited in classifying animals within species or baramins.

Baramin and Species Analyses

A specific example of several different specimens that can be placed into a baramin can be seen as a result of our knowledge of the domestication and artificial selection of dog breeds. An often used example by Ken Ham is the existence of speciation through mutations in dogs which cause them to have the massive variance that we observe today (Lovett & Hodge, 2010). According to Jensen (2007) dogs can trace their lineage back to wolves, and the different types of dogs that exist today are a result of domestication and selective breeding over thousands of years. Indeed, most dog breeds are even more recent, with lineages tracing back only to the late 18^{th} and early 19^{th} centuries in Europe. This genetic modification, which has been observed and duplicated by humans for thousands of years, is just one example of the kinds of diversity that can result from a single created kind in a relatively short amount of time.

Another example of several species that can be condensed into a baramin, or in these cases even a single species, has been found recently in studies of different dinosaur species and characteristics. As noted above, one obstacle to determining which groups of extinct animals are species or baramins is that one cannot observe the reproductive capabilities of fossilized skeletons. The characters can be observed and compared, but there is no way of knowing with certainty if an observed difference has been caused by speciation or by other morphological differences such as sexual dimorphism (different characters between genders of the same species) or ontogenesis (drastic changes in characters as a result of aging). Sexual dimorphism is observed in species alive today, such as *Odocoileus virginianus* (white-tailed deer), in which the males have antlers and the females do not. This change is observable since we can see the differences between a male and female deer and we have been able to study their entire anatomy. However, it is possible that other drastic changes could be observed and misinterpreted as different species if only the fossil remains are available when it is actually a single species with sexual dimorphism.

One of the dinosaurian examples of a possible single species being confused as several species is that of *Corythosaurus casuarius*. Peter Dodson, a paleontologist who has done extensive research into the morphology of both horned and duck-billed dinosaurs, has argued that several members of the same genus which were previously thought to be separate specimens are actually male and female morphologies of the same species. His argument is that many times sexual dimorphisms get lost in the attempt to use taxonomy and character analyses to classify fossils. Among his findings, females are usually similar to males, but males have certain characteristics that are more defined and elaborate (Dodson, 1975). From a creationist perspective, this argument not only lowers the total number of extinct species that are found in the record, but it also shows that without a living specimen, fossils may be difficult to define taxonomically. This happens not only with sexual dimorphisms, but also with age in ontogenesis.

An example of ontogenesis can be found in the bone structure of human beings throughout the life-span. Ontogenesis in human bone structure happens rather rapidly in children and adolescents and is not very noticeable as adults continue to age. Many minute changes in skull structure have been noted with age in both the spongy tissue and the compact bone structures. One example of this is noted in the facial structures of humans as they age. A recent study concluded that facial aging observed in humans is not just caused by changes in the skin, but also in the underlying bone structures of the face such as in the orbital and maxillary regions (S. E. Williams & Slice, 2010). If these minute changes happen in all humans depending on their life spans, then it is possible that changes may occur to the same or greater extent in other specimens.

An example of ontogeny from the animal kingdom is found in the bird known as the cassowary found in Australia. The discoverer of possible ontogenesis among dinosaurs, John Scannella, uses the cassowary as an example to show that some animals develop rather protrusive features later in development and this happens sometimes quite suddenly. Cassowaries develop a large bony head shield, which is the distinguishing feature of the bird, at the end of their adolescence and this characteristic is present in multiple varieties of cassowary (Romer, 1997). Had the cassowary been initially discovered as fossilized remains, the adolescent and adult varieties would have probably been classified as different species altogether.

Just as was mentioned above with the recent discoveries of genera that could be condensed from two or more species into a fewer number of species due to the presence of sexual dimorphisms, the same can be shown with ontogenesis. The goal of research done by John Scannella and Jack Horner was to investigate speculations that the ceratopsian genus *Torosaurus* was actually the more mature version of the well known genus *Triceratops*. Their research shows that after studying the fossil skeletons of many different specimens of *Triceratops* and *Torosaurus*, the defining characters of *Torosaurus* seem to be the result of ontogenesis in *Triceratops*. The lengthening of the frill and the forward turning of the horns in aging *Triceratops*, when continued, would result in the skull structure of *Torosaurus*. This theory is supported by evidence that more bone remodeling had occurred in *Torosaurus* than even the oldest of the *Triceratops* specimens (Scannella & Horner, 2010). This evidence shows that even some of the best known species of dinosaurs still have mysteries that can only fully be known if a living specimen were available for study. The actual number of species, genera, or even families may require additional re-analysis. However, the numbers can be estimated to an accurate enough value that will help further baraminological research in conjunction with Noah's ark.

Description of Extinct and Extant Vertebrates

Following the above excursions into the biblical and scientific issues surrounding the understanding of animal "kinds," I return to the primary task of this thesis: an estimation of the number of organisms carried aboard Noah's ark. In the following sections, details are given for groups of animals that may have been present on the ark. Most of these descriptions group similar families that are typically allied at the ordinal level, while some of the more interesting varieties will be described at the family level. A full list of the families mentioned is provided in the appendix. This list has been derived mainly from Carroll (1988) with a few recent discoveries being added.

The focus of the tabulation will be on the families within the classes Mammalia, Aves, and Reptilia. According to the text of Genesis 7, God brought to Noah two of every kind of beast, cattle, creeping thing, and bird and they were put on the ark (vs. 13-14).

This includes all of the animals that are air breathing and land dwelling. Amphibians are not included in this list because of their ability to survive on land and in the water. At least a period of each amphibian's life takes place in the water and each would have had the ability during that stage of life to survive the flood. Furthermore, fish would have been able to survive the flood because of their ability to extract oxygen from water, thus excluding them from the air-breathing animals on the ark. According to Whitcomb and Morris (1961), the extent of the death caused by the flood included every air-breathing animal except those that were placed on the ark. The animals that are included in the description and tabulation may not be completely up to date and accurate due to the ever-changing process of the classification of animals, but the main goal is to attempt to estimate what animals were included in the beasts, cattle, creeping things, and birds.

Class Mammalia

Order Monotremata. Within this order are two families that include the modern platypus and echidna. These families are a few of the extant non-eutherian mammals. These unique animals, especially the platypus, have left evolutionists unable to determine how they evolved (Lillegraven, 1979), which is expected if they were created kinds and here supports the "kind" defined at the level of family.

Order Triconodonta. Triconodonta is a group of five families that is typically viewed by evolutionary paleontologists as some of the earliest mammals. These families are grouped together based on their unique jaws and teeth. They share the characteristic of molars with a tricuspid alignment. The most well known example of a triconodontid is the now-extinct *Morganucodon* who is typically considered (in old-Earth views) as the most primitive mammal (Lillegraven, 1979).

Order Docodonta. This order is not very diverse or well known, but it can be separated from other orders based on its molar teeth structures. The order is only made up of one family, Docodontidae (Carroll, 1988).

Order Multituberculata. These specimens are a part of the subclass Allotheria. There are estimated to be 14 families within Multituberculata. They are named for their unique teeth which have multiple "tubercles," and were mostly about the size of a rat. The members of this order of mammals are all extinct and many of them lived in North America. The largest of the multituberculates was known as *Taeniolabis*, and was about the size of a beaver. These types of mammals probably ate mostly plants but some may have been partially carnivorous (Janis, Gunnell, & Uhen, 2008).

Order Symmetrodonta. Once again, these mammals are named for their tooth structures since they have almost symmetrical upper and lower molars that have a unique triangle shape. Three families are recognized within this group. This order, much like the rest of the orders discussed thus far, were small (rodent sized). The most well known genus within the symmetrodonts is *Spalacotherium*. All members of Symmetrodonta are extinct (Carroll, 1988).

Order Eupantotheria. Eupantotheria, another group of mammals recognized by their jaws and teeth, contains 4 known families. These mammals are known for significantly wider upper than lower teeth and a similar triangular shape as that of symmetrodonts. Many of these species are only known from the jaws and teeth that have been found. One of the known specimens is *Amphitherium* (Carroll, 1988).

Theria of Metatherian-Eutherian Grade. Some families are related informally to each other in different kinds of assemblages, especially if little is known about their morphology. Three families are grouped together and known as "theria of metatherian-eutherian grade." These mammals cannot be classified as either marsupials or placentals and are thus described separately. *Deltatherium* is one of the most well known of these families and has been described based on a nearly complete skull found in Mongolia (Carroll, 1988). The skull structure sets these mammals apart from others of similar size and shape.

Order Marsupalia. It is thought by evolutionists that marsupials and placentals evolved around the same time from a common ancestor in the therians of metatherian-eutherian grade, likely during the Cretaceous period, because of their distribution patterns in the late Cretaceous. Within this order can be found, according to Carroll (1988), 29 different families. Marsupials are distinguished from placentals in the fossil record due to the reflected angular processes on their jaws (Carroll, 1988). In modern marsupials, the presence of a pouch and the very early developed state of newborns is the main distinguishing characteristic. In the Americas, one of the most common marsupials is the opossum, from the Family Didelphidae. In Australia, one of the most recognizable marsupials is the kangaroo from the Family Macropodidae.

Order Apatotheria. This order is comprised of one family, Apatomyidae, and begins the classification of mammals known as Eutheria. Little is known about these mammals but they have been described and characterized in Janis, et al. (2008) to some extent as having a lack of an ossified bulba in its cranium and a grooved astragalus in its legs. The exact ordinal location of this family is still disputed as can be seen in the discrepancies in the classification location between Carroll (1988) and Janis, et al. (2008).

Order Leptictida. This order is known mostly from jaw and skull remains, but some complete skeletons have been discovered. There are three families listed within this order that share some characteristics. One such of these characteristics is that of a triangular exposure of the parietal bone of the skull on the occipital surface of the skull (Carroll, 1988). One genus, *Leptictis*, is thought to have been insectivorous and the families may need to be classified in a different order altogether due to its similarities to other insectivoran mammals such as their dentitions (Janis, et al., 2008).

Orders Pantolesta, Scandentia, Dermoptera, and Macroscelida. These groups are quite different orders that do not have much diversity within their families. Pantolesta contains an estimated three families and they are known from the representative genus *Pantolestes*. These mammals may have been semiaquatic and they appear to be predominantly piscivorous (Carroll, 1988). Members of the order Scandentia are known as tree shrews such as the living *Ptilocercus*. Scandentia contains one family, and is comparable to squirrels in size and ecology, but they are distinct in characters from any other order. Order Dermoptera is made up of four families and is known as the flying lemurs because of the presence of a gliding membrane that connects the limbs to the tail. The living genus, *Cynocephalus*, is similar in appearance to lemurs (Carroll, 1988). Finally, Macroscelida consists of one family of small mammals that live in Africa and are known as elephant shrews (Carroll, 1988).

Order Insectivora. One of the most diverse mammalian orders is Insectivora. There are 14 families estimated to be within the Insectivora and one more family that is unnamed. A familiar family within this order is that of Erinaceidae, best characterized by the living genus of European hedgehog, *Erinaceus*. Shrews, from Family Soricidae, are also members of Insectivora. Some of these small mammals have the ability to secrete an immobilizing toxin (Janis, et al., 2008). One way to define this order is by the characteristics of a small body, eyes, ears, and brains, along with elongate snouts. The insectivores are also similar in their dental patterns which allude to their diet on insects. Many of the other families within Insectivora are loosely related and do not share many of the same characters (2008).

Orders Tillodontia, Pantodonta, Dinocerata, and Taeniodontia. Carroll (1988) mentions these four orders as those that represent the mammal radiation. This is viewed in evolutionary terms, but the similarities of the orders are still notable. Altogether, 14 families belong to these orders and have quite different characteristics. Some of the taeniodonts are compared to the living opossum but are slightly larger in size. They may have climbed and burrowed to an extent as well. Tillodontia and Pantodonta are known for their larger builds and herbivorous diets. They ranged from the size of a rat to the size of a rhinoceros. Furthermore, the Dinoceratans were the most unique in that they were rather large in size and had a skull with many bony protuberances (Carroll, 1988).

Order Chiroptera. Chiroptera, otherwise known as bats, is one of the most diverse orders of mammals. It is made up of 11 different families that are quite separate from other families of mammal due to one key feature. The distinct characteristic of this order is their ability of powered flight. They are also typically insectivorous and nocturnal (Janis, et al., 2008). The bats are divided into Megachiroptera and Microchiroptera. Megachiropterans, known as fruit bats, are represented by one family, Pteropodidae. They are separated from the ten families of microchiropterans who are known for their insectivorous diets and use of sonar to hunt their prey (Carroll, 1988).

Order Primates. Order Primates contains 26 families and includes species as diverse as lemurs to humans. We are able to definitely distinguish one baramin in this order due to the specificity of the Bible when it says that Noah and his family, who were humans, were saved from the flood. The other members of this order are known due to their relatively large braincases and the uniqueness of their dental patterns (Carroll, 1988).

Orders Creodonta and Carnivora. Surprisingly, there are only two orders that contain the carnivorous terrestrial mammals. These include the orders Creodonta and Carnivora. The extinct Creodonta was made up of animals from the size of a small cat to that of a lion (Janis, Scott, & Jacobs, 1998). The two families within the order share a distinction from Carnivora due to the location in the jaw of shearing teeth, known as carnassials, and the absence of crushing or grinding teeth. Carnivorans have these grinding surfaces in their mouth and are represented by many living species. The 10 terrestrial families are diverse in size and features and range from coyotes and wolves, to weasels and snow leopards, and all other living terrestrial carnivorous mammals (Carroll, 1988). Within the family are five semiaquatic families that include animals such as seals and walruses, which can stay in water as long as they do not need to molt, mate, or give birth. These animals should have been able to survive the flood due to their reliance on sea life for food and the appearance of the mountain tops at day 224, which was 147 days before the end of Noah's time on the ark (Whitcomb & Morris, 1961). The mountain tops would have been sufficient enough for the semiaquatic organisms to return to land to meet their terrestrial needs, especially given many species' preference for rocky coastal areas.

Orders Anagalida, Rodentia, and Lagomorpha. These three orders are often compared to each other. This is due to their relatively small size and similar herbivorous diets. The first, Anagalida, is made up of 4 families and was once mistaken for tree shrews due to limited fossil knowledge of the extinct animals. Once again, the order is distinguished mostly by their jaw structure and the worn teeth that may have been caused by dirt from digging for food (Carroll, 1988). Rodentia is the most diverse of the mammalian orders. Most are small, but some can be large such as the extinct *Eumegamys*. Rodents are divided into four main subgroups due to their differences in jaw musculature and the configuration of the jaw and skull as a result. The "primitive" rodents share either the characteristic protrogomorphus pattern of jaw muscles, seen in the extinct Paramyidae, or the sciuromorphous pattern, seen in Sciuridae (squirrels). Porcupines have the jaw pattern known as the hystricomorphous condition while rats and mice have the myomorphous condition of jaw muscles. Rodentia is comprised of 48 different families (Carroll, 1988). This makes the number of animals on the ark jump rather drastically; however, due to the small size of most of these mammals, like mice and rats, they would have been housed easily. The Lagomorphs are well known from their living members, the rabbits and hares. The order is divided into two families, and the diversity of this order is much greater in the fossil record than today (Carroll, 1988).

Order Condylartha. The extinct order of Condylartha has the characteristic of containing both omnivores and herbivores. The diversity of this order is shown by the presence of ten different families within the order. The earliest of these animals is *Protungulatum* and is distinguished, like the rest of the order, by jaw and tooth patterns as well as the evidence of a unique diet of insects and plants (Carroll, 1988). The uniqueness of the families suggests that the order could not be grouped more closely as a baramin as may be possible for some other orders.

Ungulates. The next large classification of mammals is the ungulates, which are identified due to their hooved toes. Many orders are included in or compared with the ungulates. The first, and most diverse, of these is Order Artiodactyla. The 31 families show a wide ranging variety of characters and sizes that can be seen in the large number of extant genera (Carroll, 1988). These animals have a long history of domestication and were an important part of the survival of the human race. The types of animals range from a hippopotamus to a giraffe and share the characteristic of having an even number of hooved toes. Certainly many of the baramins within this order that were taken on the ark would have been distinguishable, as would the size of their living space allotments. Giraffes are a part of the artiodactyls, as well as Hippopotamuses which shows that some of the areas needed to be either high or wide (though some fossil species of both of these groups were smaller than extant members, reducing the needed space on the ark). The family Merycoidodontoidae contained animals that were about the size of pigs. Also, Family Antilocapridae is represented today by the pronghorned antelope. The artiodactyls also include camels (Camelidae), and mountain goats (Bovidae). The extinct Order Mesonychia resembles ungulates in almost every way, but the sole family was made up of likely carnivorous mammals (Carroll, 1988).

Orders Perissodactyla and Proboscidea. Another ungulate order is Perissodactyla, which is identified by an odd number of hooved toes. The 15 families of the order are slightly less diverse than that of the Artiodactyla but still contribute to the vast diversity of medium to large mammals we see today. Perissodactyla is comprised primarily of animals that are similar to horses, tapirs, and rhinoceroses (Carroll, 1988). The elephants are a part of a separate order of ungulates known as Proboscidea. The African and Asian elephants, along with Pygmy elephants, are the only living species from this unique order, although at one time there was a diversity of eight different families (1988).

Orders Desmostylia, Hyracoidea, Embrithopoda, and Tubilidentata. The next four orders are not very diverse; however they have quite unique features that separate them from each other. The first, Desmostylia, is comprised of one extinct family that may have been a marine mammal. This is thought due to its paddle like hands and feet and location in marine deposits (Carroll, 1988). Members of the Hyracoidea, of which there are three living genera, are rabbit-like in appearance and belong to two families. Embrithopoda is an order that is comprised of one family in which is found an extinct animal that is similar in size and shape to an elephant yet different in skull structure, *Arsinoitherium*. The skull contains four bony processes, two large and two small, on the face of the animal much like a rhinoceros. Lastly, Tubilidentata, an order which includes the modern aardvark, is made up of one family whose members are known for their digging ability and insectivorous diet (1988).

Orders Notoungulata, Litopterna, and Xenungulata. Continuing the line of ungulate orders is the order Notoungulata. These extinct animals are found in South America and share the character of a unique and particular pattern of molar cusps. The 14 families are different in body forms from each other, and size ranges from rabbit sized to hippo sized (Carroll, 1988). Animals in the order Astrapotheria are an extinct group of animals divided into two families. The skulls were domed in appearance and their bodies were up to three meters in length. Members of Order Litopterna are split into 4 families, all of which are extinct. Some families were horse-like while others were camel-like in appearance. Order Xenungulata is native to South America, and it is comparable to many other orders from other continents. The extinct order, which is made up of one family, is distinguished by its unique combination of teeth as compared to other orders. Another extinct order of ungulates is that of Pyrotheres. The order contains two families that have long and large bodies with limbs similar to elephants. The skull also had tusks and teeth that are reminiscent of elephant features (1988).

Orders Xenartha and Pholidota. The final two orders of mammals are grouped together as edentates, or toothless mammals. The first is order Xenartha, which is made up of 11 different families. This order has many living examples such as the sloths, anteaters, and armadillos. These animals appear quite different, but they all share the characteristics of a similar pelvic girdle. Also, they each have unique characters and behaviors such as the armadillo's armor and the tree sloth's inability to hold itself up while walking on the ground. Finally, the Pholidota is an order that is made up of one family and has seven living species of pangolins today. These mammals often live in trees but most of them also have limited subterranean abilities that they use to scavenge for food (Carroll, 1988).

Of the many families within the Infraclass Eutheria, three families cannot be placed into orders. One of these families remains to be named and thus is not completely defined (Carroll, 1988). These families are reminders of the difficulty of placing extinct vertebrates into defined taxonomic classifications due to the lack of knowledge of their physiologies.

Class Aves

The animals that are classified as Aves, or birds, are divided into two subclasses and four main superorders that will now be discussed in brief detail. Two of the bird families belong to Subclass Archaeornithes. Perhaps the most primitive of the birds is Archaeopteryx of Family Archaeopterygidae. While the classification of this bird has proven to be difficult for paleontologists, it is generally accepted as a part of class Aves. Archaeopteryx is known for its teeth, S-curved neck, and long bony tail. A further example of an extinct family of birds that has only been known for a few decades is Confusciusornithidae. Their fossilized remains, which range from about the size of a starling to a rook, are widely found throughout China and have the characters of a horned beak with large nostrils (Benton, 2005).

The rest of the bird families belong to Subclass Neornithes. Superorder Odontognathae is broken up into two orders, Hesperornithiformes and Icthyornithiformes that contain three and one family respectively. These extinct birds are named due to the presence of teeth in their jaw. Some of the unique characteristics of the families in this superorder are the absence of wings altogether in some species as well as the marine location of the majority of the fossils. This seems to suggest that *Hesperornis* was a diving bird that used its feet as paddles as it hunted for food (Carroll, 1988). Two other extinct orders of birds belong to a superorder classified as incertae sedis (uncertain placement). Being made up of 3 different families, this group of birds is not very diverse and in only known from *Gobipteryx* and *Enantiornis*. These species were able to fly, unlike the previous superorder, and they shared the characteristic of having teeth (1988).

The remaining birds to be discussed are classified into two other superorders of which there are living examples. The first of these is the Superorder Palaeognathae. This group is distinguished by a palate that is much more immobile than other birds. There are five orders of Palaeognathae that contain living specimens, and of these five orders only one has the ability to fly. This order, Tinamiformes, is made up of only one family and is the only bird order in Palaeognathae that is not classified as a Ratite. The remaining four extant orders and two extinct orders classified as ratites, and are flightless birds with the same characteristic palates. The eight total orders contain 11 total families. Some of the living representatives of this superorder are rheas, cassowaries, emus, kiwis, and ostriches (Carroll, 1988).

The final superorder of birds is the largest in both diversity and number of families. This group, Neognathae, is characterized by its more mobile palate structure and contains mostly flying birds. All remaining extant species of bird and many more extinct species are found within this large superorder. In fact, the group is made up of 24 different orders and an estimated 121 families. One of the more notable orders that show the diversity of Class Aves are the pelicans, or Pelecaniformes, of which there are 7 families that have long beaks with throat pouches, and can stay in flight for extremely long periods of time. On the opposite side of the Aves spectrum is the penguins (Spenisciformes), which are unable to fly in the air, but have large flight muscles that give them the ability to fly underwater (Carroll, 1988).

Class Aves also contains a large diversity in the relative sizes of birds today. For example, the largest living bird, according to wingspan of around ten feet, is the wandering albatross from Family Diomedeidae. This bird spends most of its life at sea so it may have actually been able to survive the flood without the aid of the ark, along with other members of the four families within Order Procellariiformes. The group of birds containing the world's smallest members, Family Trochilidae, is known as the hummingbirds (Carroll, 1988). The hummingbirds surely would have needed to be on the ark, but they would have taken up little space compared to some of the other avian varieties listed in the appendix.

Class Reptilia

Class Reptilia is divided into 4 subclasses, three of which are based on skull structure and the other being the unique subclass of turtles, or Testudinata. This section will deal briefly with the major characteristics of each subclass and will focus on the characteristics of the different dinosaur orders and families due to skepticism that exists against the ark being able to hold dinosaurs. The diversity of the reptiles is profound and little is known about the actual relations of many of the dinosaurs, but a brief overview will establish an estimated number of reptiles that would have needed to be carried on the ark.

To begin with, in order to eliminate the reptiles that were not on the ark, the marine reptiles are addressed first. The first of these is found in the single family from the Order Mesosauria in the Subclass Anapsida. Within the Subclass Testudines is the order Chelonioidea, known commonly as the sea turtles. To this order belong six families which can be eliminated from the ark. The next order to be eliminated due to its marine lifestyle is that known as Thalattosauria, which contains three families. Furthermore, the family Mosasauridae was composed of completely marine reptiles as part of the squamate order. The sea snakes are found in the family Elapidae, within the Suborder Serpentes.

Also, the Superorder Sauropterygia contains the Nothosauria and Plesiosauria which can be set aside as ten families of marine reptiles. The marine crocodile-like reptile families known as Teleosauridae and Metriorhynchidae are also excluded from the ark. The four families that are a part of Placodontia were also marine and thus able to survive the flood without the aid of the ark (Carroll, 1988). Finally, the nine families within the Order of Ichthyopterygia were marine animals that resembled fish or dolphins in their outward appearances, especially their thunniform body shape (Benton, 2005). These families, while quite diverse, all share the ability to survive in marine environments for an extended period of time.

The first terrestrial reptiles discussed are the Subclass Anapsida. These reptiles all share the characteristics of not having any temporal fenestrae (Benton, 2005). To this subclass belong two orders, Captorhinida and Mesosauria (already eliminated because it is aquatic). Of the Captorhinida, 11 families have been distinguished including some that are very unusual in appearance such as Pareiasauridae. These reptiles had a wide and relatively flat skull with several bony knobs on different parts of the skull (Carroll, 1988).

The subclass Testudinata is made up of 22 extant and extinct terrestrial families. The characteristics of turtles are easily recognizable as they have a hard carapace, or shell, on their backs that is a part of their skeleton, and a plastron on their underside (Benton, 2005), except for in the aquatic family Odontochelyidae which only possesses a plastron. The differences in the kinds of turtles is usually determined by differences in skull, neck, or shell structure (Carroll, 1988).

The third and largest subclass of the reptiles is that of Subclass Diapsida. These reptiles are grouped together due to the presence of two temporal fenestrae in their skulls

(Benton, 2005). The animals in this subclass are very diverse, which is seen in that all extant reptiles, except for the turtles, have a diapsid skull condition. The first four terrestrial orders are extinct among the diapsids. These orders are Araeoscelida, incertae sedis, Choristodera, and Eosuchia. Eleven families are classified under these orders and are each diverse with relatively little known about their structures (Carroll, 1988).

Reptiles belonging to the superorder Lepidosauria include most of the living species of reptiles we see today. The first of these are those belonging to the order Sphenodontida of which the only surviving genus is *Sphenodon*, or the tuatara. Originally, there were three families within the Sphenodontida class. The rest of the Lepidosauria belong to the order called Squamata. This includes all of the lizards and snakes that we see today. Lizards are classified as part of the Suborder Lacertilia, while Snakes are classified according to the Suborder Serpentes (Carroll, 1988). Lacertilia is divided into 38 terrestrial families and Serpentes is divided into 17 terrestrial species. This would make up much of the diversity on the ark as far as reptiles are concerned and results in the diversity that we know today.

Continuing in the diapsid skull condition is the Infraclass Archosauromorpha. Within this group are the three orders that are similar to crocodiles, dinosaurs, and pterosaurs, yet they contain five families that are not classified as a part of any of those groups. These orders, Protorosauria, Trilophosauria, and Rhynchosauria are unique from the previously mentioned groups because they have characteristic thecodont, or socketed, teeth as well as other important Archosauromorph features (Carroll, 1988).

The Superorder Archosauria includes all modern crocodiles as well as extinct crocodiles, dinosaurs, and pterosaurs. Altogether, the Archosauria contains 94 different terrestrial families. Of these there are 28 different terrestrial families within the Order Crocodylia, nine within Order Pterosauria, and 44 different families of dinosaurs (Orders Saurischia and Ornithischia).

The dinosaurs are classified into two orders due to their differences in pelvic girdle structure. Example of Saurischian dinosaurs would be the carnivorous *Tyrannosaurus* of the family Tyrannosauridae (Suborder Theropoda), or the immense, long-necked *Brachiosaurus* of the family Brachiosauridae (Suborder Sauropodomorpha). One of the families that was mentioned in the above discussion of morphological differences among dinosaurs was that of Ceratopsidae, which is a part of the Order Ornithischia (Carroll, 1988). Other ornithischian dinosaurs include the heavily armored *Ankylosaurus* (Family Ankylosauridae) and the hard headed *Pachycephalosaurus* (Family Pachycephalosauridae) (Benton, 2005).

The final subclass of the Class Reptilia is Synapsida, which is characterized by the presence of a single temporal opening in the skull between the jugal, postorbital, and squamosal bones (Benton, 2005). This subclass includes 55 families of extinct reptiles. Some of these animals, such as those belonging to the order Pelycosauria have very unique neural spines that form a sort of sail on their backs. Others, such as those belonging to the suborder Cynodontia had large canine-like teeth and were very heavily built (Carroll, 1988).

Other members of Synapsida are the cynodonts which include a variety of ten different families. Research shows that many of the skull features of the cynodonts are similar to mammalian characters including the enlarged nasal bone and flaring zygomatic arches. Evolutionists interpret these similarities as evidence for a relation between the two groups. Also, the members of Suborder Gorgonopsia are carnivorous and had long fangs and a large range of jaw motility which made it possible for them to feed on thick-skinned prey (Benton, 2005). These reptiles show that a large amount of diversity would have needed to be on the ark, but none of these wide ranging synapsid reptiles are alive today.

Conclusion

The previously described orders, families, and other classifications serve as an imperfect frame of reference for researchers, from creationists to evolutionists alike, in their attempts to put order to the vast diversity that we see before us in the animal kingdom. The taxonomic locations of the vertebrates have changed and will continue to change as more information is discovered and presented, so the exact number of created kinds and the exact number of ark kinds will not be able to be precisely determined. Especially due to the limited knowledge that we have of certain extinct species, an approximation, using the family as a proxy for the "kind," is the most useful and feasible.

The results of the estimation that was completed show that as of the 1988 list of genera, there were approximately 719 families within the classes of Reptilia, Aves, and Mammalia that would not have been able to survive the global flood without the aid of Noah's Ark. Of these families, 139 belonged to Class Aves, 259 belonged to Class Reptilia, and 321 belonged to class Mammalia. Within Class Reptilia, 37 of the families listed by Carroll were excluded due to their aquatic abilities. Within Class Mammalia, 29 of the families were excluded due to their aquatic abilities. This estimation shows that, assuming each animal had at least two of every kind on the ark, a minimum of 1438 animals would have needed to be on the ark. This does not include the extra animals that were brought onto the ark according to the specifications that God had given Noah.

This process of estimation serves its purpose well, however, as the amount of room for error that has been allowed by the ark feasibility studies of Woodmorappe (1996) shows that a number much greater than the number of families and subfamilies would have been able to fit on the ark. Furthermore, evidence like that presented by Dodson (1975) and Scannella and Horner (2010) challenge the assumptions that have stood for decades about the classification of extinct animals and reveal a need for reevaluation of certain defined species. The research presented here clearly demonstrates that an ark as described in the Bible could easily contain the number of animals estimated here. If the family closely approximates the "kind," then the number of organisms contained is even less than previous estimates.

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Appendix

List of Terrestrial Vertebrate Families

* marine, and not included in tally of ark-borne families

Class Reptilia
- **Subclass Anapsida**
  - **Order Captorhinida**
    - **Suborder Captorhinomorpha**
      - Protorothyrididae
      - Captorhinidae
      - Bolosauridae
      - ?Batropetidae
      - Acleistorhinidae
    - **Suborder Procolophonia**
      - **Superfamily Procolophonoidea**
        - Nyctiphruretidae
        - Procolophonidae
        - Sclerosauridae
    - **Suborder Pareiasauroidea**
      - Rhipaeosauridae
      - Pareiasauridae
    - **Suborder Millerosauroidea**
      - Millerettidae
  - **Order Mesosauria**
    - Mesosauridae*
- **Subclass Testudinata**
  - **Order Chelonia**
    - **Suborder Proganochelydia**
      - Odontochelyidae*
      - Proganochelyidae
      - Proterochersidae
    - **Suborder Pleurodira**
      - Pelomedusidae
      - Chelidae
      - Platychelyidae
      - Eusarkiidae
    - **Suborder Cryptodira**
      - **Superfamily Baenoidea**

Glyptopsidae
Baenidae
Neurankylidae
Meiolaniidae

Superfamily Trionychoidea

Kinosternidae
Dermatemydidae
Carettochelyidae
Trionychidae

Superfamily Chelonioidea

Plesiochelyidae*
Protostegidae*
Toxochelyidae*
Dermochelyidae*
Cheloniidae*
Thalassemyidae*

Superfamily Testudinoidea

Chelydridae
Emydidae
Testudinidae

Chelonia Incerte Sedis

Sinemydidae
Kallokibotiidae
Pleurosternidae
Chelycarapookidae
Family Undesignated

Subclass Diapsida

Order Araeoscelida

Petrolacosauridae
Araeoscelididae

Order Incertae Sedis

Mesenosauridae
Coelurosauravidae
Drepanosauridae
Endennasauridae

Order Choristodera

Champsosauridae

Order Thalattosauria

Thalattosauridae*

Askeptosauridae*
Claraziidae*
Infraclass Lepidosauromorpha
Order Eosuchia
Acerosodontosauridae
Younginidae
Tangasauridae
Galesphyridae
Superorder Lepidosauria
Order Sphenodontida
?Gephyrosauridae
Sphenodontidae
Pleurosauridae
Order Squamata
Suborder Lacertilia
Infraorder Eolacertilia
Paliguanidae
Kuehneosauridae
Fulengidae
Eolacertilia Incertae Sedis
Infraorder Iguania
Euposauridae
Arretosauridae
Iguanidae
Agamidae
Chameleontidae
Infraorder Nyctisauria (Gekkota)
Ardeosauridae
Bavarisauridae
Gekkonidae
Pygopodidae
Infraorder Leptoglossa (Scincomorpha)
Paramacellodidae
Xantusiidae
Teiidae
Scincidae
Lacertidae
Cordylidae (Gerrhosauridae Zonuridae)
Dibamidae

Infraorder Annulata (Amphisbaenia)

Oligodontosauridae

Amphisbaenidae

Rhineuridae

Hyporhinidae

Bipedidae

Trogonophidae

Infraorder Diploglossa (Anguimorpha)

Superfamily Uncertain

Paravaranidae

Bainguidae

Superfamily Anguoidea

Anguidae

Anniellidae

Xenosauridae

Dorsetisauridae

Superfamily Varanoidea (Platynota)

Necrosauridae

Helodermatidae

Varanidae

Lanthanotidae

Aigialosauridae

Dolichosauridae

Mosasauridae*

Anguimorpha Incertae Sedis

Suborder Serpentes

Infraorder Scolecophidia

Typhlopidae

Leptotyphlopidae

Infraorder Henophidia

Superfamily Simoliopheoidea

Lapparentopheidae

Simoliopheidae

Superfamily Anilioidea

Aniliidae

Uropeltidae

Superfamily Booidea

Dinilysiidae

Xenopeltidae

Boidae
?Palaeophidae
Superfamily Acrochordoidea
Acrochordidae
Nigeropheidae
Infraorder Caenophidia
Superfamily Colubroidea
Anomalopheidae
Russellopheidae
Colubridae
Elapidae [including Hydropheidae]
Viperidae [including Crotalidae]
Superorder Sauropterygia
Order Incertae Sedis
Claudiosauridae*
Order Nothosauria
Pachypleurosauridae*
Simosauridae*
Nothosauridae*
Cymatosauridae*
Pistosauridae*
Order Plesiosauria
Superfamily Pesiosauroidea
Plesiosauridae*
Cryptoclididae*
Elasmosauridae*
Superfamily Pliosauroidea
Pliosauridae*
Infraclass Archosauromorpha
Order Protorosauria
Protorosauridae
Prolacertidae
Tanystropheidae
Order Trilophosauria
Trilophosauridae
Order Rhynchosauria
Rhynchosauridae
Superorder Archosauria
Order Thecodontia

Suborder Proterosuchia

Proterosuchidae
Erythrosuchidae
?Proterochampsidae

Suborder Ornithosuchia

Euparkeriidae
Ornithosuchidae
Lagosuchidae

Suborder Rauisuchia

Rauisuchidae
Poposauridae

Suborder Aetosauria

Stagonolepididae

Suborder Incertae Sedis

Erpetosuchidae
Ctenosauriscidae
Gracilisuchidae
Scleromochlidae

Suborder Phytosauria

Phytosauridae

Order Crocodylia

?Suborder Trialestia

Trialestidae

Suborder Sphenosuchia

Saltoposuchidae
Sphenosuchidae

Suborder Protosuchia

Platygnathidae
Protosuchidae

Suborder Hallopoda

Hallopidae

Suborder Mesosuchia

Teleosauridae*
Metriorhynchidae*
Pholidosauridae
Atoposauridae
Goniopholididae
Dyrosauridae
Paralligatoridae

Hsisosuchidae
Bernissartiidae
Trematochampsidae
Libycosuchidae
Notosuchidae
Uruguaysuchidae
Baurusuchidae
Sebecidae
?Gobiosuchidae
?Edentosuchidae
Suborder Eosuchia
?Hylaeochampsidae
Stomatosuchidae
Dolichochampsidae
Gavialidae
Alligatoridae
Crocodylidae
Order Pterosauria
Suborder Rhamphorhynchoidea
Dimorphodontidae
Eudimorphodontidae
Campylognathoididae
Ramphorhynchidae
Suborder Pterodactyloidea
Dsungaripteridae
Ctenochasmatidae
Pterodaustriidae
Pterodactylidae
Ornithocheiridae
Order Saurischia
Suborder Staurikosauria
Stuarikosauridae
Herrerasauridae
Suborder Theropoda
Podokesauridae
Coeluridae
Shanshanosauridae
Compsognathidae
Ornithomimidae

- Deinocheiridae
- Therezinosauridae
- Elmisauridae
- Oviraptoridae
- Dromaeosauridae
- Saurornithoididae
- Megalosauridae
- Allosauridae
- Spinosauridae
- Ceratosauridae
- Dryptosauridae
- Tyrannosauridae

Suborder Sauropodomorpha

Infraorder Plateosauria

- Anchisauridae
- Melanorosauridae
- Blikanasauridae

Infraorder Sauropoda

- Cetiosauridae
- Diplodocidae
- Brachiosauridae
- Titanosauridae
- Camarasauridae
- Euhelopodidae

Dinosauria Incertae Sedis

- Segnosauridae

Order Ornithischia

Suborder Ornithopoda

- Fabrosauridae
- Heterodontosauridae
- Dryosauridae
- Hypsilophodontidae
- Iguanodontidae
- Hadrosauridae

Suborder Pachycephalosauria

- Pachycephalosauridae
- Homalocephalidae

Suborder Stegosauria

- ?Scelidosauridae

Stegosauridae
Suborder Ankylosauria
Nodosauridae
Ankylosauridae
Suborder Ceratopsia
Psittacosauridae
Protoceratopsidae
Ceratopsidae
Diapsida Incertae Sedis
Order Placodontia
?Helveticosauridae*
Placodontidae*
Cyamodontidae*
Henodontidae*
Order or Subclass Ichthyopterygia
?Hupehsuchidae*
Utatsusauridae*
Omphalosauridae*
Mixosauridae*
Shastasauridae*
Ichthyosauridae*
Stenopterygiidae*
Protoichthyosauridae*
Leptopterygiidae*
Subclass Synapsida
Order Pelycosauria
Ophiacodontidae
Varanopseidae
Eothyrididae
Sphenacodontidae
Edaphosauridae
Caseidae
Order Therapsida
Suborder Eotitanosuchia
Biarmosuchidae
Eotitanosuchidae
Phthinosuchidae
Incertae Sedis
Suborder Dinocephalia

Infraorder Titanosuchia

Brithopodidae
Deuterosauridae
Estemmenosuchidae
Anterosauridae
Titanosuchidae

Infraorder Tapinocephalia

Tapinocephalidae
?Incertae Sedis

Suborder Dicynodontia

Infraorder Venjukoviamorpha

Venjukoviidae

Infraorder Dromasauria

Galeopsidae

Infraorder Eodicynodontia

Eodicynodontidae

Infraorder Endothiodontia

Endothiodontidae

Infraorder Pristerodontia

Aulacocephalodontidae
Dicynodontidae
Kannemeyeriidae
Lystrosauridae
Oudenodontidae
Pristerodontidae

Infraorder Diictodontia

Emydopidae
Cistecephalidae
Robertiidae
Diictodontidae

Infraorder Kingoriamorpha

Kingoriidae

Suborder Gorgonopsia

?Ictidorhinidae
?Hipposauridae
?Burnetiidae
Gorgonopsidae

Suborder Therocephalia

Crapartinellidae

Pristerognathidae
Hofmeyriidae
Lycideopsidae
Ictidosuchidae
Whaitsiidae
Moschorhinidae
Ericiolacertidae
Scaloposauridae
Simorhinellidae
Bauridae

Suborder Cynodontia

Infraorder Procynosuchia

Procynosuchidae
Dviniidae
Galesauridae

Infraorder Eucynodontia

Superfamily Cynognathoidea

Cynognathidae

Superfamily Tritylodontoidea

Diademodontidae
Trirachodontidae
Traversodontidae
Tritylodontidae

Superfamily Chiniquodontoidea

Chiniquodontidae
Tritheledontidae

Class Aves

Subclass Archaeornithes

Order Archaeopterygiformes

Archaeopterygidae

Order Incertae Sedis

Confusciousornithidae

Subclass Neornithes

Ambiortidae

Superorder Odontognathae

Order Hesperornithiformes

Enaliornithidae
Baptornithidae
Hesperornithidae

Order Ichthyornithiformes

Ichthyornithidae

Superorder Incertae Sedis

Order Gobipterygiformes

Gobipterygidae

Order Enantiornithiformes

Enantiornithidae

?Zhyraornithidae

Superorder Palaeognathae

Order Unnamed

Lithornidae

Order Tinamiformes

Tinamidae

Order Struthioniformes

Struthionidae

Order Rheiformes

Opisthodactylidae

Rheidae

Order Casuariiformes

Casuariidae

Dromaiidae

Cromornithhidae

Order Aepyornithiformes

Aepyornithidae

Order Dinornithiformes

Dinornithidae

Order Apterygiformes

Apterygidae

Superorder Neognathae

Order Cuculiformes

Opisthocomidae

Musophagidae

Cuculidae

Order Falconiformes

Falconidae

Sagittariidae

Accipitridae

Pandionidae

Order Galliformes

Cracidae
Megapodiidae
Numididae
Phasianidae
?Turnicidae

Order Columbiformes

Pteroclidae
Columbidae

Order Psittaciformes

Psittacidae

Order Incertae Sedis

Zygodactylidae

Order Coliiformes

Coliidae

Order Coraciiformes (Including Trogoniformes and Galbulae)

Suborder Incertae Sedis

?Halcyornithidae

Suborder Coracii

Atelornithidae
Leptosomidae
Galbulidae
Bucconidae
Coraciidae
Primobucconidae

Suborder Halcyones (Alcedini)

Alcedinidae
Meropidae
Todidae
Momotidae
Trogonidae
Archaeotrogonidae

Order Strigiformes

Ogygoptyngidae
Protostrigidae
Strigidae
Tytonidae

Order Caprimulgiformes

Aegothelidae
Podargidae

Steatornithidae
Caprimulgidae

Order Apodiformes

Suborder Apodi

Aegialornithidae
Apodidae

Suborder Trochili

Trochilidae

Order Bucerotiformes

Bucerotidae
Upupidae
Phoeniculidae

Order Piciformes

Indicatoridae
Capitonidae
Picidae

Order Passeriformes

?Palaeoscinidae
Alaudidae
Corvidae
Sittidae
Fringillidae
Eurylaimidae

Order Gruiformes

Suborder Cariamae

Cariamidae
?Cunampaiidae
Phorusrhacidae
Bathornithidae
Idiornithidae

Suborder Grues

Geranoididae
Eogruidae
Ergilornithidae
Eleutherornithidae
Gruidae
Aramidae
Psophiidae
Heliornithidae

Rhynochetidae
Eurypygidae
Mesitornithidae
Suborder Ralli
Rallidae
Apterornithidae
Suborder Incertae Sedis
Ardeidae
Order Podicipediformes
Podicipedidae
Order Diatrymiformes
Diatrymatidae (Gastornithidae)
Order Charadriiformes
Burhinidae
Plataleidae
Chionididae
Graculavidae
Cimolopterygidae
Dakotornithidae
Rostratulidae
Dromadidae
Thinocoridae
Pedionomidae
Jacanidae
Scolopacidae
Charadriidae
Haematopodidae
Recurvirostridae
Phoenicopteridae
Glareolidae
Otididae
Stercorariidae
Laridae
Alcidae
Order Anseriformes
Presbyornithidae
Anatidae
Anhimidae
Order Ciconiiformes

Ciconiidae
Scopidae
Balaenicipitidae
Teratornithidae
Vulturidae

Order Pelecaniformes

Suborder Phaethontes

Prophaethontidae
Phaethontidae

Suborder Odontopterygia

Pelagornithidae

Suborder Fregatae

Fregatidae

Suborder Pelecani

Pelecanidae

Suborder Sulae

Sulidae
Plotopteridae
Anhingidae
Phalacrocoracidae

Order Procellariiformes

Diomedeidae
Procellariidae
Pelecanoididae
Oceanitidae (Hydrobatidae)

Order Gaviiformes

Gaviidae

Order Sphenisciformes

Spheniscidae

Class Mammalia

Subclass Prototheria

Order Monotremata

Ornithorhynchidae
Tachyglossidae

Order Triconodonta

Sinoconodontidae
Morganucodontidae
Amphilestidae
Triconodontidae

Incertae Sedis
Order Docodonta
Docodontidae
Subclass Allotheria
Order Multituberculata
Suborder Plagiaulacoidea
Arginbaataridae
Paulchoffatiidae
Plagiaulacidae
Suborder Ptilodontoidea
Boffidae
Neoplagiaulacidae
Cimolodontidae
Ptilodontidae
Suborder Taeniolabidoidea
Taeniolabididae
Eucosmodontidae
Chulsanbaataridae
Sloanbaataridae
Suborder Incertae Sedis
Cimolomyidae
Incertae Sedis
Haramiyidae
Subclass Theria
Infraclass Trituberculata
Order Symmetrodonta
Kuehneotheriidae
Spalacotheriidae
Amphidontidae
Order Incertae Sedis
Family unnamed
Order Eupantotheria
Amphitheriidae
Peramuridae
Paurodontidae
Cryolestidae
Incertae Sedis
Theria of Metatherian-Eutherian Grade
Aegialodontidae

Delatheridiidae
Incertae Sedis

Infraclass Metatheria

Order Marsupialia (New World and European Marsupials)

Suborder Didelphoidea

Didelphidae
Pediomyidae
Microbiotheriidae
Stagodontidae
Borhyaenidae
Thylacosmilidae
Argyrolagidae

Suborder Caenolestoidea

Caenolestidae
Polydolopidae

Suborder Incertae Sedis

Groeberiidae

Incertae Sedis

Bonapartheriidae
Necrolestidae

Australasian Marsupalia

Suborder Dasyuroidea

Dasyuridae
Thylacinidae
Myrmecobiidae
Notoryctidae

Suborder Perameloidea

Peramelidae
Thylacomyidae

Suborder Diprotodonta

Superfamily Phalangeroidea

Phalangeridae
Ektopodontidae
Petauridae
Thylacoleonidae
Macropodidae

Superfamily Phascolarctoidea

Phascolarctidae

Superfamily Vombatoidea

- Vombatidae
- Diprotodontidae
- Palorchestidae
- Wynyardiidae

Suborder Incertae Sedis

- Tarsipedidae

Infraclass Eutheria

Order Incertae Sedis

- Kennalestidae
- Zalambdalestidae
- Family unnamed

Order Apatotheria

- Apatemyidae

Order Leptictida

- Gypsonictopidae
- Leptictidae
- Pseudorhyncocyonidae

Order Pantolesta

- Pantolestidae
- Pentacodontidae
- ?Ptolemiidae

Order Scandentia

- Tupaiidae

Order Macroscelidea

- Macroscelididae

Order Dermoptera

Superfamily Plagiomenoidea

- Plagiomenidae
- Galeopithecidae (Cynocephalidae)
- ?Mixodectidae
- Pacentidentidae

Order Insectivora

- Family unnamed

Suborder Erinaceomorpha (Lipotyphla)

Superfamily Erinaceoidea

- Dormaaliidae
- Amphilemuridae
- Erinaceidae
- Incertae Sedis

Suborder Soricomorpha

Palaeoryctidae

Superfamily Soricoidea

Geolabididae
Talpidae
Proscalopidae
Plesiosoricidae
Soricidae
Nyctitheriidae
Micropternodontidae
Dimylidae
Incertae Sedis

Suborder Zalambdodonta

Superfamily Tenrecoidea

Tenrecidae (Centetidae)

Superfamily Chrysochloroidea

Chrysochloridae

Order Insectivora Incertae Sedis

Order Tillodontia

Esthonychidae
Incertae Sedis

Order Pantodonta

Archaeolambdidae
Bemalambdidae
Pantolambdidae
Barylambdidae
Titanoideidae
Coryphodontidae
Harpyodidae
Pantolambdodontidae
Pastoralodontidae
Cyriacotheriidae

Order Dinocerata

Uintatheriidae
Gobiatheriidae

Order Taeniodontia

Stylinodontidae

Order Chiroptera

Suborder Megachiroptera

Pteropodidae
Suborder Microchiroptera
Superfamily Icaronycteroidea
Icaronycteridae
Palaeochiropterygidae
Superfamily Emaballonuroidae
Emballonuridae
Superfamily Rhinolophoidea
Megadermatidae
Rhinolophidae
Hipposideridae
Superfamily Phyllostomatoidea
Phyllostomatidae
Superfamily Vespertilionoidea
Myzopodidae
Vespertilionidae
Molossidae
Superfamily Incertae Sedis
Order Primates
Suborder Plesiadapiformes
Superfamily Paramomyoidea
Paromomyidae
Picrodontidae
?Microsyopidae
Superfamily Plesiadapoidea
Plesiadapidae
Saxonellidae
Carpolestidae
Suborder Prosimii
Infraorder Adapiformes
Adapidae
Infraorder Lemuriformes
Superfamily Lemuroidea
Lemuridae
Megalapidae
Superfamily Lorisoidea
Lorisidae
Cheirogaleidae
Superfamily Indrioidea

- Indriidae
- Daubentoniidae
- Archaeoloemuridae
- Palaeopropithecidae

Infraorder Tarsiiformes

- Omomyidae
- Tarsiidae

Suborder Anthropoidea

Infraorder Incertae Sedis

Infraorder Platyrrhini

- Cebidae
- Atelidae

Infraorder Catarrhini

Superfamily Parapithecoidea

- Parapithecidae

Superfamily Cercopithecoidea

- Ceropithecidae
- Oreopithecidae

Superfamily Hominoidea

- Pliopithecidae
- Hylobatidae
- Pongidae
- Hominidae

Order Creodonta

Suborder Hyaenodontia

- Hyaenodontidae
- Oxyaenidae

Order Carnivora

Superfamily Miacoidea

- Miacidae
- Viverravidae

Superfamily Aeluroidea (Feloidea)

- Viverridae
- Hyaenidae
- Felidae

Superfamily Arctoidea (Canoidea)

- Mustelidae
- Phocidae*
- Canidae

Procyonidae
Amphicyonidae
Ursidae
Superfamily Otarioidea
Enaliarctidae*
Desmatophocidae*
Otariidae*
Odobenidae*
Carnivora Incertae Sedis
Order Anagalida
Anagalidae
Psuedictopidae
Eurymylidae
Mimotonidae
Family incertae sedis
Order Rodentia
Suborder Sciurognathi
Infraorder Protrogomorpha
Superfamily Ischyromyoidea
Paramyidae
Sciuravidae
Cylindrodontidae
Protoptychidae
Ischyromyidae
Ischyromyoidea Incertae Sedis
Superfamily Aplodontoidea
Aplodontidae
Mylagaulidae
Infraorder Sciuromorpha
Superfamily Sciuroidea
Sciuridae
Infraorder Castorimorpha
Castoridae
Eutypomyidae
Infraorder Unnamed
Superfamily Gliroidea
Gliridae (Myoxidae)
Seleviniidae
Infraorder Myomorpha

Superfamily Geomyoidea
- Eomyidae
- Florentiamyidae
- Geomyidae
- Heteromyidae

Superfamily Dipodoidea
- Dipodidae
- Zapodidae
- Simimyidae

Superfamily Muroidea
- Cricetidae
- Muridae

Superfamily Spalacoidea
- Rhizomyidae

Infraorder Indeterminate

Superfamily Ctenodactyloidea
- Ctenodactylidae
- Chapattimyidae
- Cocomyidae

Superfamily Pedetoidea
- Pedetidae

Superfamily Anomaluroidea
- Anomaluridae

Superfamily Threridomyoidea
- Theridomyidae (Pseudosciuridae)

Suborder Hystricognathi

Infraorder Bathygeromorpha
- Bathygeridae
- Tsaganomyidae

Infraorder Hystricomorpha
- Hystricidae

Infraorder Phiomorpha

Superfamily Thryonomyoidea
- Phiomyidae
- Thryonomyidae
- Diamantomyidae
- Kenyamidae
- Myophiomyidae

Infraorder Caviomorpha

Superfamily Octodontoidea
Octodontidae
Echimyidae
Ctenomyidae
Abrocomidae
Capromyidae
Superfamily Chinchilloidea
Chinchillidae
Dasyproctidae
Dinomyidae
Superfamily Cavioidea
Eocardiidae
Caviidae
Hydrochoeridae
Superfamily Erethizontoidea
Erethizontidae
Order Rodentia Incertae Sedis
Order Lagomorpha
Stem lagomorphs-no family designated
Ochotonidae
Leporidae
Order Condylartha
Arctocyonidae (Oxyclaenidae)
Paroxyclaenidae
Tricuspiodontidae
Mioclaenidae
Hyopsodontidae
Meniscotheriidae
Periptychidae
Phenacodontidae
Didolodontidae
Phenacolophidae
Order Artiodactyla
Suborder Palaeodonta
Dichobunidae
Helohyidae
Suborder Suina
Superfamily Entelodontoidea
Choeropotamidae

Cebochoeridae
Entelodontidae (Elotheridae)
Leptocheridae
Superfamily Suoidea
Suidae
Tayassuidae (Dicotylidae)
Superfamily Hippopotamoidea
Anthracotheriidae
Haplobunodontidae
Hippopotamidae
Suborder Tylopoda
Superfamily Merycoidodontoidea (Oreodontoidea)
Agriochoeridae
Merycoidodontidae (Oreodontidae)
Superfamily Anoplotheroidea
Cainotheriidae (Caenotheriidae)
Anoplotheriidae
Superfamily Cameloidea
Camelidae
Oromerycidae
Superfamily Incertae Sedis
Xiphodontidae
Amphimerycidae
Protoceratidae
Suborder Ruminantia
Infraorder Traguloidea
Hypertragulidae
Tragulidae
Leptomerycidae
Gelocidae
Infraorder Pecora
Superfamily Cervoidea
Palaeomerycidae
Moschidae
Cervidae
Giraffidae
Superfamily Cervoidea Incertae Sedis
Superfamily Bovoidea
Antilocapridae

Bovidae
Superfamily Bovoidea Incertae Sedis
Order Artiodactyla Incertae Sedis
Order Mesonychia (Acreodi)
Mesonychidae
Order Cetacea
Suborder Archaeoceti
Protocetidae*
Basilosauridae (Zeuglodontidae)*
Suborder Archaeoceti Incertae Sedis
Suborder Odontoceti
Kentriodontidae*
Squalodontidae*
Platanistidae*
Ziphiidae*
Delphinidae*
Rhabdosteidae (Eurhinodelphidae)*
Albireonidae*
Acrodelphidae*
Monodontidae (Delphinapteridae)*
Phocaenidae*
Pontoporiidae*
Physeteridae*
Agorophiidae*
Suborder Odontoceti Incertae Sedis
Suborder Mysticeti
Aetiocetidae*
Cetotheriidae*
Eschrichtiidae (Rhachianectidae)*
Balaenopteridae*
Balaenidae*
Order Cetacea Incertae Sedis
Order Perissodactyla
Suborder Hippomorpha
Superfamily Equoidea
Equidae
Palaeotheriidae
Superfamily Brontotherioidea
Brontotheriidae (Titanotheriidae)

Suborder Ancylopoda

Eomoropidae

Chalicotheriidae

Suborder Ceratomorpha

Superfamily Tapiroidea

Isectolophidae

Helaletidae (Hyrachyiidae)

Lophialetidae

Deperetellidae

Lophiodontidae

Tapiridae

Tapiroidea Incertae Sedis

Superfamily Rhinocerotoidea

Hyracondontidae

Amynodontidae

Rhinocerotidae

Ceratomorpha incertae sedis

Order Proboscidea

?Suborder Moeritherioidea

Anthracobunidae

Moeritheriidae

Suborder Euelephantoidea

Gomphotheriidae (Trilophodontidae)

Elephantidae

Suborder Mammutoidea

Stegodontidae

Mammutidae

Suborder Deinotherioidea

Deinotheriidae

Suborder Barytherioidea

Barytheriidae

Order Sirenia

Prorastomidae*

Dugongidae (Halicoridae)*

Manatidae (Trichechidae)*

Protosirenidae*

Order Desmostylia

Desmostylidae

Order Hyracoidea

Procaviidae
Pliohyracidae
Order Embrithopoda
Arsinoitheriidae
Order Tubulidentata
Orycteropodidae
Order Notoungulata
Suborder Notoprongonia
?Arctostylopidae
Henricosborniidae
Notostylopidae
Suborder Toxodontia
Oldfieldthomasiidae (Acoelodidae)
Archaeopithecidae
Isotemnidae
Homalodotheriidae
Leotiniidae
Notohippidae
Toxodontidae
Suborder Typotheroidea
Superfamily Typotheroidea
Interatheriidae
Mesotheriidae
Superfamily Hegetotheroidea
Archaeohyracidae
Hegetotheriidae
Notoungulata Incertae Sedis
Order Astrapotheria
Trigonostylopidae
Astrapotheriidae
Order Litopterna
Proterotheriidae
Protolipternidae
Macraucheniidae
Adianthidae
Order Xenungulata
Carodniidae
Order Pyrotheria
Pyrotheriidae

Colombitheriidae

Order Xenarthra

Infraorder Loricata (Cingulata)

Superfamily Dasypodoidea

Dasypodidae

Palaeopeltidae

Superfamily Glyptodontoidea

Glyptodontidae (Hoplophoridae)

Infraorder Pilosa

Superfamily Magalonychoidea

Megalonychidae

Megatheriidae

Superfamily Mylodontoidea

Mylodontidae

Entelopidae

Infraorder Vermilingua

Myrmecophagidae

Order Incertae Sedis

Suborder Palaeanodonta

Metacheiromyidae

Epoicotheriidae

?Ernanodontidae

Order Pholidota

Manidae

MAMMALIA INCERTAE SEDIS

Didymoconidae (Tshelkariidae)