Vestibular sensitivity and locomotor behavior in early Paleocene mammals

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The end-Cretaceous extinction triggered the collapse of ecosystems and a drastic turnover of mammalian communities. During the Mesozoic, mammals were ecologically diverse, but less so than extant species. Modern ecological richness was established by the Eocene, but questions remain about the ecology of the first wave of mammals radiating after the extinction.Postcranial fossils are often used to determine locomotor behavior; however, the semicircular canals of theinner ear also represent a reliable proxy. These canals detect the angular acceleration of the head duringl ocomotion and transmit neuronal signals to the brain to allow stabilization of the eyes and head. Accordingly, vestibular sensitivity to rapid rotational head movements is higher in species with a larger canal radius of curvature and more orthogonal canals. We used high-resolution computed tomography scanning to obtain inner ear virtual endocasts for 30 specimens. We supplemented these with data from the literature to constructa database of 79 fossil from the Jurassic to the Eocene and 262 extant mammals. We compared data on canal morphology and another lifestyle proxy, the size of the petrosal lobules, which have a role in maintaining eyes' movements and position.
We find that Paleocene mammals exhibited a lower average and more constricted range of Agility Indices (AI), a new measure of canal radius size relative to body size, compared to Mesozoic, Eocene and extant taxa. Inthe early Paleocene, body mass and canal radius increased, but the former outpaced the latter leading to an AIdecline. Similarly, their petrosal lobules were relatively smaller on average compared to other temporal groups, which suggests less ability for fast movements. Additionally, Paleocene mammals had similar AIs to extant scansorial and terrestrial quadrupeds. In contrast, the lack of canal orthogonality change from the Mesozoic to the Paleocene indicates no trend toward lower vestibular sensitivity regardless of changes in body size. This result may reflect functional differences between canal orthogonality and radius size. Our results support previous work on tarsal morphology and locomotor behavior ancestral state reconstruction suggesting that ground dwelling mammals were more common than arboreal taxa during the Paleocene. Ultimately, this pattern may indicate that the collapse of forested environments immediately after extinction led to the preferential survivorship of more terrestrially adapted mammals.