Dental Variation in Pteropodidae (Chiroptera: Mammalia)

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BACKGROUND

Pteropodidae is a family comprised of usually frugivorous, non-echolocating bats that occupy a large geographic range. Their sister taxa include other chiropterans, most of which are insectivorous and echolocating. Pteropodids are on average the largest bats and have undergone considerable increases in body size over the last 54 million years (Figure 1). Patterns of dental morphology may have implications for the specialization of the megabat diet, evolution of body size, and the wide geographic distribution of Family Pteropodidae.

METHODS

- We measured 102 total megabat specimens (Family: Pteropodidae) from the MVZ collection. They represent 2 subfamilies, 3 genera, and 6 species of pteropodid (Table 1, Figure 1).
- We used digital calipers to measure the lengths and widths of the premolars and molars of the maxilla and mandible of each specimen (Figure 2). We calculated the molar module component (MMC) and premolar/molar module (PMM) of each specimen following Hlusko et al. 2016 (Figure 2).
- We compared differences in dental metrics and MMC and PMM ratios across sex, species, and genus. All statistics and figures were done in R (version 3.1.2) [1].

Table 1. Pteropodidae Species Sampled

Species	Female (n)	Male (n)	N
Dobsonia minor	4	10	14
Dobsonia moluccensis	3	2	5
Rousettus amplexicaudatus	25	6	31
Pteropus conspicillatus	16	4	20
Pteropus woodfordi	1	1	2
Pteropus yapensis	14	16	30
Total	63	39	102

n = sample size   N = total sample size

Figure 2. Illustration of Measurements and Ratios

A. Palatal view of a *P. conspicillatus*.
B. Occlusal view of a *P. conspicillatus* mandible.
C. Length and width measurements are always perpendicular.

MMC and PMM ratios capture size-independent genetic patterning mechanisms [2].

$$MMC = \frac{M_3 \text{ length}}{M_1 \text{ length}} \qquad PMM = \frac{M_2 \text{ length}}{P_4 \text{ length}}$$

Notation
P: premolar   Superscript: maxillary position
M: molar   Subscript: mandibular position

Photo courtesy Madeleine Zuercher

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RESULTS

- Dental metrics capture variation in body size rather than phylogenetic relatedness (Figure 3A, a-d).
- We find no sex differences in dental metrics or ratios except in the P_4 of *R. amplexicaudatus*, a sexually dimorphic species (p<0.05).
- PMM is significantly lower in *Dobsonia* than other genera. MMC is significantly different between all genera (ANOVA, Figure 3A, e-f).
- A bivariate plot shows clear discrimination of genera using the MMC and PMM phenotypes (Figure 3B).
- PCA shows discrimination of species using dental metrics and captures body size variation, with the only overlap seen between *D. moluccensis* and species of *Pteropus* (Figure 3C).
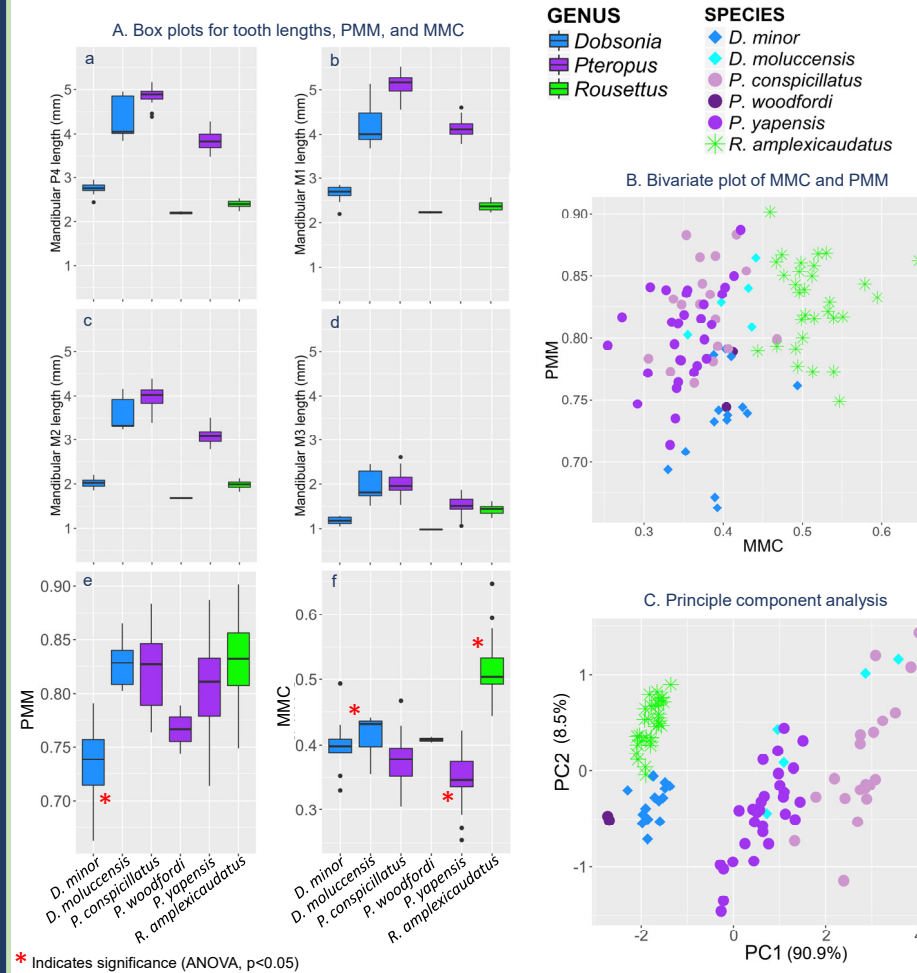
Figure 1. Background on Pteropodidae

A. Examples of species used in this study, from the MVZ.
B. A large megabat, *Pteropus conspicillatus*, hangs in a tree [3].
C. The phylogeny of the species sampled [4]. The pteropodid lineage has been estimated to be 54 million years old [5].
D. Sampling locations of the specimens used represents a subset of the species' larger ranges. Locations taken from MVZ catalog.

Figure 3. Variation in Dental Metrics and Genetic Patterning Ratios

A. Box plots for tooth lengths, PMM, and MMC

GENUS
- *Dobsonia*
- *Pteropus*
- *Rousettus*

SPECIES
- *D. minor*
- *D. moluccensis*
- *P. conspicillatus*
- *P. woodfordi*
- *P. yapensis*
- *R. amplexicaudatus*

B. Bivariate plot of MMC and PMM

C. Principle component analysis

* Indicates significance (ANOVA, p<0.05)

CONCLUSIONS

- Variation in dental metrics reflects body size variation in megabats.
- There is clear taxonomic discrimination using genetic patterning ratios (MMC and PMM).
- *Dobsonia minor* and *Rousettus amplexicaudatus* are distinct from other species in their low PMM and high MMC ratios respectively, which may reflect differences in ecological and/or evolutionary strategies.
- We plan to further investigate dental variation and biogeography in future studies.

REFERENCES: [1] R Core Team 2016. [2] Hlusko, L. J., Schmitt, C. A., Monson, T. A., Brasil, M. F., & Mahaney, M. C. (2016). *Proc Nat Acad Sci*. [3] iNaturalist.org (2018). [4] Almeida, F. C., Giannini, N. P., DeSalle, R., & Simmons, N. B. (2011). *BMC Evol Biol*. [5] Agnarsson, I., Zambrana-Torrelio, C. M., Flores-Saldana, N. P., & May-Collado, L. J. (2011). *PLoS Currents*.