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Number and Length of Whiskers in Dormice (Rodentia: Gliridae)

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Abstract: Whiskers (vibrissae) are hairs present in most mammals, which transmit vibrotactile information. Until now, information on whiskers in dormice has been scarce. We describe for the first time the number, length and arrangement of whiskers in both garden dormouse and the hazel dormouse and present additional information on those of the edible dormouse. Five cadavers per species were investigated to compare the maximum number of vibrissae as well as the length of buccal vibrissae. Arrangement of whiskers differed between the three species. Hazel dormouse specimens had a maximum number of 33 whiskers whereas the edible and the garden dormice had the same maximum number of 49 whiskers. Length of whiskers differed between species according to their body size and ecology. Anatomical studies on whiskers provide data for comparative studies between different species. Moreover, knowledge about whiskers and whisker use can assist in the design of enriched enclosures for captive mammals.

Key words: vibrissae, behaviour, morphology, *Eliomys quercinus*, *Muscardinus avellanarius*, *Glis glis*

Introduction

Whiskers or vibrissae are slender, curved, tapered, keratinised hairs that transmit vibrotactile information (Grant & Goss 2021). While most mammals use whiskers for orientation, some tactile specialists – mainly small, social, nocturnal and arboreal species such as dormice tend to have extraordinary long and numerous whiskers, which they use to scan the environment, especially during locomotion and foraging (Arkley et al. 2017, Muchlinski 2010, Sokolov & Kulikov 1987). The complex, dynamic and non-contiguous nature of their environment presents unique cognitive, locomotory and sensory challenges to canopy-dwelling animals (Harel et al. 2022). Whiskers occur in groups or singly with the majority of vibrissal groups being concentrated near the mouth, eyes or ears (Sokolov & Kulikov 1987). There are marked differences between species with respect to whisker arrangement, number, length, musculature, development and growth cycles (Grant & Goss 2021, Muchlinski 2010, Sokolov & Kulikov 1987). However, nearly everything known about whiskers and whisker use derives from just a handful of species, including laboratory rats *Rattus norvegicus* and mice *Mus musculus* as well as some species of pinnipeds and marsupials (Greaves et al. 2004, Hirons et al. 2001, Ibrahim & Wright 1975). Until now, information on whiskers in dormice is sparse and does not include the garden dormouse *Eliomys quercinus*. We therefore describe for the first time

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the number, length and arrangement of whiskers in the garden dormouse and compare them to the hazel dormouse *Muscardinus avellanarius* and the edible dormouse *Glis glis*.

Materials and Methods

Specimens (garden dormice: $n = 5$; hazel dormice: $n = 5$; edible dormice: $n = 5$) used for this analysis are derived from free-living populations in Germany (Table 1) and were found dead. They were stored in frozen condition until the date of examination. After defrosting the animals, vibrissae on either the left or right side of each cadaver's face were plucked (vibrissae were counted on only half of the face) and arranged on a sheet of paper according to their position on the head. Following Pocock (1914), positions of vibrissae were referred to as: (a) buccal (on the muzzle, upper and lower lip and chin), (b) genal (on the cheek) and (c) superciliary (over the eye) (Fig. 1). No distinction was made between buccal and interramal (chin) whiskers and no subocular vibrissae were found in the specimens studied.

The vibrissae were counted and the length of every hair was measured using the freeware image analysis program ImageJ (Schneider et al. 2012). As vibrissae can fall out peri- or post-mortem (Pocock 1914, Sokolov & Kulikov 1987), we used the maximum numbers for comparison between species. Following Sokolov & Kulikov (1987) and Dougill et al. (2020), for interspecies comparison whisker lengths were normalised against the species' body lengths (hazel dormouse: 80 mm, garden dormouse: 135 mm, edible dormouse: 170 mm). As no difference was found between the length of vibrissae in males and females (Sokolov & Kulikov 1987), we did not differentiate between sexes. Statistical analysis was performed using the Kruskal-Wallis Test and Dunn's Multiple Comparison Test in GraphPad Prism (Version 5.00 for Windows, GraphPad Software, San Diego California USA).

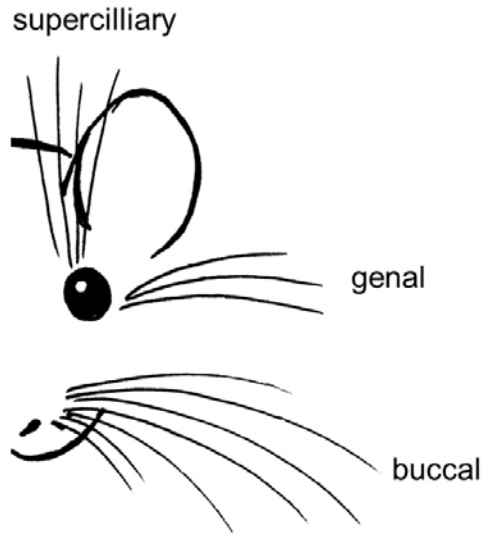

Fig. 1. Positions of vibrissae on the head of dormice referred to in this paper.

Table 1. Origin of specimens and number of whiskers for individuals of three dormouse species from Germany.

Specimens	Origin		Number of whiskers		
	Federal state	Coordinates	Buccal	Genal	Superciliary
Hazel dormouse 1	Northrhine-Westfalia	N 50.7° / E 7.1°	20	1	0
Hazel dormouse 2	Hesse	N 50.8° / E 9.5°	17	1	0
Hazel dormouse 3	Hesse	N 50.6° / E 9.0°	27	1	0
Hazel dormouse 4	Hesse	N 50.8° / E 9.5°	30	1	0
Hazel dormouse 5	Hesse	N 50.8° / E 9.5°	31	1	1
Garden dormouse 1	Hesse	N 50.0° / E 8.4°	44	3	2
Garden dormouse 2	Hesse	N 50.0° / E 8.4°	34	2	2
Garden dormouse 3	Hesse	N 50.1° / E 8.5°	42	3	2
Garden dormouse 4	Hesse	N 50.0° / E 8.3°	38	2	2
Garden dormouse 5	Hesse	N 50.1° / E 8.5°	40	2	2
Edible dormouse 1	Rhineland-Palatinate	N 50.2° / E 7.5°	42	2	3
Edible dormouse 2	Rhineland-Palatinate	N 50.2° / E 7.5°	33	4	2
Edible dormouse 3	Saxonia	N 50.9° / E 14.3°	38	2	2
Edible dormouse 4	Saxonia	N 50.9° / E 14.3°	38	3	2
Edible dormouse 5	Saxonia	N 50.9° / E 14.3°	42	1	3

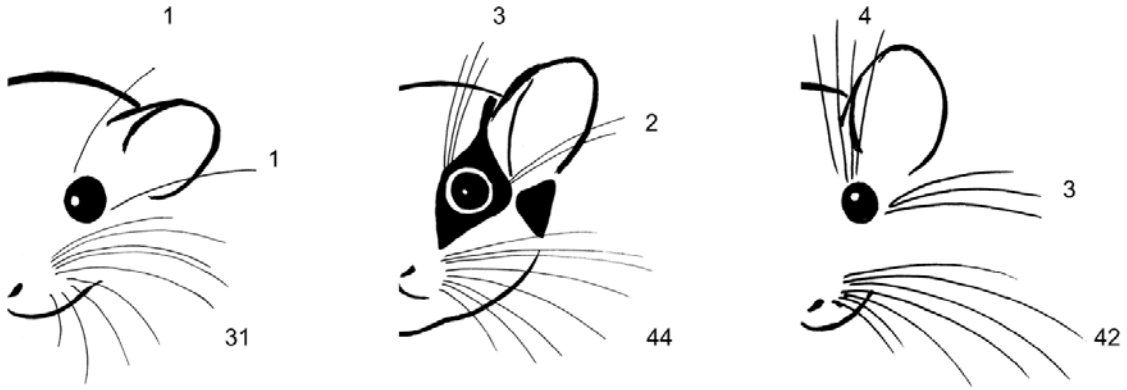

Fig. 2. Arrangement and maximum numbers of whiskers in the hazel dormouse, the garden dormouse and the edible dormouse (from left to right).

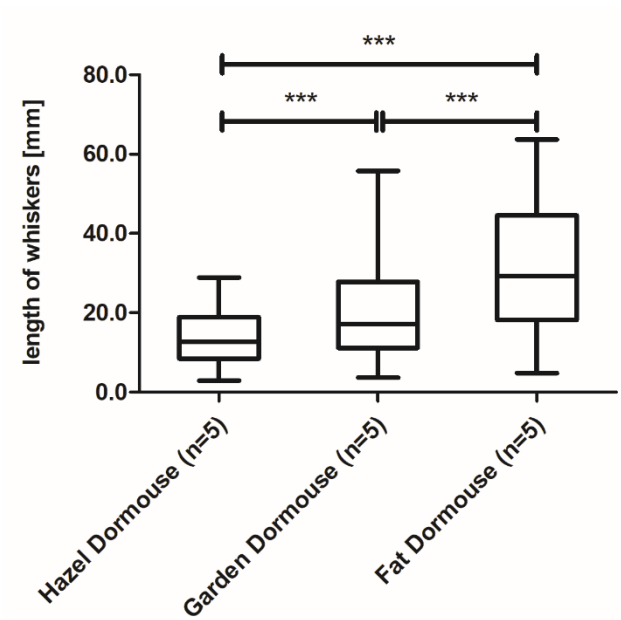

Fig. 3. Absolute length of the buccal whiskers of five hazel dormice, garden dormice and edible dormice each. Boxes show the first and the third quartile. The median is indicated by the line across the box. Minimum and maximum values are represented by the "whiskers" of the box plots. The asterisks mark significant differences between the species.

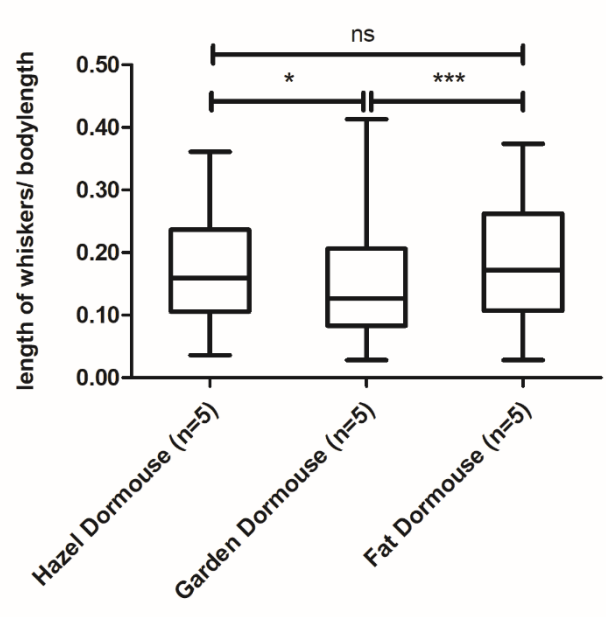

Fig. 4. Relative length of buccal whiskers of the hazel dormouse, the garden dormouse and the edible dormouse. Boxes show the first and the third quartile. The median is indicated by the line across the box. Minimum and maximum values are represented by the "whiskers" of the box plots. The asterisks mark significant differences between the species. "ns" stands for non-significant.

Results

The number of whiskers differed between the specimens (Table 1). The edible dormouse and the garden dormouse specimens had the same maximum number of whiskers (49). Hazel dormouse specimens had a lower maximum number of whiskers (33). Arrangement of whiskers differed between the three species (Fig. 2).

The absolute length of buccal whiskers was significantly different ($p < 0.05$) between species. Dunn's Multiple Comparison Test showed significant differences between all three species. Buccal whiskers were shortest in the hazel and longest in the edible dormice. In relation to body length, garden dormice had significantly ($p < 0.05$) shorter buccal whiskers than the two other species (Fig. 4).

Discussion

Number and arrangement of whiskers differed between the three species. In the hazel dormouse specimens, a maximum number of 33 whiskers were counted, whereas the edible and the garden dormice had the same maximum number of 49 whiskers. To our knowledge, the edible dormouse is the only

one of the three species whose whisker number has been published to date. Sokolov & Kulikov (1987) found 30 vibrissae at the head region, including 2 genal and 2 superciliary vibrissae. With 3 genal, 4 superciliary and 42 buccal vibrissae, we found a higher maximum number in our specimens. This difference might be artificial because vibrissae can fall out peri- or post-mortem (Pocock 1914, Sokolov & Kulikov 1987) but differences in whisker number between populations cannot be ruled out either.

Whiskers and their use enable mammals to rapidly, tactually scan their environment to guide locomotion and foraging in efficient manner, especially in complex habitats such as forest canopies. We therefore expected not only differences in absolute whisker length according to the different size of the species studied, but also differences in relative whisker length according to the different habitat use. Hazel and edible dormice are strictly arboreal species living in the canopy, the edge of forests and in shrubs (Juškaitis 2014, Juškaitis & Šiožinytė 2008). Garden dormice use a variety of habitats, from deciduous to coniferous to mixed forests, from plains to hilly landscapes as well as cultivated lands and urban areas (Bertolino et al. 2008, Storch 1978, Nava et al. 2024). They are less arboreal than the two other species (Bertolino 2017, Kelm et al. 2015) and it was therefore not surprising that the relative length of their whiskers was shorter than that of both hazel and edible dormice.

Anatomical studies on whiskers not only provide data for comparative studies between different species. Knowledge of whiskers and whisker use can also be helpful in designing enriched enclosures for captive mammals. Given the importance of whiskers for exploration, foraging, and social interactions, the welfare of a captive animal is enhanced if it has a diverse range of objects, textures and climbing frames to explore tactually, manipulate and interact with (Arkley et al. 2017).

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