

Felidae Phylogeny

Classification

Tigers, lions, and caracals all share kingdom, phylum, class, order, and family.

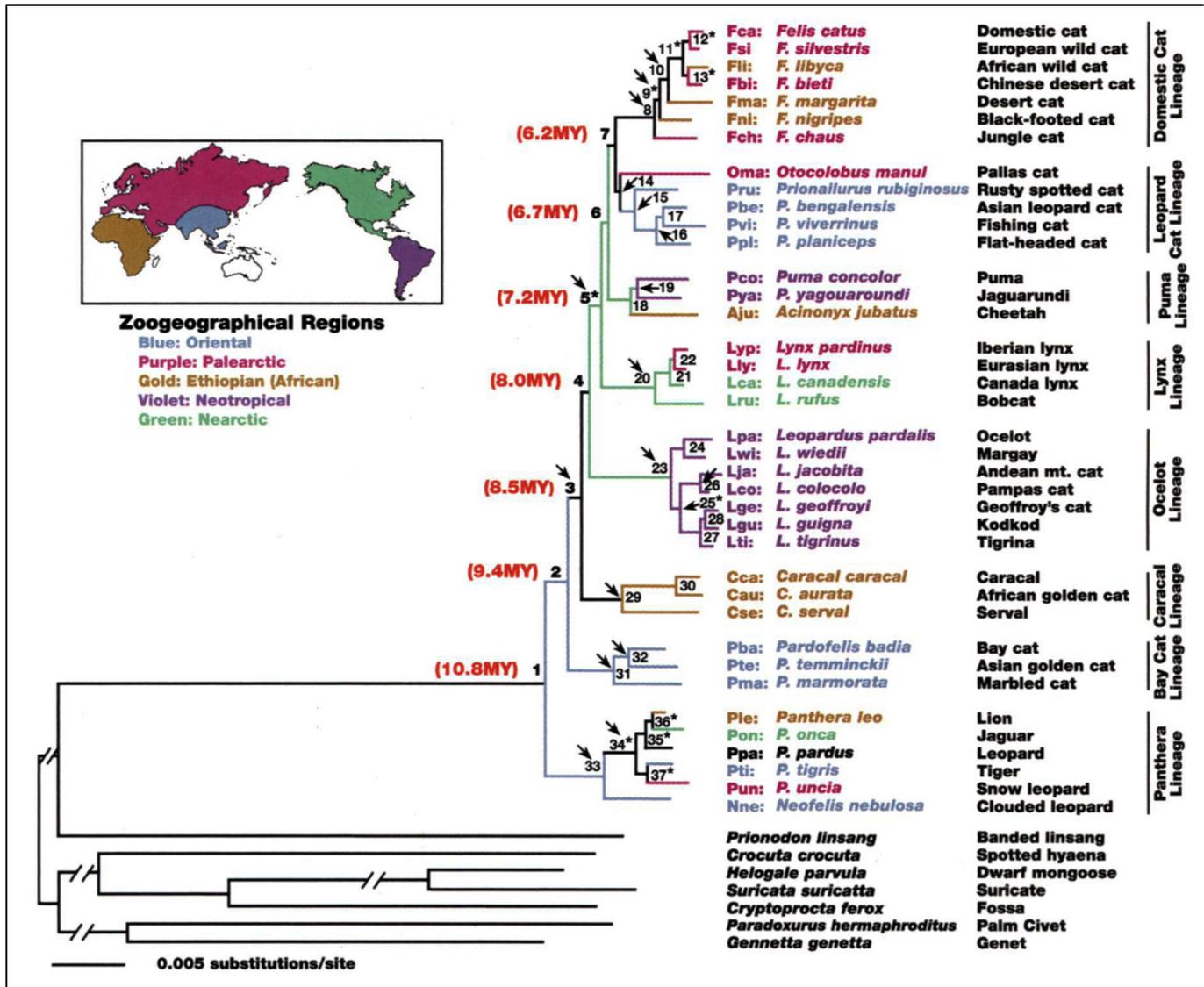
Kingdom: Animalia

Phylum: Cordata

Class: Mammalia

Order: Carnivora

Family: Felidae



Tigers, lions, and caracals are all in the family Felidae (the cat family), and lions and tigers belong to the same genus, *Panthera*. Johnson *et al.* (2006) created a phylogeny for Felidae, pictured above. The most recent common ancestor of lions, tigers, and caracals is also the most common ancestor of all other members of Felidae. Therefore, these three species do not form a monophyletic group.

Members of felidae descend from a common ancestor around 10.8 million years ago (Johnson *et al.* 2006). Within Felidae, the *Panthera* group is the first to diverge, followed by the genus *Pardofelis*. The next group to diverge is the genus *Caracal*. Other genera within the family Felidae include *Leoparda*, *Lynx*, *Acinonyx*, *Puma*, *Otocolobus*, *Prionailurus*, and *Felis*.

Characteristics of Felidae

Synapomorphies

For our lineage, a synapomorphy would entail a trait that arose within Felidae. It is shared by the Felidae common ancestor, but is a trait that is not shared by an earlier common ancestor (i.e. earlier Carnivora ancestor). Thus, a synapomorphy is a derived trait that is shared by multiple lineages.

After reviewing primary literature, we noted three distinct synapomorphies (solitary hunting, hyper-carnivore, and the morphological differences in skull skeletal/muscular structures that accompany these traits). In comparison to other Carnivora species, Felidae differ in their hunting strategy. Felidae are solitary hunters, while other Carnivora (i.e. wolves, hyenas, etc.) are cooperative hunters and hunt in packs (Gittleman 1985).

On this same continuum, Felidae are hyper-carnivores. A hyper-carnivore is defined as a species whose diet is comprised of 70 % or more of meat. The majority of species within Carnivora (bears, dogs, foxes, etc.) are generalists and consume 50-60% meat along with vegetable matter (Holliday 2007). Therefore, it appears the switch to a hyper-carnivore diet is a derived character of Felidae.

Morphological differences in skull skeletal/muscular structures have been associated with being a hyper-carnivore. The crushing function of Felidae teeth has been reduced, their tongue is covered with numerous posteriorly-directed horny papillae, and the facial portion of the skull is shortened (Taylor 2011 and Holliday 2007). Felidae do not need the crushing/grinding function of their teeth as much as they need the lacerating/tearing ability. This has been demonstrated by the increase in the relative length of shearing edges of dentition in comparison to other Carnivora. The papillae on the tongue have been postulated to provide the feline with a better ability to grip and position the meat within the mouth (Taylor 2011). The shortened snout component of the skull is presumed to aid in a higher bite force (Holliday 2007). Since Felidae do not cooperatively hunt, a higher bite force is necessary for the successful capture of prey by a lone individual.

Synapomorphies within our group of species also exist. As clearly noted upon observation, caracals have triangular ears, while other Felidae have rounded ones. Triangular ears have arisen separately from the rest of Felidae and are present in the lineages of *caracal serval*, *caracal caracal*, and *caracal aurata*. However, this trait is not a synapomorphy with other pointed ear cats, as it is hypothesized pointed ears arose independently in these other genera (*Felis* and *Lynx*). See section labeled "Hypothesis" below for a phylogenetic tree including our traits of interest.

Plesiomorphies

In the Felidae family plesiomorphies are found to be traits that are seen in the carnivora or ancestral species and our 3 focal species: tigers, lions, and caracals.

Carnivora Ancestral Traits	Panthera leo	Panthera tigris	Caracal caracal
Carnassial Teeth	✓	✓	✓
Bone-cracking cheek-teeth	✓	✓	✓
Specialized Muscles for stalking/Attacking	✓	✓	✓

Traits such as tooth structure is a big key to identifying how species are classified and related. Predators such as the three focal species above all have carnassial teeth that allow them to shear flesh. Species that were around before all three focal species possessed these meat incising teeth that allowed them to hunt larger prey. Bone cracking teeth are essential, because each focal species and the ancestral species hunt prey that are generally larger. Specialized muscle structure was found to be shared by both the focal species and ancestral species. These muscles increased their hunting efficiency, allowing them to be stealthier as they hunted, but also enabling them to pounce from great distances with accuracy. These various findings have helped scientist link species with distant common ancestors. (Savage1976)(Valkeburgh1999)

Focal Traits

Body Size

Since body size is a continuous, quantitative trait involving many genes, it is difficult to give an exact point in which large body size arose. However, given the smaller size of the clouded leopard (*Neofelis nebulosa*), which weighs around 17kg (Sunquist & Sunquist 2002), the larger body size of tigers, lions, and other members of the genus *Panthera*, it seems likely that large body size arose after the clouded leopard and *Panthera* lineages diverged. In addition, the oldest known common ancestor of the Felidae, *Proailurus lemanesis*, was small compared to cats of the genus *Panthera*, giving extra weight to the hypothesis that small body size is an ancestral trait (Turner *et al.* 2011).

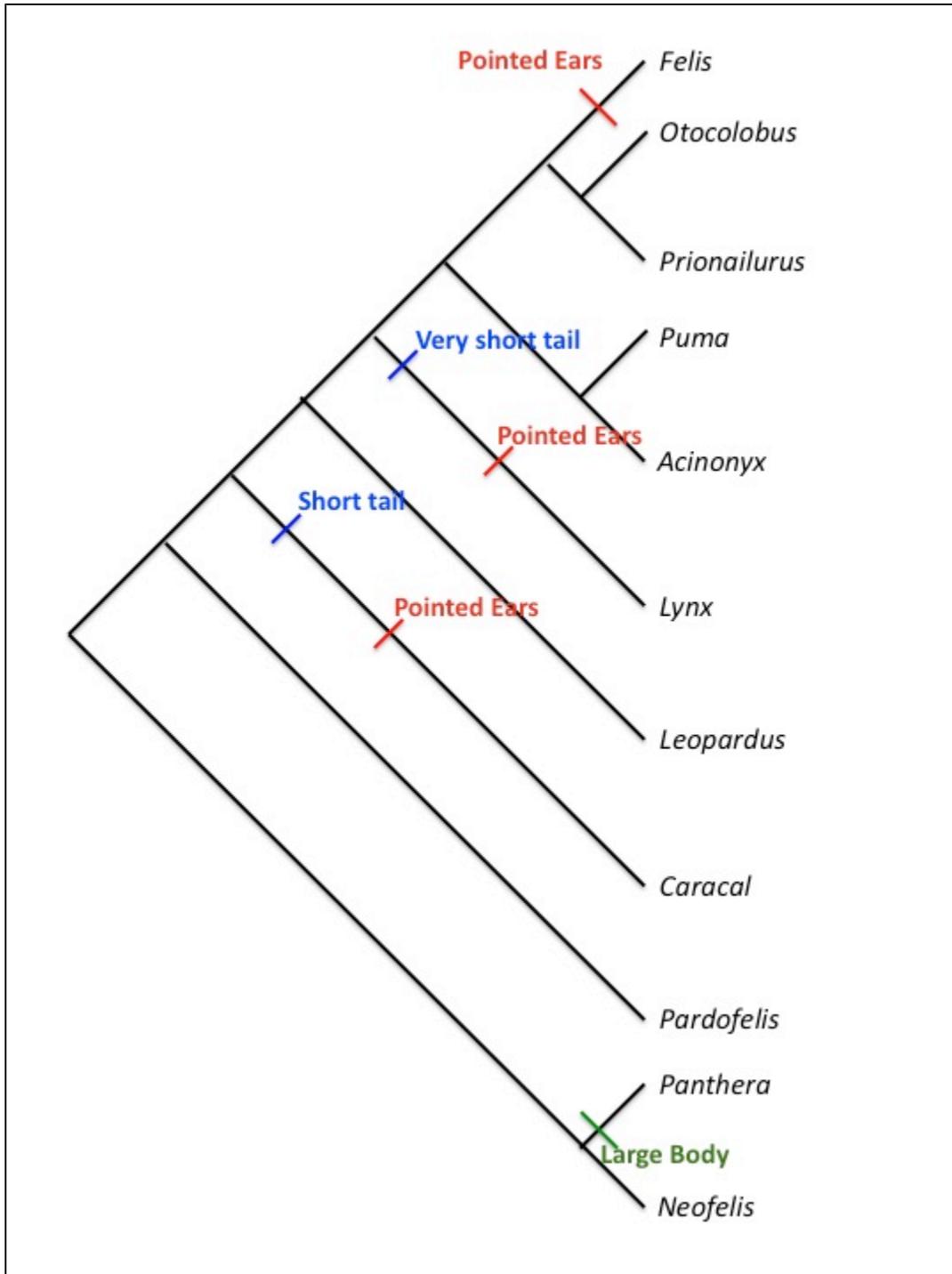
Ear Shape

Cats of the genera *Panthera* and *Pardofelis*, which diverged from other cats before *Caracal*, had rounded ears. This implies that rounded ears are ancestral in Felidae. Understanding when exactly these traits arose, however, is difficult. Most genera in Felidae have rounded ears, however cats in the distantly related genera *Caracal*, *Lynx*, and *Felis* have pointed ears. Pointed ears may have arisen before *Caracal* diverged and reverted in *Leopardus* and after *Lynx* diverged, then arisen again later in *Felis*. However, it is most parsimonious to say that pointed ears is a homoplastic character that arose independently in *Caracal*, *Lynx*, and *Felis*.

Tail Length

Cats of the genus *Pardofelis*, which diverged from other cats after *Panthera* but before *Caracal*, had long tails relative to their body size. This implies that long tails are the ancestral trait in Felidae. Cats in the genus *Caracal* have slightly shorter tails than other cats (excluding the genus *Lynx*). Cats in the genus *Leoparda*, which diverged from other cats after *Caracal*, have longer tails (Sunquist & Sunquist, 2002), making it most likely that short tails arose after *Caracal* diverged.

Hypothesis



Based on phylogeny from Johnson *et al.* (2006).

We hypothesize that small body size, rounded ears, and long tails are ancestral characters in Felidae. Large body size likely arose within the genus *Panthera*. Short tails and pointed ears are likely both homoplastic traits. Pointed ears probably arose separately in the genera *Caracal*, *Lynx*, and *Felis*. Short tails appear to have arisen in *Lynx* and *Caracal* separately.

References

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