Species boundaries of brushtail possums in the Queensland wet tropics

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Introduction

The *Trichosurus* genus of possums is a group of nocturnal, primarily herbivorous marsupials (Order Diprotodontia, Family Phalangeridae) found throughout Australia, with an introduced population in New Zealand. Despite the abundance of the genus throughout its range, the species boundaries within the genus remain relatively obscure. The wet tropics of Queensland in northeastern Australia are home to two different kinds of brushtail possums: the common brushtail, *Trichosurus vulpecula*, which is gray-furred and found throughout Australia; and the coppery brushtail, *Trichosurus johnstonii*, which is reddish-brown in color and unique to the wet tropics of Queensland. Previous research has been inconclusive as to the real species status of these possums. By quantifying differences in skull and body morphology, we hope to make a recommendation as to whether *T. vulpecula* and *T. johnstonii* are the same species.

Methods

A total of 45 skulls and pelts were measured from *Trichosurus* specimens collected in Queensland, Australia. Specimens were obtained from the NMNH and the AMNH. For each skull, a series of 21 measurements was taken, many following the precedent set in Kerle, et al. (1991). These measurements are depicted in Figure 2. The measurements were recorded to the nearest .1 mm using calipers. In addition to these 21 measurements, age was determined based on the condition of the teeth and a suture at the base of the skull.

Another series of measurements were conducted on the pelts of specimens. These measurements were gathered from the data tag on each specimen. If a total length, tail length, or hind tarsus length were not known from the tag, the measurement was collected from the pelt of the specimen. Pelts and skulls were only used as study specimens if their locality was known from the specimen tag. Only adults in which all measurements could be collected were used in the principal component and cluster analyses.

Figure 1. Sampling locations of possums

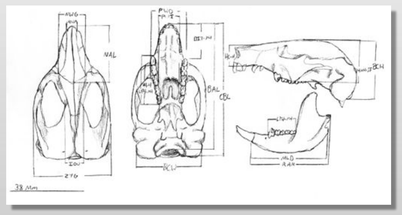


Figure 2. Skull measurements taken (Adapted from Kerle et al. 1991). Illustrated by D. Rowsey.

Image Credit: Donald Hobern, Aranda, ACT

Image Credit: Ken Clifton, Atherton, QLD

Results

Using a t- test, Females of both species tended to be similar in skull morphology, but male coppery possums had significantly larger tooth measurements than gray males (see Figure 3 inset.) Most strikingly, both male and female coppery possums had a longer tail than gray possums (t_{male} = 3.86, 12 d.f., p = .0011; t_{female} = 7.54. 19 d.f., $p < 1^{*}\ 10^{-6}$).

A principal components analysis was used to test for differences in skull dimensions. After removing uninformative variables, a scatter plot of the scores for each individual shows that coppery males tend to have higher scores than gray males at the third component. An examination of the factors that control the plotting of these points indicates that tooth dimensions are the controlling factors (See figure 3). Interestingly, no clear grouping was found among females of coppery and gray brushtail possums.

A cluster analysis was performed using the PCA scores for each individual's body measurement scores. The analysis shows consistent grouping of almost every coppery individual in a distinct cluster (Figure 4).

A discriminant function analysis of skull measurements suggests not only clear grouping of individuals based on species, but also that there is more skull dimorphism among gray possums than coppery possums (Figure 5).

Figure 3. PCA for male QLD *Trichosurus* specimens. Green diamonds: Gray males; Blue squares: Coppery males. **Inset:** Loadings of male possums at third component. Measurements that showed a significant difference in size between the two groups are marked brown.

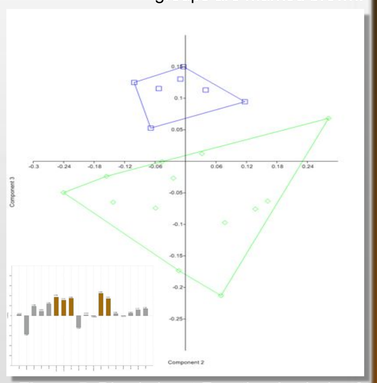
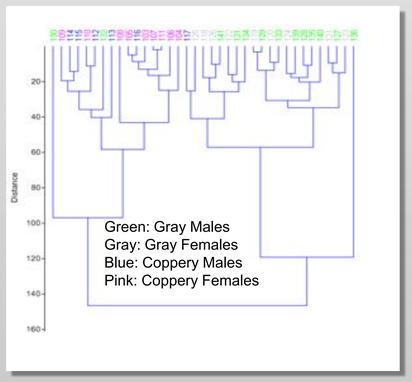
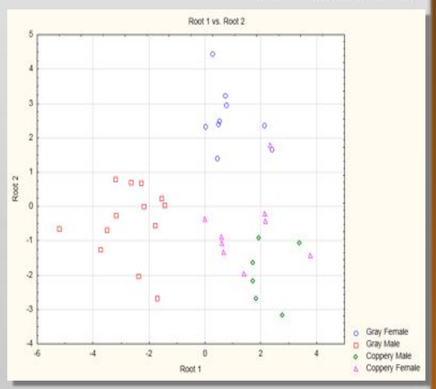


Figure 5. Discriminant Function Analysis of skull measurements.

Figure 4. Cluster Analysis of QLD possum specimens based on external body measurements.





Discussion

The results lend support for the hypothesis that *Trichosurus vulpecula* and *Trichosurus johnstonii* are, in fact, two distinct species. The primary support for this hypothesis comes from the external measurements taken on these specimens, with tail length being the most decisive factor. *T. johnstonii*, on average, has a longer tail than *T. vulpecula*, and males of *T. johnstonii* also have larger molars than *T. vulpecula*.

A surprising result was the lack of sexual dimorphism in *T. johnstonii*. This finding suggests that the ecology of these species may be different. Additionally, the trait of a coppery pelt may be an ontogenetically derived one, as we viewed photographs of adult coppery possums with juveniles that had only small amounts of coppery color in the fur. A larger sample size will help ensure that no sampling error has occurred, and additional skull/external measurements or techniques may elucidate differences between the two species that were not detected by the techniques utilized in this study.

We recommend performing a molecular analysis of these possums to confirm our findings. Furthermore, a survey of the two species to determine their abundance is necessary to ensure that neither species is experiencing decline, as has happened with *T. vulpecula* in the Australian interior (Taylor 2004). Finally, a comparative study of juveniles may confirm the ontogeny of the coppery coat trait.

Conclusions

- Support for *T. johnstonii* as a separate species
- Tail length and male tooth size are main distinguishing characteristics
- More sexual dimorphism within *T. vulpecula* than *T. johnstonii*
- Larger sample size, genetic analysis, and additional measurements may solidify evidence presented in this study

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