Primate origins: a new synthesis based on data from the fossil record and mammalian genomics

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The origin of the order Primates has fascinated generations of evolutionary biologists and paleontologists, partly because primates differ in several fundamental ways from other mammals, and partly because Primates is the order to which humans belong. Many of the anatomical characteristics that distinguish primates from other mammals relate to their arboreal lifestyle. This explains why primates have evolved nails, rather than claws, on their fingers and toes; why primates have grasping big toes that are functionally akin to human thumbs; and why primates have highly mobile shoulders, elbows, hips and ankles, allowing them to adopt a wide range of body postures in a three-dimensionally complicated environment. Primates also differ from most other mammals in having emphasized vision at the expense of olfaction. As a result, the eye sockets of primates are rotated forward, allowing stereoscopic vision because of the widely overlapping visual fields of both eyes. Primate brains are larger than those of most other mammals. Primates live relatively long life spans and typically give birth to only one or two developmentally precocious offspring at a time. Given the multiple important differences that distinguish primates from other mammals, it is clear that a major anatomical and ecological gap separates primates from all of their living relatives. As a result, there has been little consensus on where primates fit on the evolutionary tree of mammals, where the first primates arose, and what transitional forms may exist in the fossil record.

This lecture integrates current data from the fossil record and comparative mammalian genomics that point toward significant advances in our understanding of primate origins. Evidence from the diverse assemblage of extinct mammals collectively known as plesiadapiforms, typified by *Plesiadapis tricuspidens* from the Paris Basin, indicates that these mammals were not “archaic primates” as they are often portrayed in textbooks. Specializations of their postcranial skeleton link them instead with living Southeast Asian flying lemurs (order Dermoptera). Some plesiadapiforms appear to have shared a more recent common ancestry with living flying lemurs than they do with each other, and paromomyid plesiadapiforms were probably capable of gliding like their modern relatives. Although plesiadapiforms are best regarded as “archaic dermopterans,” their anatomy helps to bridge the gap between living primates and living flying lemurs. These two highly arboreal mammalian lineages appear to be living sister taxa that jointly comprise the higher-level taxon Primatomorpha. Early members of the primatomorph clade were distinguished from ancestral tree shrews and other mammals by having a suite of postcranial adaptations allowing them to exploit the rich array of food resources that were located on vertical tree trunks. Early primatomorphs also developed an advanced pattern of neural projections linking the eyes with the midbrain, indicating an early reliance on stereoscopic vision. Hence, early primatomorphs already were fully committed to life amongst the trees, and this early adaptive shift was retained in the vast majority of living primates and flying lemurs.

The paleontological and anatomical evidence suggesting that flying lemurs are the nearest living relatives of primates has recently been confirmed by the discovery a set of rare genomic rearrangements common to both groups (exonic indels). Because flying lemurs are found only in southeastern Asia, it is most parsimonious to reconstruct the ancestral birthplace of Primates on that continent, rather than Africa.