= Voalavo =

Voalavo is a genus of rodent in the subfamily Nesomyinae , found only in Madagascar . Two species are known , both of which occur in mountain forest above 1250 m (4100 ft) altitude ; Voalavo gymnocaudus lives in northern Madagascar and Voalavo antsahabensis is restricted to a small area in the central part of the island . The genus was discovered in 1994 and formally described in 1998 . Within Nesomyinae , it is most closely related to the genus Eliurus , and DNA sequence data suggest that the current definitions of these two genera need to be changed .

Species of Voalavo are small , gray , mouse @-@ like rodents , among the smallest nesomyines . They lack the distinctive tuft of long hairs on the tail that is characteristic of Eliurus . The tail is long and females have six mammae . In Voalavo , there are two glands on the chest (absent in Eliurus) that produce a sweet @-@ smelling musk in breeding males . In the skull , the facial skeleton is long and the braincase is smooth . The incisive foramina (openings in the front part of the palate) are long and the bony palate itself is smooth . The molars are somewhat hypsodont (high @-@ crowned) , though less so than in Eliurus , and the third molars are reduced in size and complexity .

= = Taxonomy = =

A specimen of the genus was first collected in 1994 in Anjanaharibe @-@ Sud , northern Madagascar . The genus was named Voalavo in 1998 by Michael Carleton and Steven Goodman , with a single species , the type Voalavo gymnocaudus , restricted to the Northern Highlands of Madagascar . The generic name Voalavo is a Malagasy word for " rodent " . A second species , Voalavo antsahabensis , was named by Goodman and colleagues in 2005 from the region of Anjozorobe in the Central Highlands . The two Voalavo species are closely related and quite similar , but differ in various subtle morphological characters (mainly measurements) and by 10 % in the sequence of the mitochondrial gene cytochrome b .

Voalavo is part of the subfamily Nesomyinae , which includes nine genera that are all restricted to Madagascar . Before the discoveries of Monticolomys (published in 1996) and Voalavo (1998) , all of the known genera within Nesomyinae were quite distinct from each other , so much so that phylogenetic relationships among them long remained obscure . Like Monticolomys (closely related to Macrotarsomys) , however , Voalavo shows clear similarities to another nesomyine genus , Eliurus . In their description of Voalavo , Carleton and Goodman argued that , although closely related , Eliurus and Voalavo form separate monophyletic groups ; but a 1999 molecular phylogenetic study by Sharon Jansa and colleagues , who compared cytochrome b sequences among nesomyines and other rodents , found that Voalavo gymnocaudus was more closely related to Eliurus grandidieri than to other species of Eliurus . This finding called into question the separate generic status of Voalavo . However , tissue samples of Eliurus petteri , a species that is thought to be closely related to E. grandidieri , were not available , so this species could not be included in the study . Data from nuclear genes also supports the relationship between V. gymnocaudus and E. grandidieri , but E. petteri remains genetically unstudied and the taxonomic issue has not been resolved .

Molecular phylogenetic analysis of nuclear DNA supports a close relationship between Eliurus , Voalavo , and two other nesomyine genera , Gymnuromys and Brachytarsomys . These genera are more distantly related to the other nesomyine genera and even more distantly to the other subfamilies of the family Nesomyidae , which occur in mainland Africa .

= = Description = =

Voalavo is a small rodent resembling a mouse with gray fur . Species of the genus are among the smallest known nesomyines , close in size only to Monticolomys koopmani . In terms of external morphology , Voalavo is barely different from Eliurus ; fur coloration patterns , general morphology of the feet , and number of mammae (six) are all the same in both genera . However , all species of

Eliurus have a pronounced tuft of elongated hairs at the tip of the tail , a feature that is absent in Voalavo , although the latter does have slightly longer hairs near the tip . The tail is longer than the head and body . Relative tail length in V. gymnocaudus (136 % of head and body length) is comparable to that of the longest @-@ tailed species of Eliurus , E. grandidieri and E. petteri , but V. antsahabensis has a somewhat shorter tail . Furthermore , the pads of the feet are larger in Eliurus , and specifically , the thenar pad (located at the middle of the tarsus) is circular and fairly small in Voalavo , but longer and larger in Eliurus . On the chest , Voalavo species have a gland that produces a sweet @-@ swelling musk in breeding males ; this gland is absent in Eliurus . Unlike all other nesomyines but Brachyuromys , Voalavo lacks an entepicondylar foramen , an opening on the humerus (upper arm bone) .

The skull of Voalavo also resembles that of Eliurus , with a long facial skeleton , an hourglass @-@ shaped interorbital region (between the eyes) , and a smooth interorbital region and braincase , without ridges or shelves . Other shared characteristics include an essentially featureless bony palate , without many pits and ridges , and a broad mesopterygoid fossa (the opening behind the palate) . In other characteristics , Voalavo resembles some but not all species of Eliurus . For example , the length of the incisive foramina matches the maximum seen in Eliurus species (in this case , in Eliurus majori and Eliurus penicillatus) . The back margin of the incisive foramen is rounded in V. antsahabensis , but angular in V. gymnocaudus . The two species also differ in the shape of the suture (dividing line) between the maxillary and palatine bones , which is straight in V. antsahabensis , but more curved in V. gymnocaudus . The capsular process , a projection at the back of the mandible (lower jaw) that houses the root of the lower incisor , is indistinct in Voalavo , a feature it shares with E. grandidieri , E. majori , and E. petteri , but not the other species of Eliurus .

Other features of the skull distinguish the two genera . The tegmen tympani , the roof of the tympanic cavity , is much reduced in Voalavo relative to Eliurus . The subsquamosal fenestrae , openings in the squamosal bone at the back of the skull , are larger in Voalavo than in Eliurus . The zygomatic plate , a plate at the sides of the skull that roots the front part of the zygomatic arches (cheekbones) , is narrower in Voalavo , and lacks a clear zygomatic notch (a notch formed by a projection at the front of the zygomatic plate) , which is present in Eliurus . Among nesomyines , only Brachytarsomys has a more reduced zygomatic notch .

Like Eliurus , Voalavo has moderately high @-@ crowned (hypsodont) molars with crowns that consist not of discrete cusps , but of transverse laminae (plates) that generally lack longitudinal connections . However , Eliurus molars are slightly more hypsodont than those of Voalavo . The third upper and lower molars are smaller relative to the second molars in Voalavo than in Eliurus . Perhaps as a consequence , the upper third molar lacks discrete laminae in Voalavo , and the lower third molar has only two laminae (three in Eliurus) . There are three roots under each upper molar and two under each lower .

= = Distribution and ecology = =

Both species of Voalavo occur in montane forest . V. gymnocaudus is restricted to the Northern Highlands , where it is found at 1 @,@ 250 ? 1 @,@ 950 m (4 @,@ 100 ? 6 @,@ 400 ft) altitude in Marojejy and Anjanaharibe @-@ Sud . The known range of V. antsahabensis is restricted to the vicinity of Anjozorobe at 1 @,@ 250 ? 1 @,@ 425 m (4 @,@ 101 ? 4 @,@ 675 ft) altitude . Although most of the 450 km (280 mi) between the ranges of the two species consists of montane forest ? suitable habitat for Voalavo ? the area is bisected by the low @-@ lying Mandritsara Window , which may serve as a barrier between the two species . Subfossil remains of Voalavo have been found in the former Mahajanga Province (northwestern Madagascar) .

Very little is known of the ecology of Voalavo antsahabensis , but V. gymnocaudus is thought to be largely terrestrial with some scansorial (tree @-@ climbing) abilities . It is active during the night , bears up to three young per litter , and probably eats fruits and seeds . Various parasites have been recorded on V. gymnocaudus , including mites and Eimeria .

= = Conservation status = =

Because Voalavo antsahabensis has a small range that is threatened by the practice of slash @-@ and @-@ burn agriculture (known in Madagascar as tavy) , it is listed on the IUCN Red List as " Endangered " . Although V. gymnocaudus also has a small range , it is mostly within protected areas , and this species is therefore listed as " Least Concern " .