

## The Monkey Puzzle

The Monkey Puzzle tree *Araucaria araucana* is a strange looking coniferous evergreen with evenly spaced branches that are arranged in regular whorls around the trunk. They can grow to over 100 feet tall and take on a distinct Christmas tree shape when mature. No one is absolutely sure where the Monkey Puzzle tree gets its name. One charming (and probably false) legend originating out of Europe in the 1800's has it that an Englishman commented on how it would certainly be a puzzle for a monkey to climb and the name stuck.

Although one sees Monkey Puzzle trees throughout the world, cultivated for their distinctive and unusual appearance, they are in fact native to Argentina and Chile in South America where today, outside of zoos, there are no monkeys. Monkeys are, of course, found in South America, but they are largely confined to the tropical, forested regions to the North.

South American monkeys are known as Platyrrhines, or more commonly, "New World Monkeys" and differ considerably from their "Old World" cousins the Catarrhine monkeys having evolved largely in isolation. The name Platyrrhine derives from the broad, flat shape of their external nostrils. All Platyrrhines are small, the largest is only around 10kg. They also exhibit many primitive dental and skeletal features including having three pre-molars. In contrast, Catarrhines (narrow nosed old world monkeys) have, like us, only two pre-molars.

All Platyrrhines have a tail of some sort and five genera have prehensile tails, the most well known of these probably being the spider monkey. The puzzle, so to speak, is why are there monkeys in South America at all? They really shouldn't be there and primatologists and palaeontologists don't know how they got there.

Primates, which in living diversity include, prosimians (galagos, lorises, lemurs and tarsiers), platyrrhines (New World monkeys), catarrhines (Old World monkeys) and hominoids (apes and humans), have their origins in some type of an insectivorous mammal that lived in the late Cretaceous, an epoch which ended 65 million years ago with the extinction of the dinosaurs. The earliest possible primate discovered so far comes from North America and is about 60 million years old. Named *Purgatorius*, this tiny insectivore is only loosely morphologically allied with later primates. There are possible older *Purgatorius* specimens going back into the latest Cretaceous, but most are from dubious context. It is only in the late Paleocene (about 55 million years ago) that we see more numerous remains of primate-like animals appearing in the fossil record.

Known as the Plesiadapiforms these near-primates appear to have evolved in North America and Europe. The Plesiadapiforms radiated into many different niches, but in the early Eocene (about 45 to 50 million years ago), it seems that the rise of rodents caused a rapid decline in the number and diversity of Plesiadapiforms. But Plesiadapiforms are probably not the ancestors of living primates, as they possessed too many specializations to have given rise to the first Prosimian primates that would appear a few million years later. So at this time, the only primate-like mammal that is a firm candidate as ancestor of all higher primates is the tiny *Purgatorius*.

The first true, Prosimian primates appear, and literally explode in diversity, in the early Eocene Epoch (between 54 and 38 million years ago). Eocene aged Prosimian primates are commonly found in North America and Europe and more rarely in Asia and Africa. No early primates have ever been found in South America or Antarctica as the former was an island continent, while we have as of yet found fossil deposits of this age in the latter. In these earliest primates the bony ring around the orbit was complete like in modern primates, nails replaced claws and larger brains were evolved. These early Eocene primates were clearly true primates and took two distinct forms: lemur-like adapids and galago- (bushbaby) like omomyids. Although the living forms are different species, these animals descendants can clearly be seen in the lemurs of Madagascar and the galagos, lorises and tarsiers of Africa and Asia.

As the Eocene drew to a close and the Oligocene epoch began about 37 million years ago, the continents were approaching their modern form and position, with the exception of there being no land bridge between South America and North America. The world was however, in a state of geographical transition. India was colliding with the continent of Asia, lifting the great Himalayas. South America and Australia had pulled away from Antarctica and formed independent island continents. Deep water currents could thus circulate around Antarctica, bringing cold waters northward and subsequently cooling the oceans of the world. At the same time, the rise of the Himalayas blocked the northward curve of the jet stream, changing the climate south of this great mountain range.

Primates in Europe suddenly go extinct while in North America their fossils become increasingly rare and there is a general decline in mammalian diversity. Up until recently the global climatic changes of the early Oligocene have been blamed almost wholly on the mammalian extinctions that occurred at this time, but in November of 2001, scientists from the United States Geological Service announced that what was previously thought to be a relatively small extraterrestrial impact in the Chesapeake Bay area was in fact quite large (around 137 kilometers in diameter), and struck at approximately 35 million years ago, right at the point of extinction of many of the North American primates and at a point of general loss of mammalian diversity. One has to wonder, when combined with the global environmental changes, whether this bolite strike was the proverbial straw that broke the camels back.

And so we reach the nub of the monkey puzzle question: why are there monkeys at all in South America? Prior to about 30 million years ago there are no primates or even primate-like animals in South America. Around 25 to 30 million years ago a wide variety of new forms of mammal suddenly appear in South America but no one knows where they come from. Among the new forms are rare fossil primates which look very much like existing Platyrrhines. As the only major difference in continental position between that of today and then was that no land bridge existed between North and South America, any introduction of primates into South America would require some form of open water crossing, possibly rafting on large fallen tree trunks or large mats of vegetation. Because of relatively shallow water in the South Atlantic during lower sea level periods, there were almost certainly many islands exposed between Africa and South America, effectively bringing the two continents much closer together and making potential rafting hops shorter. In fact, most geophysicists suggest that at the time the open water distance between North America and South America was probably greater than that between the latter and Africa!

Predications of current direction also tentatively support a West to East crossing rather than a North to South rafting event. The fossil record also supports an “Out of Africa theory by raft” for the origin of Platyrrhines. At this time, there are simply no known primates advanced enough in North America to be suitable ancestral candidates of the early Platyrrhines, but Africa has a host of possible ancestral Platyrrhine forms. Further tantalizing evidence of an African connection is the fact that the closest living relatives of South American rodents are the African Hystricids, more commonly known as porcupines.

Of course another possible source for Platyrrhine origins would be Antarctica, but we know nothing about the later fossil record, if it exists at all, of Antarctica at this time. The same may be said about Asia, where there is presently little or no evidence for Platyrrhine origins. And so the great South American monkey puzzle is actually no more complete than it ever was, and the origin of South American monkeys stands as one of the great questions and mysteries of primate evolution.

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