Mesozoic and Tertiary Fossil Mammals and Birds of Great Britain

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References

In this reference list the arrangement is alphabetical by author surname for works by sole author and dual authors. However, where there are references that include the first-named author with others, the sole-author works are listed chronologically first, followed by the dual author references (*alphabetically*) followed by the references with three or more authors listed *chronologically*, for ease of identifying 'et al.' references. Chronological order is used within each group of identical authors.

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Glossary

This glossary provides brief explanations of the technical terms used in the introductions to the chapters and in the 'conclusions' sections of the site reports. These explanations are not rigorous scientific definitions but are intended to help the general reader. Detailed stratigraphical terms are omitted as they are given context within the tables and figures. Genus and species names are also excluded but can be found in the Fossil Index. Words in **bold** type indicate an internal reference to another glossary entry. References to geological time are based on Gradstein *et al.* (2004).

Adapisoriculid: any member of the extinct **mammal family** Adapisoriculidae (tentatively referred to the **order Lipotyphla**). Small insect eaters, they evolved in the **Paleocene Epoch** and became extinct during the **Eocene Epoch**.

Afrosoricida: also known as 'Tenrecomorpha', a **mammal order** of the magnorder **Afrotheria**. Contains two **families** of small mammals, the Tenrecidae (tenrecs) and the Chrysochloridae (golden moles).

Afrotheria: a magnorder of the **class Mammalia** that links the African mammals together according to molecular evidence. A large and diverse group consisting of about one third of all living placental mammal **orders**, it is thought to be one of the first **clades** to diverge from other placental mammals. From an ultimately **Gondwanan** origin its members are inferred to have evolved and radiated in Africa in the **Cretaceous Period** (100–88 Ma) when Africa was drifting and isolated from the other continents. Includes elephants, hyraxes, sea cows, elephant shrews, tenrecs, golden moles and aardvarks.

Albian Stage: a **chronostratigraphical** division of the **Cretaceous Period**. The last **stage** of the Early Cretaceous Epoch, it ranges from approximately 112 to 100 million years ago and is preceded by the **Aptian Stage** and followed by the Cenomanian Stage.

Allotherian: any member of the extinct **mammal** subclass Allotheria, consisting of two one **orders**, the 'Haramyida' and **Multituberculata**. First appearing in Late **Triassic** times they existed for over 100 million years until the **Eocene Epoch**.

Amniote: any member of the group Amniota, which contains modern **reptiles**, birds (**aves**), and **mammals**. This group of **tetrapods** arose during the **Carboniferous Period** and divided into three main branches, the **Anapsida**, **Diapsida** and **Synapsida**, and were the first creatures to break the link with water. They lay eggs that have a semi-permeable outer membrane and a shell that allows gases to pass through, and therefore they do not need to lay them in water.

Amphibian: any member of the **class** Amphibia (subphylum **Vertebrata**), the first animals to colonize the land. They do not have **amniotic** eggs and therefore lay their eggs in water. Most species spend time on both land and in the water. Includes frogs, salamanders, newts and toads.

Amphicyonid: any member of the extinct

mammal family Amphicyonidae (suborder **Caniformia**, **order Carnivora**), which lived from **Eocene** to **Miocene** times. Described as 'bear-dogs', they were closely related to bears and were often large and predatory.

Amphilemurid: any member of the extinct **mammal family** Amphilemuridae (**order Lipotyphla**, suborder Erinaceomorpha). Small, hedgehog-like animals.

Amphilestid: any member of the extinct **mammal family** Amphilestidae, which lived from mid-**Jurassic** to Early **Cretaceous** times.

Anapsid: any member of the subclass Anapsida (**class Reptilia**, series **Amniota**). Characterized by a roofed temporal region in which there are no openings, this early branch of amniotes gave rise to the turtles.

Anatid: any member of the bird **family** Anatidae (**order Anseriformes**). Includes ducks, geese and swans.

Anoplotheriid: any member of the extinct **mammal family** Anoplotheriidae (**order Artiodactyla**), which died out in the **Oligocene Epoch**.

Anoxic: literally 'without oxygen'; often used to describe an anaerobic environment.

Anseranatidae: a **family** of the bird **order Anseriformes**. Today represented only by the magpie goose.

Anseriform: any member of the bird **order** Anseriformes. Includes waterfowl such as ducks, geese, swans and screamers.

Apodidae: a **family** of the bird **order Apodiformes**. Includes true swifts.

Apodiform: any member of the bird **order** Apodiformes. Includes hummingbirds and swifts.

Aptian Stage: a **chronostratigraphical** division of the **Cretaceous** Period. The penultimate **stage** of the Early Cretaceous Period, it ranges approximately from 125 to 112 million years ago and is preceded by the **Barremian Stage** and followed by the **Albian Stage**.

Archaeocete: any member of the extinct **mammal** suborder 'Archaeoceti' (**order Cetacea**). These ancient aquatic creatures were primitive whales and the oldest known cetaceans to have flourished in the **Eocene Epoch**.

Archetype: an ideal model of particular broad classes of animals.

Archipelago: a group of islands.

Archonta: a **mammal clade** comprising **Euarchonta** and **Chiroptera** (bats).

Arctocyonid: any member of the extinct **mammal family** Arctocyonidae (**order** 'Condylarthra'). These dog-sized animals had broad molars for crushing plant food. Some had mobile ankle joints suggesting that they climbed trees.

Arenite (adj. **arenaceous**): a general term for a detrital, **clastic** sedimentary rock made of sand-sized particles.

Artiodactyl: any member of the **ungulate** (hoofed **mammal**) **order** Artiodactyla or cloven-hoofed mammals (superorder **Cetartiodactyla**). **Terrestrial** mammals characterized by having an even number of hooves or toes, and where the axis of the foot passes between the third and fourth digits. Examples include the two-hoofed modern camels, sheep and cows, and the four-hoofed modern pigs and hippos.

Australosphenida: a **mammal** subclass consisting of a southern group of mammals which evolved in **Gondwana** in the **Jurassic Period**. The Australian **monotremes** (division Monotremata) are the only living representatives.

Aves: a **class** of **vertebrates** composed of the birds – 'warm-blooded', egg-laying **tetrapods** primarily adapted for flying.

Avifauna: the collection of birds characterizing a period, region or environment.

Barremian Stage: a **chronostratigraphical** division of the **Cretaceous** Period. The fourth **stage** of the Early Cretaceous Epoch, it ranges approximately from 130 to 125 million years ago and is preceded by the **Hauterivian Stage** and followed by the **Aptian Stage**.

Bathonian Stage: a **chronostratigraphical** division of the **Jurassic Period**. The penultimate **stage** of the Middle Jurassic **Epoch**, it is dated to approximately 168–165 Ma and is preceded by the Bajocian Stage and followed by the **Callovian Stage**.

Bed: in **lithostratigraphy**, a subdivision of either a **member** or a **formation**; the smallest unit within the scheme of formal **lithostratigraphical** classification. Also used informally to indicate a stratum within a sedimentary rock succession.

Berriasian Stage: a **chronostratigraphical** division of the **Cretaceous** Period. The first **stage** of the Early Cretaceous **Epoch**, it ranges from approximately 146 to 140 million years ago and is followed by the **Valanginian Stage**.

Biogenic: produced by living organisms or

biological processes.

Biostratigraphy: the **stratigraphical** subdivision, classification and correlation of sedimentary rocks based on their fossil content.

Biostratinomy: the study of what happens between the death of an organism and burial.

Bolonian Substage: a **chronostratigraphical** subdivision of the **Tithonian Stage** of the **Jurassic Period**. The earlier of two such substages, it ranges approximately from 151 to 148 million years ago and is followed by the **Portlandian Substage**.

Boreoeutheria: the 'northern placentals', a magnorder of placental **mammals** that, according to molecular evidence, remained after the **Afrotheria** and **Xenarthra** split off. During the **Cretaceous Period** it too divided into two major groups, the **Laurasiatheria** and **Euarchontoglires** grandorders.

Boreosphenida: a major **clade** of **mammals** including **marsupials**, placentals (**Theria**) and extinct relatives that originated and radiated in the northern continents during the **Cretaceous Period**. During the **Cenozoic Era** they spread to all continents.

Brontothere: any member of the extinct **mammal family** Brontotheriidae (**order Perissodactyla**), which were widespread in the **Eocene Epoch**. Late members were large creatures similar in appearance to modern-day rhinos; they had nose horns and are believed to have roamed in herds.

Calcarenite: a **limestone** composed mainly of sand-sized calcium carbonate grains.

Callovian Stage: a **chronostratigraphical** division of the **Jurassic Period**. The last **stage** of the Middle Jurassic **Epoch**, it ranges approximately from 165 to 161 million years ago and is preceded by the **Bathonian Stage** and followed by the **Oxfordian Stage**.

Caniform: any member of the **mammal** suborder Caniformia (**order Carnivora**). Includes dogs, bears, the extinct amphicyonids, racoons, weasels and **pinnipeds**.

Carbonate: a mineral salt of carbonic acid, usually referring to the common sedimentary form of calcium carbonate in **limestones** and **invertebrate** shells, but also encompassing other minerals, notably dolomite.

Carboniferous Period: a geological time division (*see* **chronostratigraphy**) of the **Paleozoic Era**. Ranging from 359 to 299 million years ago, it precedes the **Permian Period** and follows the **Devonian Period**.

Carnian Stage: a **chronostratigraphical** division of the **Triassic Period**. The first **stage** of the Late Triassic **Epoch**, it ranges approximately from 228 to 217 million years ago and is preceded by the Ladinian Stage and followed by the **Norian Stage**.

Carnivora: a placental **mammal order**, referred to as 'carnivorans' (meat eaters), although not all meat eaters are in this order, and not all Carnivora are meat eaters (e.g. the panda). Includes modern cats, dogs, bears, seals and sealions.

Carnivore: meat eaters. Includes, but is not exclusive to, members of the **order Carnivora**.

Cathartid: any member of the bird **family** Cathartidae (**order Falconiformes**). Includes the new world vultures such as turkey vultures, black vultures and condors.

Cebochoerid: any member of the extinct **mammal family** Cebochoeridae (**order Artiodactyla**). Small pig-like creatures.

Cenozoic Era: a geological time division (*see* **chronostratigraphy**) ranging from approximately 66 million years ago to the present day, and comprising the **Paleogene** and **Neogene periods**, and the **Tertiary** and **Quaternary** sub-eras.

Cetacean: any member of the mammal **order** Cetacea (superorder **Cetartiodactyla**). Includes whales, dolphins and porpoises.

Cetartiodactyl: any member of the **mammal** superorder Cetartiodactyla. Consists of two **orders**, **Cetacea** and **Artiodactyla**, following studies that have indicated that whales are close relatives of artiodactyls.

Chalicothere: any member of the extinct **mammal family** Chalicotheriidae (**order Perissodactyla**), which lived in the **Eocene** and **Pleistocene epochs**. Characterized by distinct three-clawed, three-toed feet, some of them were 'knuckle walkers' and were gorilla-like. Modern-day relatives include rhinos, horses and tapirs.

Charadriiform: any member of the bird **order** Charadriiformes. Includes plovers, oystercatchers, sandpipers, skuas, gulls, terns, guillemots and puffins.

Chert: microcrystalline silica (quartz and chalcedony), which may be of organic or inorganic origin. It occurs as layers or nodules in sedimentary rocks (mainly chalk and other **limestone**).

Chiroptera: a **mammal order** of comprising the bats. The order has a history dating back to the beginning of the **Eocene Epoch** and contains a very large number of species.

Chronostratigraphy: the subdivision and correlation of rock units on the basis of relative age. The hierarchy of principal chronostratigraphical units to which layers of sedimentary rock are allocated through the study and interpretation of their **stratigraphy** is **era**, **period**, **epoch** and **stage** (Gradstein *et al.*, 2004).

Ciconiiform: any member of the bird **order** Ciconiiformes. Consists of five or six families of stork-like birds, including herons, bitterns and ibises.

Clade: a group of all the organisms that share a particular common ancestor and therefore have similar features.

Cladistics: a system of **phylogenetic** classification in which organisms are grouped together on the basis of similarities due to recent origin from a common ancestor.

Cladogram: a branched tree-like diagram produced by a **cladistic** analysis.

Class: a category used in the **taxonomic** classification of organisms, which consists of one or several related **orders**. Similar classes are grouped into a **phylum**.

Clast (adj. **clastic**): a fragment of a pre-existing rock.

Clay: an extremely fine-grained sediment (grain-size less than 0.004 mm) composed of so-called 'clay minerals'.

Columbiform: any member of the bird **order** Columbiformes. Includes pigeons and doves.

'Condylarth': any member of the extinct **mammal order** 'Condylarthra', which lived in the **Paleocene** and **Eocene epochs**. This large group of placental, modest-sized animals, were five-toed and are believed to be the distant ancestors of hoofed mammals and whales.

Conglomerate: a sedimentary rock consisting of rounded pebbles.

Coraciiform: any member of the bird **order** Coraciiformes. Includes kingfishers, bee-eaters, hoopoes and hornbills.

Creodont: any member of the extinct **mammal order** Creodonta, which ranged from **Paleocene** to **Miocene** times. Meat-eaters, they may have looked superficially like cats and dogs but are only distantly related to modern **Carnivore** order.

Cretaceous Period: a geological time division (*see* **chronostratigraphy**) of the **Mesozoic Era**. Ranging from 146 to 66 million years ago, it follows the **Jurassic Period** and precedes the **Tertiary Sub-era** and **Paleogene Period**.

Cuculiform: any member of the bird **order** Cuculiformes, land birds that are mostly insectivorous. Includes cuckoos and road-runners.

Cynodont: a stem group of extinct **mammal**-like **reptiles** of the **order** 'Cynodontia' that includes the ancestors of mammals.

Deinothere: any member of the extinct **mammal family** Deinotheriidae (**order Proboscidea**), which flourished during **Miocene** and **Pliocene** times until about 2 million years ago. They looked much like small elephants, but with downturned tusks in the lower jaws.

Dendrochronology: the dating and study of tree rings.

Dermoptera: a **mammal order** of the grandorder **Euarchonta** or of the superorder **Archonta**. Also referred to as the 'flying lemurs', or colugos, only two living species in a single **genus** exist, found in south-east Asia.

Devonian Period: a geological time division (*see* **chronostratigraphy**) of the **Paleozoic Era**. Ranging from 416 to 359 million years ago, it precedes the **Carboniferous Period** and follows the Silurian Period.

Diapsid: any member of the subclass Diapsida (**class Reptilia**, series **Amniota**). Characterized by a pair of openings in the skull immediately behind the eye socket, this extant branch of amniotes includes crocodiles, lizards, snakes, dinosaurs, and the descendent birds.

Docodont: any member of the extinct **mammal order** Docodonta. One of the most primitive orders of mammals known, found in **Jurassic** deposits, they were mouse-sized with long narrow snouts.

Dryolestid: any member of the extinct **mammal family** Dryolestidae of the clade cladotheria, sister group to **Boreosphenida** The most diverse group of mammals in late **Jurassic** and early **Cretaceous** times, most were small and similar in size and shape to a shrew or mouse, with teeth adapted for eating insects.

Enantiornithid: any member of the extinct bird **order** Enantiornithes, which flourished in the **Cretaceous Period**. Termed 'opposite birds' because the bone structure of the shoulder blade, which is oriented opposite to that of modern birds.

Entelodont: any member of the extinct **mammal family** Entelodontidae (**order Artiodactyla**), distant relatives of living pigs.

Eocene Epoch: a geological time division (*see* **chronostratigraphy**) of the **Paleogene** Period (**Tertiary** Sub-era, **Cenozoic Era**). Ranging from approximately 56 to 34 million years ago it follows the **Paleocene Epoch** and precedes the **Oligocene Epoch**.

Eomyid: any member of the extinct **mammal family** Eomyidae (**order Rodentia**), which is related to the North American pocket mice and pocket gophers.

Epoch: a **chronostratigraphical** unit , of shorter duration than a **period** and itself divisible into **stages**.

Era: a major **chronostratigraphical** unit, which is divided into **periods** (e.g. the **Paleozoic Era**).

Euarchonta: superorder, which includes the **orders Primates**, **Scandentia** (tree shrews) and **Dermoptera** (colugos).

Euarchontoglires: a **mammal** grandorder, based on molecular evidence, which includes the **orders Primates**, **Rodentia** and **Lagomorpha**.

Eutherian: any **mammal** of the cohort Eutheria. Includes all placental mammals (Placentalia) plus their extinct relatives.

Evaporite: a sediment or mineral grown from a saline solution by evaporation of water, which may be marine or continental in origin.

Falconid: any member of the bird **family** Falconidae (**order Falconiformes**). Includes falcons and caracaras.

Falconiform: any member of the bird **order** Falconiformes. Includes diurnal birds of prey, such as vultures, eagles, hawks, falcons and ospreys.

Family: a category used in the **taxonomic** classification of organisms, which consists of one or several related **genera**. Similar families are grouped into an **order**.

Fauna: animals – often referring to the characteristic animal assemblage of a region or time period.

Feliform: any member of the **mammal** suborder Feliformia (**order Carnivora**). Includes cats, mongooses, civets and hyaenas.

Flora: plants – often referring to the characteristic plant assemblage of a region or time period.

Formation: a succession of contiguous rock strata that is distinctive enough in its **lithology** from the surrounding rocks to be mapped as a unit; the fundamental unit of **lithostratigraphy**.

Galliform: any member of the bird **order** Galliformes (**Galloanserae** subdivision). A large and diverse group, with 70 **genera** and more than 250 species, members are commonly referred to as 'gallinaceous birds' (meaning 'chicken-like') or game birds because of their chicken-like appearance. Includes turkeys, grouse, quails and pheasants.

Galloanserae: a subdivision of the bird superdivision **Neornithes**. Consists of two **orders**, the **Anseriformes** and the **Galliformes**, and includes ducks and chickens.

Gaviiform: any member of the bird **order** Gaviiformes. Large aquatic birds, the order contains a single **family**, the Gaviidae (loons or divers).

GCR: Geological Conservation Review, in which nationally important geological and geomorphological sites were assessed, and selected with a view to their long-term conservation as **SSSIs**.

Genus (pl. **genera**): a category used in the **taxonomic** classification of organisms, which consists of one or several related species. Similar genera are grouped together into a **family**. Forms the first part of a binomial scientific (Latin) name.

Glires: a placental **mammal clade**. Includes **rodents** (Rodentia) and rabbits, hares and pikas (Lagomorpha).

Glirid: any member of the mammal family Gliridae (**order Rodentia**). Dormice.

Gomphothere: any member of the extinct **mammal family** 'Gomphotheriidae' (**order Proboscidea**), which lived in the **Oligocene** and **Pliocene epochs**. Extinct relatives of modern elephants, they had four tusks.

Gondwana: a grouping of the major southern continental plates of Africa, Australasia, Antarctica, South America, India, and several smaller plates and fragments of what are now parts of Mediterranean Europe, which

together formed a massive southern supercontinent straddling the South Pole in early **Paleozoic** times. It began to split up when 'Avalonia' broke away in early Ordovician times.

Grainstone: a term used in the 'Dunham' system of **limestone** classification to denote a mud-free, grain-supported, **carbonate** sedimentary rock.

Granivore: an animal that eats mainly seeds.

Gruiform: any member of the bird **order** Gruiformes. A very diverse group of ground-feeding and usually ground-nesting birds, it includes bustards, cranes and rails.

Halcyornithidae: an extinct bird **family** from the **order Coraciiformes**, which existed in the **Eocene Epoch**. Originally thought to be kingfishers.

Hauterivian Stage: a **chronostratigraphical** division of the **Cretaceous Period**. The third **stage** of the Early Cretaceous **Epoch**, it ranges approximately from 136 to 130 million years ago and is preceded by the **Valanginian Stage** and followed by the **Barremian Stage**.

Hesperornithiform: any member of the small extinct bird **order** Hesperornithiformes. A highly specialized order of **Cretaceous** toothed birds, they were mostly flightless and specialized for diving.

Homoplastic: of, or relating to, physical characteristics or resemblance not due to inheritance from a common ancestry, e.g. parallelisms, convergences and reversals.

Hyrachyid: any member of the extinct **family** 'Hyrachyidae' (**order Perissodactyla**). These small, browsing, herbivores are primitive rhino relatives that lived during the **Eocene Epoch**.

Hyracoidea: a **mammal order** considered to be a close relative of the order **Proboscidea**. Consists of small rabbit-like hyraxes from Africa and the Middle East.

Hystricognath: any member of the suborder Hystricognathi (**order Rodentia**). Includes guinea pigs, capybaras and chinchillas.

Ichthyornithiform: any member of the extinct bird **order** Ichthyornithiformes, which lived in the **Cretaceous Period**. A small order of flying, toothed birds.

Insectivore: any member of the **order** Insectivora, a 'wastebasket' order which had been used to group together all the small insect-eating **mammals**. The term is also broadly given to any insect-eating animal or plant. Modern insectivorans are commonly grouped together in the restricted order **Lipotyphla**, which includes shrews, hedgehogs and moles. Other insectivores have been relegated to different groups, e.g. **Macroscelidea**, **Scandentia**.

Invertebrate: any animal lacking a backbone.

Jurassic Period: a geological time division (*see* **chronostratigraphy**) of the **Mesozoic Era**. Ranging from about 200 to 146 millon years ago; it precedes the **Cretaceous Period** and follows the **Triassic Period**.

Karst: descriptive of a distinctive terrain developed upon a soluble rock, typically **limestone**; characterized by caves, sinkholes and dry valleys.

Kimmeridgian Stage: a **chronostratigraphical** division of the **Jurassic Period**. The second **stage** of the Late Jurassic **Epoch** it ranges approximately from 155 to 151 million years ago and is preceded by the **Oxfordian Stage** and followed by the **Tithonian Stage**.

Kuehneotheriid: any member of the primitive extinct **mammal family** Kuehneotheriidae, which lived in Late **Triassic** to Early **Jurassic** times. Tiny mammals, they preyed upon insects.

Lagomorph: any member of the **mammal order** Lagomorpha (**clade Glires**, superorder Anagalida). These plant-eating creatures have fully furred feet and two pairs of upper incisors. Includes rabbits, hares and pikas.

Laurasiatherian: any member of the **mammal** grandorder Laurasiatheria (magnorder **Boreoeutheria**) based on molecular evidence. **Orders** assigned to this group were first found in the supercontinent Laurasia and include **Cetacea** (whales), **Chiroptera** (bats), **Carnivora**, **Perissodactyla**, **Artiodactyla**, Pholidota and **Lipotyphla**.

Lias (adj. **Liassic**): a **lithostratigraphical** group of mainly Early **Jurassic** strata, but also used as a time term equating with the Early Jurassic **Epoch**.

Limestone: sedimentary rock composed largely of calcium **carbonate**, often partly derived from the shells of organisms.

Lipotyphlan: any member of the **order** Lipotyphla, modern insect-eaters (**insecti-**

vores). Includes moles, hedgehogs and true shrews.

Lithology: descriptive of the constitution of a sediment or other rock, including composition, texture, colour and hardness.

Lithostratigraphy: the organization and division of strata into mainly mappable rock units and their correlation, based entirely upon their **lithological** characteristics. Units are named according to their rank in a formal hierarchy, namely supergroup, group, **formation**, **member** and **bed**.

Lithornithid: any member of the bird **family** Lithornithidae (**order** Lithornithiformes). Related to **Ratites** (ostriches etc.).

Maastrichtian Stage: a **chronostratigraphical** division of the **Cretaceous Period**. The final **stage** of the Late Cretaceous **Epoch**, it ranges approximately from 71 to 66 million years ago, and is preceded by the Campanian Stage.

Macroscelidea: a placental **mammal order** comprising the elephant shrews of Africa.

Malm Epoch: also known as the Late Jurassic Epoch. A geological time division of the **Jurassic Period**, it lasted from 161 to 146 million years ago.

Mammal: any member of the **class** Mammalia, which all share three characteristics not found in other vertebrates – three middle ear bones, hair, and the production of milk by mammary glands. Modern mammals are divided into three major **clades**, the **Eutheria** (placental mammals), **Metatheria** (**Marsupialia** – pouched mammals) (together the theria), and the **Monotremata** (egg-laying mammals).

Mandible: lower jaw.

Marsupial: any member of the infraclass Marsupialia, grouped with its nearest extinct relatives in the clade **Metatheria**. Commonly thought of as pouched **mammals** they give birth to live young and carry them in their pouches for weeks or months.

Member: in **lithostratigraphy**, a subdivision of a **formation**.

Metatheria: *see* **marsupial**.

Mesonychid: any member of the extinct **mammal family** Mesonychidae (order 'Condylarthra'), which lived in the **Paleocene** and **Eocene** epochs. These hoofed, hyaena-like land-dwelling mammals were once thought to have been the ancestors of the whales.

Mesozoic Era: a geological time division (*see* **chronostratigraphy**) ranging from 251 to 66 million years ago and comprising the **Triassic**, **Jurassic** and **Cretaceous periods**.

Micrite: a microcrystalline calcite; typically a lime mud.

Miocene Epoch: a geological time division (*see* **chronostratigraphy**) of the **Neogene Period** (**Cenozoic Era**). Ranging from approximately 23 to 5 million years ago it follows the **Oligocene Epoch** and precedes the **Pliocene Epoch**.

Monophyletic: pertaining to a natural **taxonomic** group (**clade**) that includes all descendants of a single common ancestor. An example is the **Amniota**, which includes the **reptiles**, birds and **mammals**.

Monotreme: any member of the **mammal order** Monotremata, also referred to as **prototherians.** They lay shell-covered eggs that are incubated and hatched outside of the body. This small group consists of only three members, the platypus and two echidnas, and is considered to be the most primitive of all modern mammalian groups.

Morganucodontid: any member of the extinct **mammal family** Morganucodontidae, which lived in from Late **Triassic** to Middle **Jurassic** times. These tiny shrew-like creatures were among the most primitive mammals.

Morphospecies: a group of biological organisms that differs in some morphological respect from all other groups.

Mudstone (**mudrock**): a fine-grained sedimentary rock; lithified mud.

Multituberculate: any member of the extinct **mammal order** Multituberculata. They lived in mid-**Jurassic** to Late **Eocene** times. Together with their relaives, the haramyids, they were the first plant-eating mammals.

Musophagid: any member of the bird **family** Musophagidae (**order** Cuculiformes). Includes touracos.

Myomorph: any member of the **mammal** infra-order Myomorpha (**order Rodentia**). This group radiated 'explosively' in the last 20 million years and includes rats and mice.

Mysticete: any member of the **mammal** suborder Mysticeti (**order Cetacea**). Also known as the 'baleen whales' or 'whalebone whales', they are largest animals on earth, and include right whales, blue whales and humpback whales.

Neogene Period: a geological time division (*see*

chronostratigraphy) of the **Cenozoic Era**. Ranging from approximately 23 million years ago until the present day, it includes the **Miocene, Pliocene and Pleistocene epochs**.

Neornithes: a superdivision of the birds. Also referred to as 'new birds', it contains all modern birds and is divided into two divisions.

Neptunian dyke: a sheet-like body of sand or other sediment that cuts through bedded sediment in a manner analogous to an igneous dyke. Formed by the upward or downward injection of liquefied sand through a fissure, often as a result of earthquake activity.

Norian Stage: a **chronostratigraphical** division of the **Triassic Period**. The second (and middle) **stage** of the Late Triassic **Epoch**, it ranged approximately from 217 to 204 million years ago and is preceded by the **Carnian Stage** and followed by the **Rhaetian Stage**.

Odontocete: any member of the **mammal** suborder Odontoceti (**order Cetacea**), also defined as 'toothed whales'. Includes dolphins, killer whales, and sperm whales.

Odontopterygiformes: a bird **order** proposed by Harrison and Walker (1979b), consisting of the bony-toothed birds – the families **Odontopterygidae**, **Pseudodontopterygidae** and **Dasornithidae**. All of these families are grouped in the extinct family **Pelagornithidae** by Olson (1985) within the modern order Pelecaniformes.

Oligocene Epoch: a geological time division (*see* **chronostratigraphy**) of the **Paleogene Period (Cenozoic Era)**. Ranging from approximately 34 to 23 million years ago it follows the **Eocene Epoch** and precedes the **Miocene Epoch**.

Omomyid: any member of the extinct **mammal family** Omomyidae (**order Primates**), which lived in the **Eocene** to **Miocene epochs**. Generally very small and nocturnal, most fed on fruit and insects, some including leaves in their diet.

Oolith (ooid): a spherical or sub-spherical **carbonate**-coated sedimentary particle, less than 2 mm in diameter.

Oolite (adj. **oolitic**): a rock, usually **limestone**, made up largely of **ooids** produced by accretion of **carbonate** around a nucleus.

Order: a category used in the **taxonomic** classification of organisms, which consists of one or several related families. Similar orders are grouped together in a **class**.

Oxfordian Stage: a **chronostratigraphical** division of the **Jurassic Period**. The first **stage** of the Late Jurassic Epoch, it is dated to approximately 161–155 Ma, and is preceded by the **Callovian Stage** and followed by the **Kimmeridgian Stage**.

Palaeo-: 'ancient' (occurring, or formed in, geological time).

Paleocene Epoch: a geological time division (*see* **chronostratigraphy**) of the **Paleogene Period (Cenozoic Era)**. Ranging from approximately 66 to 56 million years ago it is the first **epoch** of the Paleogene Period, and precedes the **Eocene Epoch**.

Palaeoclimate: the climate at a particular geological time.

Paleogene Period: a geological time division (*see* **chronostratigraphy**) of the **Cenozoic Era**. Ranging from approximately 66 to 23 million years ago in includes the **Paleocene**, **Eocene** and **Oligocene epochs**.

Palaeognathae: a division of the bird superdivision **Neornithes**. Represented by modern ostriches and emus and by extinct Lithornithidae, they are mostly flightless and are grouped together **taxonomically** based on palate (jaw) structure.

Palaeontology: the study of fossil **fauna** and **flora**, including their evolution and the reconstruction of the environments in which they lived.

Paleozoic Era: a geological time division (*see* **chronostratigraphy**), ranging from 542 to 251 million years ago and comprising the Cambrian, Ordovician, Silurian, **Devonian, Carboniferous** and **Permian periods**.

Paludal: of or relating to a swamp; marshy.

Palyno-: prefix indicating 'pollen' or 'spores'.

Palynomorph: a microscopic, acid-resistant, organic-walled body studied in palynology.

Pandionid: any member of the bird **family** Pandionidae (**order Falconiformes**). Ospreys.

Pantodont: any member of the extinct **mammal order** Pantodonta, which lived in **Paleocene** to Late **Eocene** times. Some of the largest mammals of the Paleocene Epoch, they reached bear-size, and were slow-moving plant-eaters, believed by some to look similar to modern hippos.

Pantolestid: any member of the extinct primitve placental **mammal family** Pantolestidae (**order** Pantolesta). Otter-like, with long

sharp canines and broad molars.

Paramyid: any member of the **mammal family** Paramyidae (**order Rodentia**). One of the oldest known families of rodents, they were widespread in the **Eocene Epoch**.

Passeriform: any member of the bird **order** Passeriformes. Known as the 'perching birds' or 'songbirds', the Passeriforms underwent a huge radiation in **Tertiary** times. Includes song thrushes and sparrows.

Pelagornithid: any member of the extinct bird **family** Pelagornithidae (**order Pelecaniformes**). Large seabirds, Olson (1985) argued that the members of the bony-toothed **order Odontopterygiformes** should be included within this family.

Pelecaniform: any member of the bird **order** Pelecaniformes. Includes modern pelicans, cormorants and gannets, and extinct **Pelagornithids**.

Period: a geological time unit (*see* **chronostratigraphy**); of shorter duration than an **era** and itself divisible into **epochs**.

Perissodactyl: any member of the '**ungulate**' (hoofed **mammal**) **order** Perissodactyla (grandorder **Laurasiatheria**). Terrestrial herbivorous creatures characterized by having normally an odd number of hooves or toes, or where the axis of the foot runs down the middle digit. Examples include horses, tapirs and rhinos, and extinct brontotheres and chalicotheres.

Permian Period: a geological time division (*see* **chronostratigraphy**) of the **Paleozoic Era**. Ranging from about 299 until 251 million years ago, it follows the **Carboniferous Period** and precedes the **Triassic Period**.

Phasianid: any member of the bird **family** Phasianidae (**order Galliformes**). Also referred to as the 'pheasant family', it includes the partridge and peacock.

Pholidotan: any member of the placental **mammal order** Pholidota. This small group of mammals commonly known as 'pangolins' or 'scaly anteaters' feed mainly on ants. The oldest undoubted fossils are from Middle **Eocene** deposits.

Phylum (pl. **phyla**): a category used in the **taxonomic** classification of animals, which consists of one or several related **classes**.

Phylogeny (adj. **phylogenetic**): the line, or lines, of direct descent in a given group of organisms.

Pinniped: an aquatic member of the **order Carnivora**. Includes sealions (Otariidae) seals (Phocidae), walruses (Odobenidae), and extinct realtives with fin-like flippers as organs of locomotion. Their nearest realtives are bears.

Pisolite (adj. **pisolitic**): a sedimentary rock consisting mainly of pisoids, which are like **ooids** but larger (>2mm diameter).

Plagiaulacid: any member of the extinct **mammal family** Plagiaulacidae (**order Multituberculata**), which lived in Late **Jurassic** to Early **Cretaceous** times. Small plant eaters.

Pleistocene Epoch: a geological time division (*see* **chronostratigraphy**) of the **Neogene Period** (**Quaternary Sub-era**, **Cenozoic Era**). Ranging from approximately 1.81 million years ago to 10 000 years ago, it follows the **Pliocene** Epoch and precedes the Holocene Epoch.

Plesiadapiform: any member of the extinct **mammal** order Plesiadapiformes, which lived in the **Paleocene** and **Eocene** epochs. These tree-dwelling plant eaters were originally classified as **primates**.

Pliocene Epoch: a geological time division (*see* **chronostratigraphy**) of the **Neogene Period** (**Cenozoic Era**). The second **epoch** of the Neogene Period it is dated to approximately 5 to 1.81 million years ago and follows the **Miocene Epoch** and precedes the **Pleistocene Epoch**.

Polyphyletic: relating to, or characterized by, evolution from more than one ancestral type. For example, the **classes Mammalia** and **Aves**, whose 'warm-bloodedness' was independently evolved.

Portlandian Substage: a **chronostratigraphical** subdivision of the **Tithonian Stage.** The later of two such substages, it ranges approximately from 148 to 146 million years ago and is preceded by the **Bolonian Substage**.

Presbyornithid: any member of the bird **family** Presbyornithidae (**order Anseriformes**). Now extinct, the presbyornithids were present in **Paleocene** and **Eocene** times and have a good fossil record.

Primate: any member of the **mammal** order Primates (**clade Euarchonta,** superorder Archonta). Includes humans, monkeys, apes, chimpanzees, lemurs, lorises and bushbabies and the extinct omomyids and adapids.

Primoscenid: any member of the extinct bird **family** Primoscenidae (**order Passeriformes**), which lived in early **Tertiary** times.

Proboscidean: any member of the **mammal order** Proboscidea. Includes elephants and their relatives and evolved largely in Africa before expanding worldwide as a diverse group in the **Miocene Epoch**. Close relatives include the **orders Sirenia** (sea cows) and **Hyracoidea** (hyraxes).

Procellariiform: any member of the bird **order** Procellariiformes. Includes petrels, shearwaters, fulmars and albatrosses.

Pseudosciurid: any member of the extinct **mammal family** Pseudosciuridae (**order Rodentia**).

Psittaciform: any member of the bird **order** Psittaciformes. Includes parrots and cockatoos.

Quaternary Sub-era: a geological time division (*see* **chronostratigraphy**) of the **Cenozoic Era**. In modern definitions it corresponds to the very latest part of the **Neogene Period** and follows the **Tertiary Sub-era.** It begins in late **Pliocene** times at the beginning of the Gelasian Stage, 2.6 million years ago and ranges up to the present day.

Radiometric dating: methods of dating rocks or minerals using the relative abundances of radioactive and stable isotopes of certain elements, together with known rates of decay of radioactive elements. Radiocarbon dating can extend back to only 50 000 years, but other elements (potassium, argon, lead, uranium) can be used to obtain dates of the order of tens to thousands of millions of years.

Regression: retreat or contraction of the sea as a result of a fall in sea level or **uplift** of the land.

Reptile: any member of the **class** 'Reptilia'. These **amniote vertebrates** have a long fossil history dating back to the **Carboniferous Period**. Characterized by being 'cold-blooded', usually egg-laying, they have an external covering of scales or plates. Examples include snakes, turtles, crocodiles and lizards. Not a **clade**, since it excludes its descendants, the birds and mammals.

Rhaetian Stage: a **chronostratigraphical** division of the **Triassic Period**. The last **stage** of the Late Triassic **Epoch**, it is dated to approximately 204–200 million years and is preceded by the **Norian Stage** and followed by the Hettangian Stage.

Rodent: any member of the **mammal order** Rodentia (**clade Glires**, superorder Anagalida). The largest modern order of **mammals**, over 1800 species exist (40% of all mammal species). Includes mice, rats, squirrels and guinea pigs. The **lagomorphs** (rabbits and hares) are close relatives.

Ruminant: any member of the mammal infraorder Ruminantia (**order Artiodactyla**). These even-toed (cloven-hoofed), usually horned, creatures are characterized by having a stomach divided into three or four compartments and chewing cud. Includes cattle, sheep, goats, deer and giraffes.

Scandentia: a placental **mammal order** of the **clade Euarchonta, superorder Archonta**. Also known as 'treeshrews'.

Sciuromorph: any member of the **mammal** infraorder Sciuromorpha (**order Rodentia**). Includes squirrels and beavers.

Shale: a **mudrock** that splits easily into layers.

Sinemurian Stage: a **chronostratigraphical** subdivision of the **Jurassic Period**. The second **stage** of the Early Jurassic **Epoch**, it ranges from approximately 197 to 190 million years ago and is preceded by the Hettangian Stage and followed by the Pliensbachian Stage.

Sinoconodont: any member of the **mammal family** Sinoconodontidae. A very early and primitive **family** known only from China.

Sirenia: a **mammal order** of the magnorder **Afrotheria**. These large, cylindrical, herbivorous marine creatures are commonly referred to as 'sea cows'. They include manatees and the dugong and their nearest terrestrial relatives are elephants and hyraxes.

SSSI: Site of Special Scientific Interest; the designation of an area of land for statutory protection under the Wildlife and Countryside Act 1981.

Stage: a **chronostratigraphical** division of lower rank than an **epoch**, and usually taken to be the smallest standard unit. The fundamental unit for establishing chronostratigraphical boundaries at all ranks.

Stratigraphy: the study of the temporal and spatial relationships within a rock succession.

Stratotype: a sequence of sedimentary rocks at a particular locality chosen as the standard against which other sequences can be compared. Stratotypes are established for **lithostratigraphical, biostratigraphical** and **chronostratigraphical** units, both regionally

and internationally.

Subsidence: the sinking of a local or regional portion of the Earth's surface with respect to its surroundings.

Synapsid: any member of the clade Synapsida (**class Reptilia**, series **Amniota**), the group that includes mammals and their stem relatives, mammal-like reptiles.

Systematics: the scientific study of the classification of living organisms into a hierarchical series of groups which emphasizes their natural inter-relationships.

Taphonomy: in **palaeontology**, the study of the changes, including transportation, that affect organisms after death, including the physical and chemical interactions that take place between burial of the organism and its subsequent discovery as a fossil.

Taxonomy (adj. **taxonomic**): the science and principles of classification.

Taxon (pl. **taxa**): in biology, a group of organisms; the hierarchical system (largest to smallest group) is kingdom, phylum, class, order, family, genus and species.

Terrestrial: of or relating to the Earth or the Earth's dry land. As an ecological term, referring to animals living on the ground.

Tertiary Sub-era: a geological time division (*see* **chronostratigraphy**), now commonly considered as obsolete. Ranging from 66 to 2.6 million years ago, it is decoupled from the **Neogene** and **Paleogene periods**, and is therefore often referred to as a 'Sub-era', preceding the **Quaternary Sub-era**, and part of **the Cenozoic era**.

Tethys: an E–W-extending major ocean, which separated the southern supercontinent of **Gondwana** from Laurasia in **Mesozoic** times; subducted to form the Alpine–Himalaya mountain belt.

Tetrapod: any member of the **vertebrate** superclass Tetrapoda. Characterized by having four limbs, the first tetrapods arose in the **Devonian Period** and lived an amphibious lifestyle. During the **Carboniferous Period** a new group of tetrapods, the **amniotes** arose, which were able to walk and survive on land. Tetrapods can be considered to have two subgroups, **amphibians** and **amniotes**.

Therapsid: any member of the **order** 'Therapsida' (clade **Synapsida**). These extinct **mammal**-like reptiles lived during late **Permian** to early **Triassic** times and are considered to include the direct ancestors of mammals.

Therian: any member of the **mammal** clade Theria, including all living mammals except the **monotremes**. Divided into two living groups, the **Eutheria** (placental mammals), and the **Metatheria** (**marsupials**).

Tithonian Stage: a sub-division of the **Jurassic Period**. The last division of the Late Jurassic **Epoch**, it ranges from approximately 151 to 146 million years ago and is subdivided into the **Bolonian Substage** and the **Portlandian Substage**.

Transgression (adj. **transgressive**): the inundation of the land by water due to sea-level or lake-level rise or land subsidence.

Triassic Period: a geological time division (*see* **chronostratigraphy**) of the **Mesozoic Era**. Ranging from 251 to 200 million years ago, it is preceded by the **Permian Period** and followed by the **Jurassic Period**.

Triconodont: any member of the extinct **mammal order** Triconodonta. Characterized by the possession of shearing molar teeth with three main cusps.

Tubulidentata: a **mammal order** of the magnorder **Afrotheria**. The sole living member is the aardvark.

Type locality/area: the place where the **type section** (or **stratotype**) for a **stratigraphical** unit is located, or from where the **type specimen** of a fossil came.

Type section: see **stratotype**.

Type specimen: in palaeontology, a single fossil specimen or one of a series of specimens, designated as typifying a named species or subspecies.

Ungulate: any hoofed **mammal** belonging to the superorder Ungulata. According to moprhological characteristics, ungulates are grouped into the **orders Artiodactyla** (even-hoofed representatives), cetacea (whales), **Perissodactyla** (odd-hoofed representatives), Sirenia (sea cows), Hyracoidea (hyraxes), Proboscidea (elephants) and their extinct relatives. On molecular evidence, these orders are divided between two major **clades**, the **Laurasiatheria** and **Afrotheria**.

Unconformity: the surface that separates two sedimentary rock sequences of different ages; it represents a gap in the geological record when there was no deposition, usually accompanied by erosion, and/or tectonism. There is

often an angular discordance between the stratification of the sequences either side of the unconfomrity.

Valanginian Stage: a **chronostratigraphical** subdivision of the **Cretaceous Period**. The second **stage** of the Early Cretaceous **Epoch**, it ranges approximately from 140 to 136 million years ago and is preceded by the **Berriasian Stage** and followed by the **Hauterivian Stage**.

Vertebrate: any animal of the sub**phylum** Vertebrata. Characterized by the presence of a backbone, the vertebrates include the fish, **amphibians**, **reptiles**, birds (**aves**) and **mammals**.

Fossil index

Note: Page numbers in **bold** and *italic* type refer to **tables** and *figures* respectively. This index refers to genus and species names. Higher orders are referenced in the General Index.

Fossil index

Fossil index

Fossil index

General index

Note: Page numbers in **bold** and *italic* type refer to **tables** and *figures* respectively. This index includes supra-generic terms for fossil groups; the genus and species index is provided separately ('Fossil Index'). Figures 1.7 and 1.13 provide the classification of the major groups of birds and mammals.