**Tree description**

Most intrafamilial relationships are not known and are therefore left as polytomies. This is known to have minor impact on variance-covariance matrix estimation (Finarelli and Flynn 2006, Meloro et al. 2008, Raia et al. 2010). Species first appearance records in the NOW and paleodb databases were used to calculate branch lengths (Finarelli and Flynn 2006, Meloro et al. 2008, Raia et al. 2010). Ages for internal nodes, corresponding to genera, families, orders, and other inclusive nodes were taken directly from the fossil record. For further details see Meloro et al. (2008), Meloro et al. (2010), Carotenuto et al. (2010), Raia et al. (2010), Raia (2010), and Raia et al. (2011).

Ungulates fall within the clade Laurasiatheria, which includes hedgehogs + shrews + moles, bats, whales + artiodactyls, carnivorans, pangolins and perissodactyls (Waddell et al. 1999).

Hippopotamidae and included species were placed within Cetarctiodactyla according to Boisseire et al. (2005). The phylogeny of Suidae and allies follows Orliac et al. (2010) and Made (2010).

As for ruminants, the tree was produced by using the phylogenetic topology in Hernandez-Fernandez and Vrba (2005) and Decker et al. (2009) for living species and interfamilial relationships, and the works of specialists for placing extinct species. The higher-level relationships between ruminants are now reaching a consensus and support a (camels,(chevrotains,(pronghorns,(giraffes,(deer,bovids))))) topology (Decker et al. 2009, Spaulding et al. 2009). *Andegameryx* was assigned to Hypertragulidae (Barry et al. 2005). Within Pecorans, the phylogeny of antilocapridae follows Semprebon and Rivals (2007). Paleomerycids were allied to cervoids (Gentry et al. 1999). *Orygotherium* was considered a true paleomerycid (Vislobokova 2004). *Lagomeryx* and *Stephanocemas* were placed in the Muntiacinae (Janis and Scott 1987, Gentry 1994). Within bovinae, tragelaphini and bovini are sister groups, with nilgai and its fossil relatives (boselaphini) sister to both. Oiocerini were placed close to Caprinae in keeping with Solounias (1981). Urmiatherini and *Criotherium* were allied to ovibovini (Geraads and Spassov 2008). Pliocervini were allied to Cervini (Petronio et al. 2007).

The phylogeny of rhinos follows the comprehensive cladistic analysis in Cerdeño (1995), and taxonomic attribution in Lacombat (2003), for some of the species. In keeping with Cerdeño (1995) we placed *Diaceratherium* in the subfamily Aceratheriinae. Phylogeny and taxonomy of tapiromorph perissodactyls was depicted after Holbrook (1999).

The phylogeny and taxonomy of equids follows Strömberg (2006), and Maguire and Stigall (2008).

Higher-level tree topology and split ages within Carnivora follows Wesley-Hunt and Flynn (2005) and Finarelli and Flynn [2006, see also Finarelli (2008), Meloro and Raia 2010]. Canid subfamilies ages and relationships were taken from Wang (1994), Wang et al. (1999), Finarelli and Flynn (2006), and Tedford et al. (2010). Internal relationships within Borophaginae canids follow Wang et al. (1999). Within Mustelidae, clades arrangement follows Koepfli et al. (2008). Mephitidae are recognized as a separate family allied to a Procyonidae + Mustelidae clade (Flynn et al. 2005). The phylogeny of the Procyonidae follows Koepfli et al. (2007).

Nimravidae are placed basal to other Feliformia, as in Peigné (2003). We depicted internal relationships of this clade according to Peigné (2003) and Morlo et al. (2004) (see Meloro et al. 2008). *Pseudaelurus* and *Proailurus* are considered ancestral to all the other feloids. Within the Felidae family, Machairodontinae forma a distinct subfamily. The phylogeny of machairodont felids follows Slater and Van Valkenburgh (2007). The current phylogeny of Felidae is robust but molecular estimates of time of divergence are not (Johnson et al. 2006), and were thence taken directly from the fossil record. Taxonomy and phylogeny of hyenas follow Werdelin and Solounias (1991) and Turner et al. (2007). Viverridae tree topology was taken from Gaubert and Begg (2007), and Gaubert and Cordeiro-Estrela (2006). Hemicyoninae ursids were placed according to Ginsburg and Morales (1998). For internal relationships within Ursidae we followed Mazza and Rustioni (1994), and Amphicyonidae were considered to be the sister clade to other caniformia (Wesley-Hunt and Flynn 2005b, Finarelli and Flynn, 2006).

The tree topology for creodonts follows Polly (1996), Peigné et al. (2007) and Egi et al. (2005, 2007).

As for proboscideans, we followed the phylogenetic descriptions and age estimates in Shoshani and Tassy (2005), and Thomas et al. (2000).

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