Identification of bat fossil petrosals from Zoolithenhöhle (Burggailenreuth, Franconia, Germany) via micro-CT 3D modelling

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BACKGROUND

Both modern and fossil bats are considered good indicators of changes in climate and vegetation cover. Each species has specific ecological requirements and responds quickly to environmental changes. Thus, the study of fossil bat faunas responses to palaeoenvironmental and climatic changes can contribute to the conservation of today's species.

The chiropteran palaeontological record is often exceptional. Moreover, unambiguous morphological determination is based exclusively on mandibles, maxillae, isolated teeth, and distal epiphysis of the humerus. However, the petrosal part of the temporal bone is also commonly preserved in deposits due to its high density and round shape. Given these bones' potential, here we investigate the external and internal morphology of nine isolated bat petrosals from Zoolithen cave through µCT 3D reconstructions.

Learn more about the cave

See more about internal ears

MATERIALS & METHODS

- 9 isolated petrosal bones from Zoolithen cave
- High-resolution µCT scanning
- Segmentation and 3D modelling of:
  - Petrosal bone and stapes (if present)
  - Bony labyrinth endocast
  - Nerve pathways endocasts
  - Main cochlear vasculature
- Identification based on petrosal morphology, after Sapper (2005)
- Up to 19 different endocast measurements + 6 on the petrosal → PCAs

RESULTS

Wear the glasses!

M. exilis/daubentonii
[= *M.* cfr. *daubentonii* (Sapper, 2005)]
→ intermediate form between *M. exilis* and *M. daubentonii* (Lower to Middle Pleistocene)

M. cfr. *brandtii*
↕
Cryptic species
↕
M. cfr. *mystacinus*

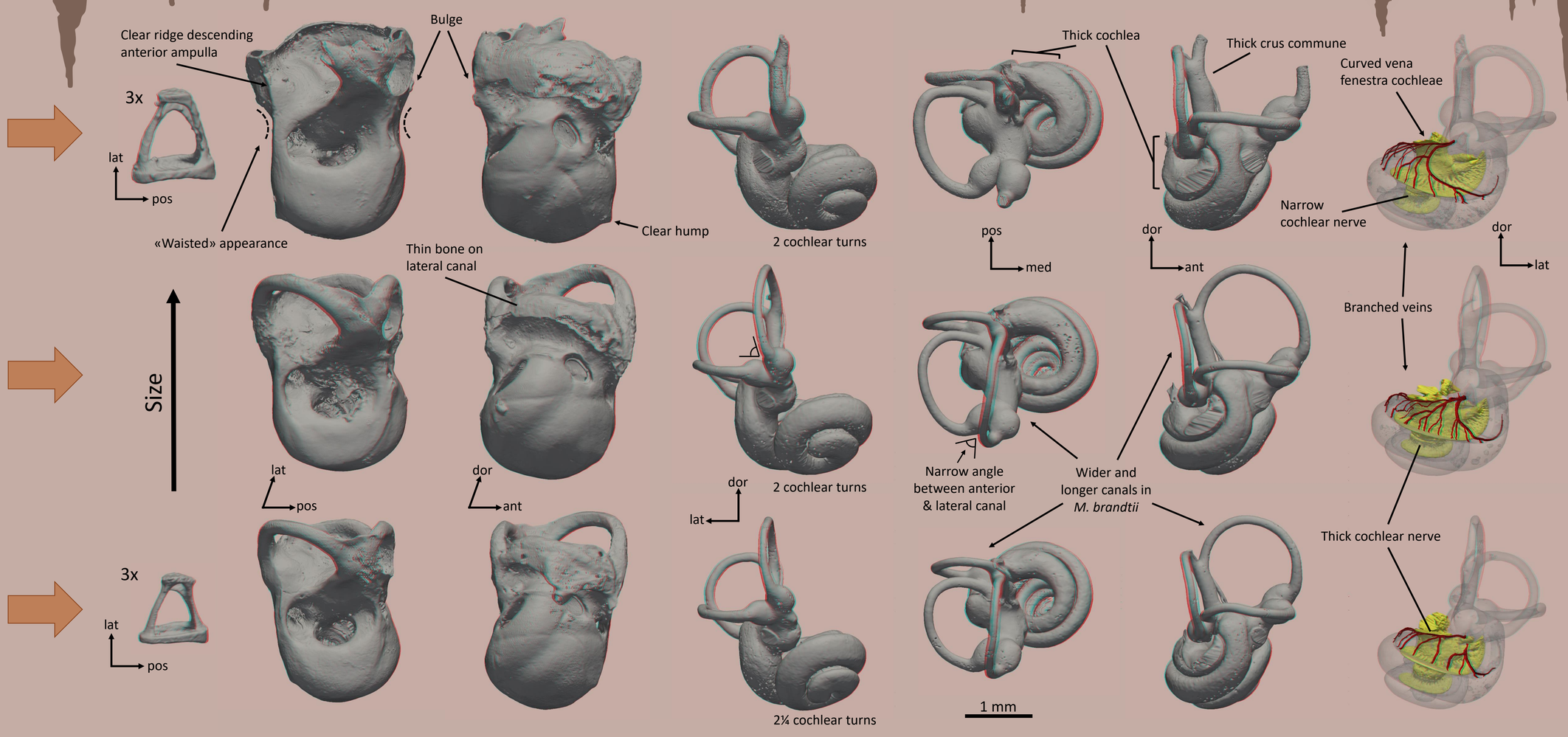

Fig. 1 – Comparison of the three species. 3D models anaglyph. From left to right: stapes in ventral view; petrosals in dorsomedial and ventrolateral view; endocasts in anterior, dorsal, lateral and posterior view.

DISCUSSION

- *M. brandtii* and *M. mystacinus* (cryptic species) could be distinguished
  - Measurements from only the petrosal bone show less clear separation
  - Reconstructed endocasts are a good proxy for precise identification
- Endocasts of bony labyrinth and innervations show species-specific morphology
- The vasculature presents a wider intraspecific variability
- *M. brandtii* and *M. mystacinus* samples are metrically closer to Lower & Middle Pleistocene size
- The faunal composition - however the small sampling - is different than what expected from other bones
- Morphology and size point at an older age (Lower and Middle Pleistocene) than conventional ^{14}C-dating of bone carbonate (max. Upper Pleistocene)

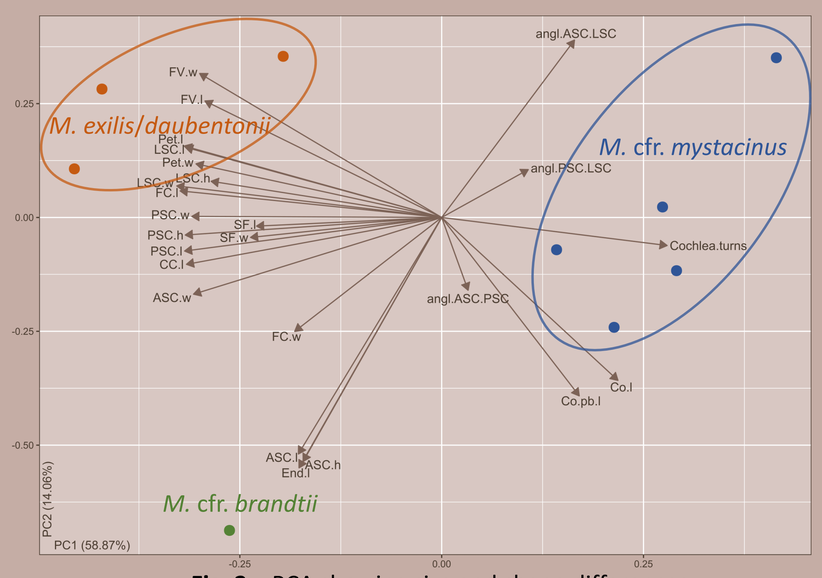

Fig. 2 – PCA showing size and shape differences.

CONCLUSIONS

- µCT methods improve the identification of broken samples and cryptic species
  - Greater detail, immediate manipulation, and improved visualization
  - Endocasts morphology is systematically relevant
- Petrosals can be used to identify fossil bat remains
  - The fauna characteristics can then be interpreted in palaeoecological and palaeoclimatic terms
  - While other bat bones offer a limited biostratigraphic value, the petrosal bones display variations in morphology and size through time that could be useful for biochronological timescales

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Literature

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