# REPTILES

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## Contents



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## Summary

Reptiles represent one of the most diverse vertebrate groups on Earth. They greatly exceed the mammals and amphibians in species richness and are nearly as speciose as birds.

Because of their relatively secretive habits, the majority of reptiles are not frequently encountered by humans, who generally remain neutral or positive in their attitude to all but large crocodilians and snakes. Yet their diversity and biomass would imply that reptiles play an important role in maintaining ecosystem services in many parts of the world.

This paper provides an overview of the groups of extant reptiles, the taxa they contain, and their global ranges. The majority of the world's reptiles are currently in decline as a result of anthropogenic impacts on their native habitats and/or increasing exploitation of natural populations for human consumption as pets, skins, food or traditional medicine.

Conserving remaining stocks of reptiles to ensure that they can be exploited sustainably, is currently inhibited principally by lack of knowledge of essential ecological and demographic features of most species, the inability or unwillingness of world governments to prevent over-harvesting of many species and the on-going destruction or degradation of their habitats through intentional or unintentional human interventions, such as agriculture, grazing, timber extraction or the introduction of invasive species.

## 1. Introduction

Approximately 7 500 species of extant reptiles have been formally described: some 15% of the world's described vertebrate fauna, but about 30% of its non-marine (mostly terrestrial) vertebrates. Estimates of the number of species still to be described, based on recent rates of description of new taxa, range from <2% of the currently described fauna in Europe to >30% in New Guinea and parts of tropical South America; the global reptile fauna, therefore, is estimated to comprise about 9 000 species.

Reptiles (excluding birds, see below) differ from other living vertebrates in many features of their anatomy, morphology, physiology, and behavior. Key features which, taken together, distinguish them from all other extant vertebrates and define their ecological roles are the possession of air-breathing lungs; pentadactyle limbs (although these have independently been lost or become vestigial in several groups, such as snakes); impervious keratinized scaly skins; and reproduction on land via internal fertilization and the laying of shelled, cleidoic eggs within which a series of sacs contain the food, water and waste disposal systems needed to support the development of the embryo until it hatches.

Fertilization is internal. In tuataras this occurs by cloacal exchange, as there are no intromittent organs. A single penis occurs in the males of crocodilians and turtles, whereas there are paired penises in lizards and snakes.

Evolved modifications of some of these group characteristics, often independently, have allowed reptiles to exploit a wide range of global environments: for example, various forms of egg retention and allantoic placentation have resulted in viviparous forms in which the developing embryo is incubated within the body of the female; such forms are better adapted to reproduction in cold climates (e.g., lacertid and scincid lizards, elapid and colubrid snakes) or in entirely aquatic environments (e.g., the hydrophiid sea snakes). Digits or entire limbs have been lost or become vestigial in several groups of lizards (primarily as an adaptation to a fossorial lifestyle) and limbs (and other limb girdle elements) have been lost entirely in snakes.

Ecologically and energetically, reptiles are poikilothermic (ectothermic) organisms, dependent on external heat sources to maintain metabolic processes and mobility. Active reptiles must generally maintain their body temperature within a range of 20-35ºC, although species living in extreme climates such as alpine regions, deserts or extreme latitudes tend to have their preferred activity temperature range roughly correlated with the mean annual temperature or annual hours of sunshine of their region. Few reptiles, even under extreme desert conditions, can tolerate a body temperature exceeding 39ºC. Most reptiles must retire to shelter and become dormant when their body temperature rises above 36ºC or falls to about 10ºC, although a few, such as the New Zealand tuataras, actively forage at body temperatures as low as 4ºC.

But a reptile's body temperature does not simply vary with its immediate ambient temperature, and much reptilian activity aims at maintaining a body temperature within

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a relatively narrow optimum range, outside which individuals retreat to shelter sites. In diurnal reptiles, such activity is dominated by periodic basking (shuttling heliotherms), or by exposure to secondary sources of heat, such as warm rocks or soil (thigmotherms). Even nocturnal species may use direct solar heat during the day to elevate body temperature prior to evening activity. Most terrestrial and arboreal reptiles utilize a mixture of heliothermic and thigmothermic behavior to optimize their body temperatures. Fossorial species are generally subject to a narrower daily or seasonal range of temperatures, but select subterranean sites on similar criteria to those of terrestrial species, for example, those with temperature gradients allowing individuals to remain active for feeding and essential metabolic and predator-avoiding activities.

Ectothermy is often viewed erroneously as physiologically inferior to the endothermic capabilities of birds and mammals. But with their concomitantly high metabolic rates and low conversion efficiencies, these warm-blooded vertebrates generally lack the ability to survive prolonged extreme climatic conditions such as droughts or extended periods of extreme heat or cold. Reptiles, in contrast, can (where the climate demands) retreat to deep shelter sites where they can survive without food and free water for weeks or months by becoming inactive and depressing their metabolic rates. It has been argued that many of the giant reptiles of the Mesozoic and later periods were so large that they would have had to evolve endothermy to survive, but the data remain equivocal.

Of particular relevance to reptilian conservation, and the potential negative impacts of global warming, is that temperature-dependent sex determination exists in many oviparous species of turtles, lizards, snakes and crocodilians. Slight deviations on either side of a particular incubation temperature (usually about 30ºC) can result in dramatic changes in the sex ratio of the offspring, and can lead to all males (lower) or all females (higher) if the temperature deviates by more than a degree or two from the mean.

Most reptiles are strictly terrestrial, but many are arboreal and some species of arboreal geckos (Gekkonidae) and dragons (Agamidae) have evolved efficient gliding structures.

Some families of snakes and turtles have evolved adaptations to a primarily marine existence. These include two families of sea turtles (Cheloniidae and Dermochelyidae) and two families of marine snakes (Hydrophiidae and Laticaudidae). Of the remaining families of reptiles, only one lizard in the family Iguanidae (the Galapagos marine iguana, *Amblyrhynchus cristatus*) and one crocodile in the family Crocodylidae (the estuarine crocodile, *Crocodylus porosus*) spend significant proportions of their lives in the sea.

All sea snakes (Hydrophiidae) are viviparous, whereas all other marine species of reptiles are oviparous (see below under family accounts), with the females having to come ashore to deposit their eggs. The selective exposure of breeding females and eggs to terrestrial predators can have profound demographic effects, especially from growing human populations which are able to exploit such species at every stage in their life cycle.

A major barrier to any animal in marine environments is the need to maintain fairly

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constant tissue salt and water balances. Salt water, through osmosis across cell membranes, will rapidly extract water from tissues causing salt buildup and dehydration. All marine reptiles have evolved effective mechanisms for excreting excess salt (as a concentrated brine), via nasal salt glands in marine iguanas (a pre-adaptation, in that such glands had already evolved in several groups of terrestrial iguanid lizards), via salt glands under the tongue or in the roof of the mouth (sublingual and premaxillary glands) in marine snakes, via numerous small salt glands (lingual glands) scattered over the surface of the tongue in many crocodiles, and via tear (Harderian) glands in sea turtles.

Because it is not possible in such a brief article to provide detailed and fully referenced reviews of such a biologically and ecologically diverse group of organisms, the reader is referred to the primary sources and their cited literature in the Annotated Bibliography.

## 2. Diversity and Systematics

Reptiles have traditionally been treated as a distinct Class of vertebrates, and are treated as such here. But this is simply a taxonomic convenience, for in evolutionary terms the reptiles and birds together represent a single clade - birds are essentially feathered, endothermic reptiles.

As indicated above, the extant world reptile fauna is estimated to consist of some 8 000-9 000 species, with about 7 500 named species distributed through four clades (Figure 1), each representing extant Orders (with the exception of birds, already noted above, which are removed from the crocodilian clade and treated elsewhere in this volume as a distinct Class, the Aves).

Order **Rhynchocephalia** (tuataras) - 2 species

Order **Squamata** (lizards, snakes and amphisbaenians) - about 7000 species

Order **Testudinata** (turtles, tortoises and terrapins) - about 250 species

Order **Crocodilia** (crocodiles, alligators and caimans) - about 23 species

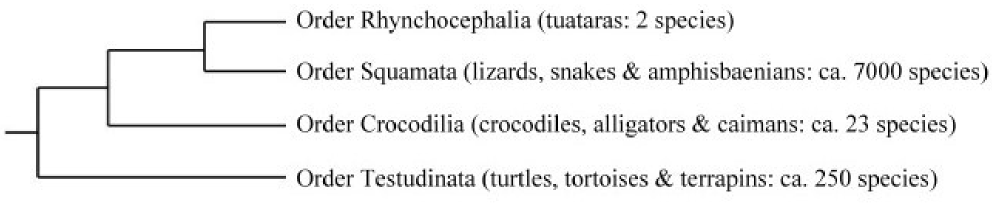


Figure 1. Phylogram of extant orders of reptiles.

The distribution of these species is shown below via world range maps of the 66 families to which they are currently assigned. As a general rule, species richness tends to be greatest in equatorial regions, declining with increasing latitude. While there has been a tendency in the conservation literature for species-richness to be treated as a surrogate for biomass, there appear to be few data to support this assumption. Studies of

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total reptilian biomass are rare, with most biomass estimates confined to particular species rather than to assemblages or communities. Thus while tropical forests are generally regarded as having the greatest reptilian diversity (as measured by species-richness), many temperate woodlands and drylands are highly productive for reptiles, and the total number of individuals and their combined biomass may exceed that of more species-rich habitats.

Further, both high species richness and biomass may reflect not only ecosystem productivity but also ecological/evolutionary opportunism in the absence of ecological analogues in other groups of animals. In Australia, for example, the dearth of mid-sized mammalian carnivores has long been considered to have provided a vacant niche for exploitation by carnivorous lizards of the family Varanidae, which have their greatest species richness and morphological/ecological diversity in that continent.

Most families of reptiles have had a relatively stable nomenclatural history, but cladistic and genetic studies over the past 2-3 decades have led to several changes in family-level classifications which have received varying degrees of acceptance by the herpetological community. The following schema of 66 families, together with brief summaries of their content and distributions, is deliberately conservative in order to make it easier for the general reader to cross-reference and compare family names in other works.

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**Biographical Sketch**

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