

BACKGROUND AND RESEARCH QUESTIONS

1. Snout shape is a defining ‘trait’ of different ecological groups in extant and extinct ruminant species

2. Previous assessment of snout shape lacked rigour, or created gaps between groups based on limited sampling

A. To what extent can these functional groups of browsers and grazers be delimited within a statistically-robust and geometry-based framework?

B. Can ornithopod dinosaurs, extinct analogies of ruminants, be classed in a similar manner using the ruminant morphospace as a classification basis?

AIMS AND OBJECTIVES

1. To identify a morphospace that describes the geometry of ruminant snouts (ventral aspect of premaxilla) using principal components analysis

2. To see if snout shape can be used to delimit discrete functional groups (browsers and grazers) using a canonical variates analysis

3. To identify that major modes of shape variation that describe the different functional groups

4. To see where ruminants of ‘unknown’ ecology plot in this functional morphospace

5. To test how ornithopod dinosaurs project into the morphospace, and whether we can infer their ecologies based on this

MATERIALS AND METHODS

1. Ventral outlines of the premaxillae of 121 ruminant species were digitised, and delimited into ecological groups based on a range of secondary criteria

2. Outlines were transformed into chains of 100 equally-spaced and interpolated semi-landmarks, using the maxilla-premaxilla junctions as the start and end points

3. Landmark data were subject to a Procrustes (Generalised Least Squares) superimposition for analysis in shape, not form, space

4. Superposed data were subject to a covariance-based Principal Components Analysis, then a Canonical Variates Analysis

5. Unknown species were projected in this space to analyse their shapes and which groups they may belong to

RESULTS

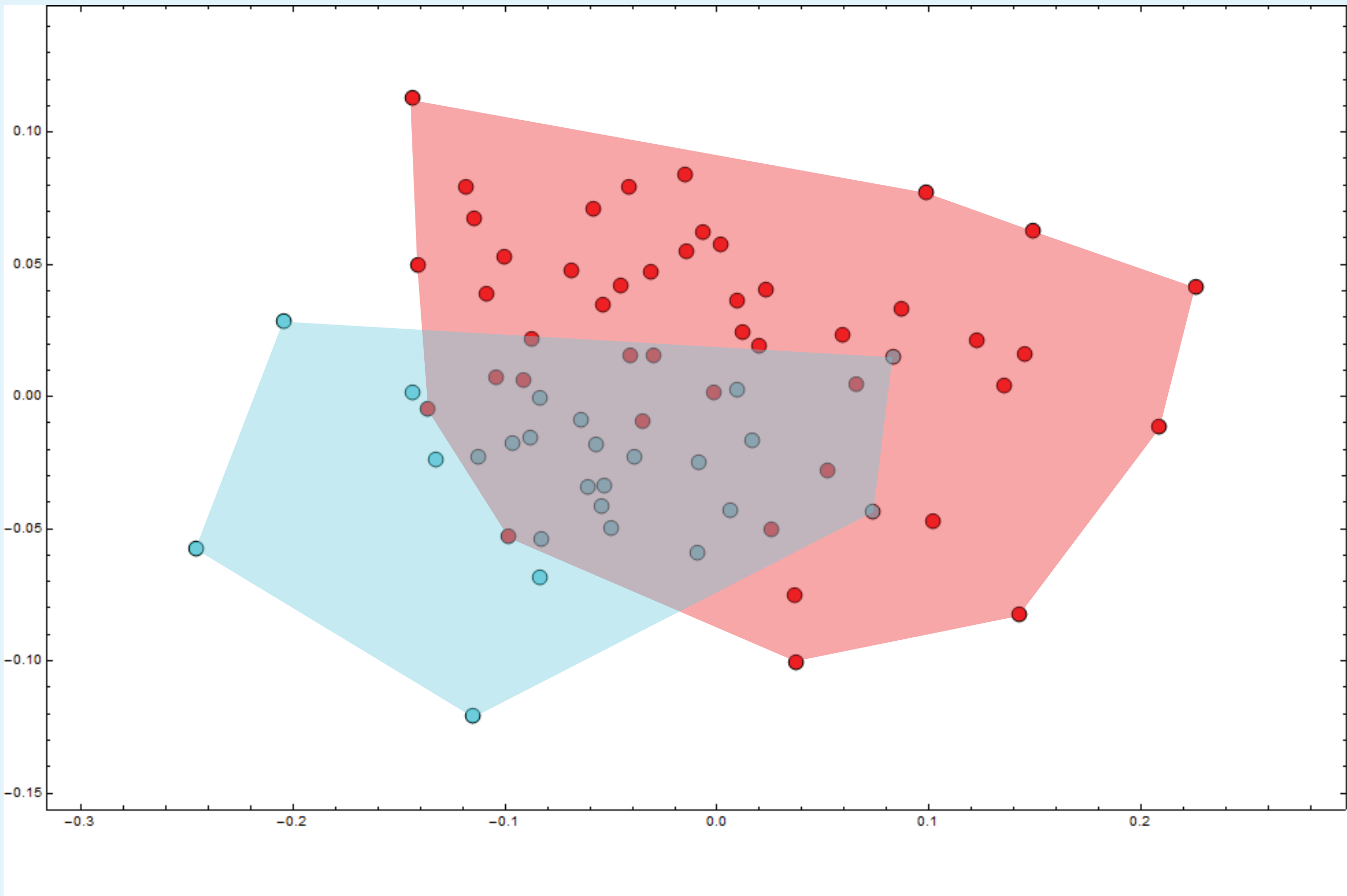


Figure 1. PCA score plot describing the morphospace occupied by browsing and grazing ruminant species. Many species occupy an overlapping position around the grand mean, implying widespread convergence.

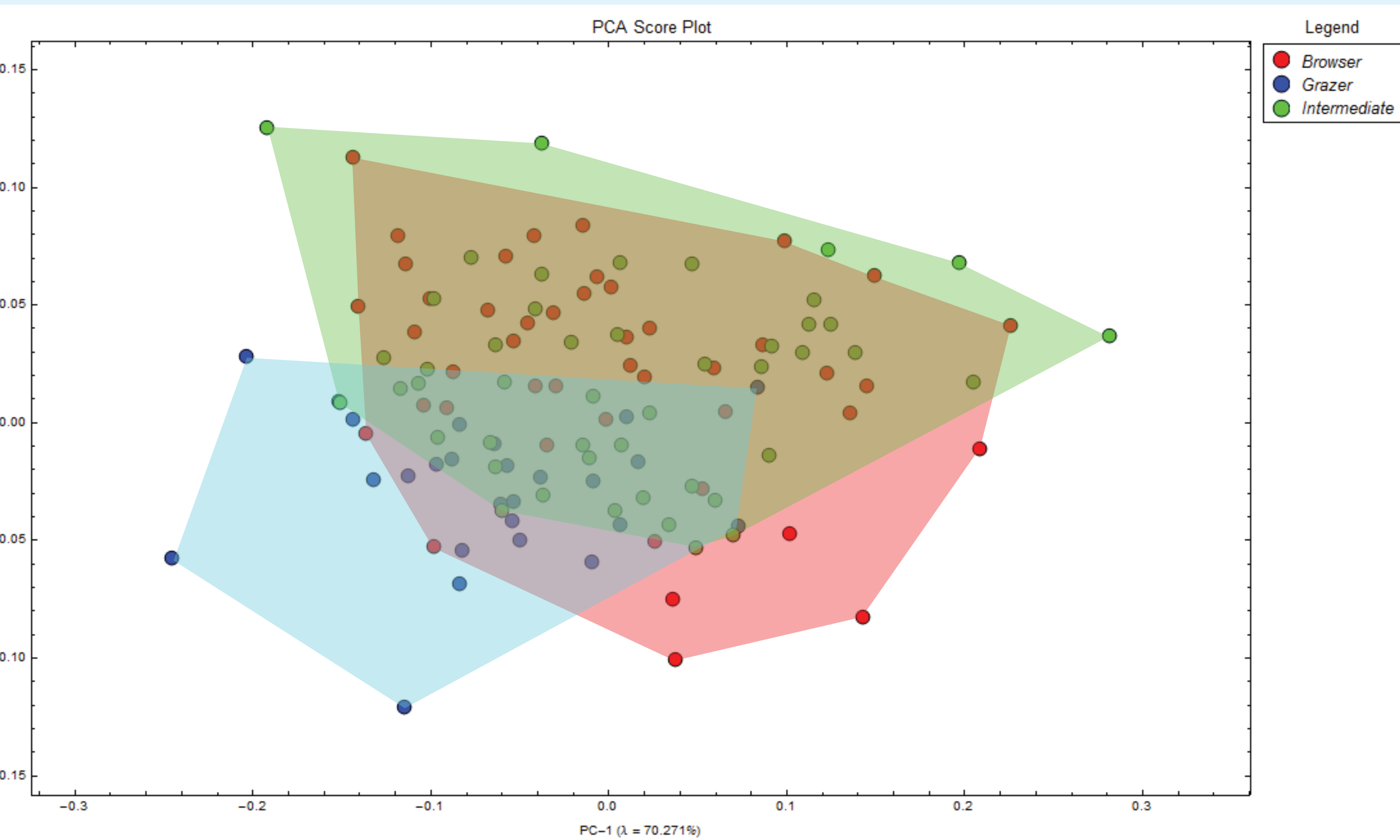


Figure 2. PCA score plot (as above) with ‘intermediate’ species projected into the defined morphospace. Note the more general shape similarity with ‘browser’-classified species.

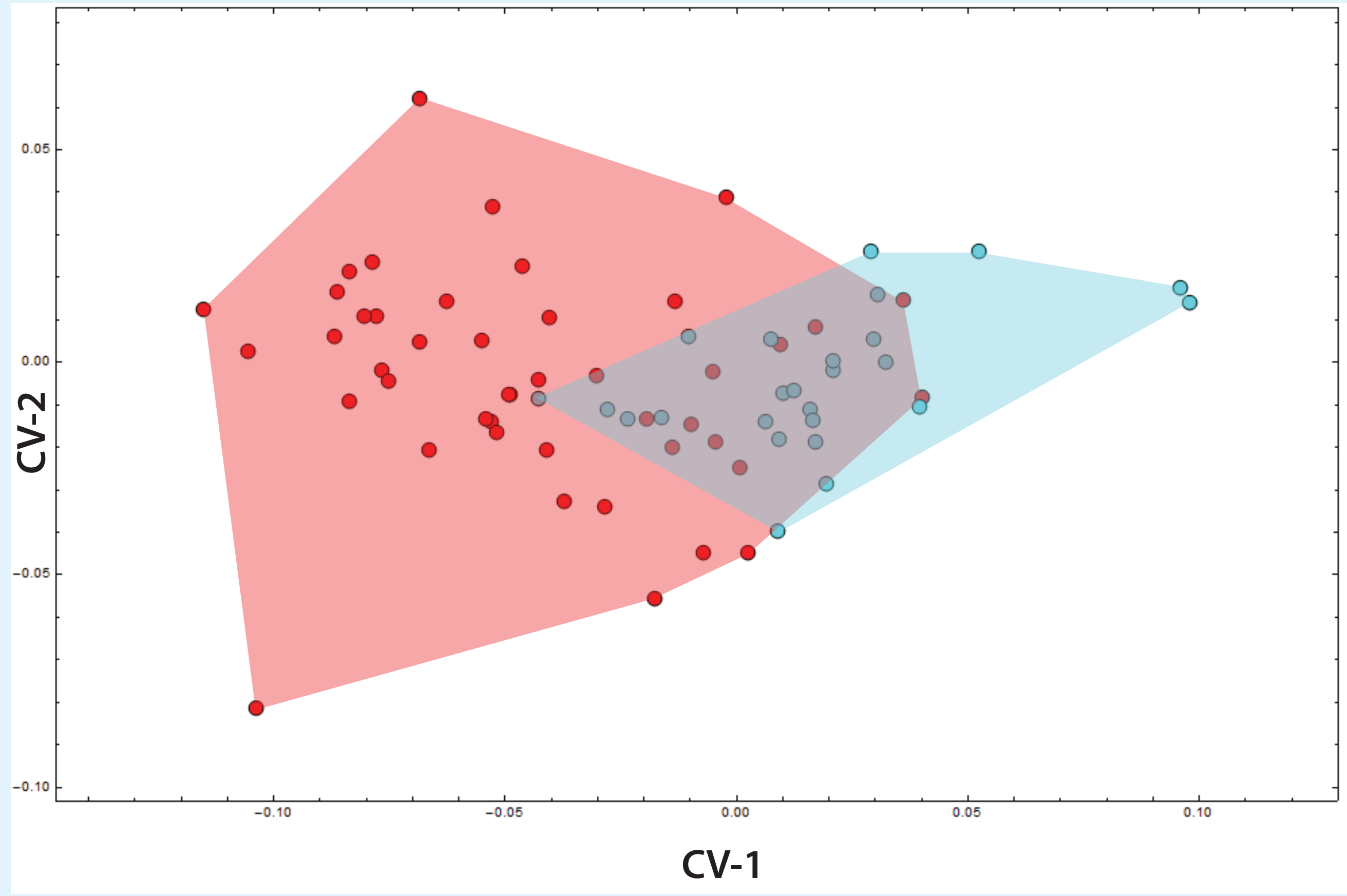


Figure 3. CVA score plot for browsers and grazers

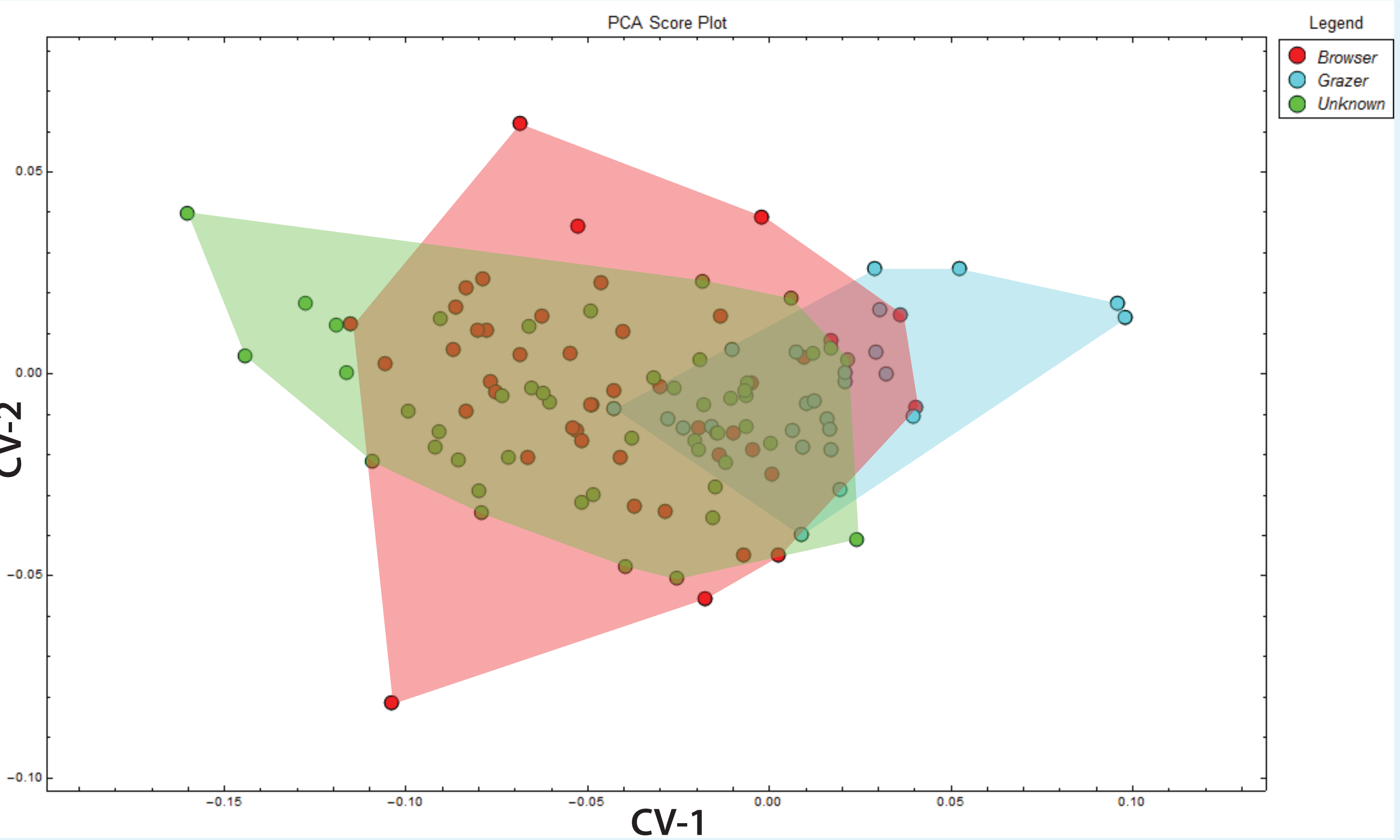
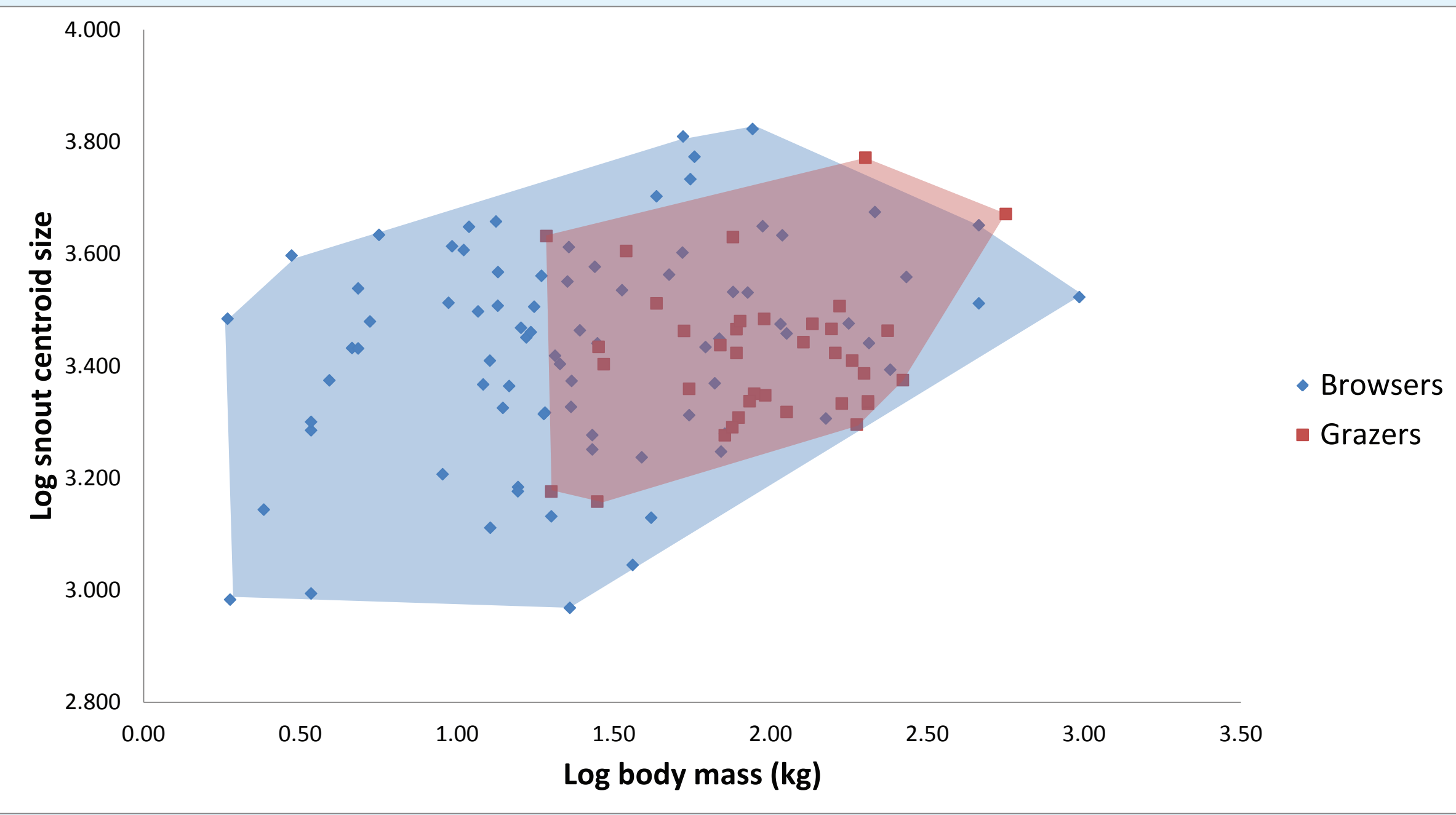


Figure 4. Projection of ‘unknowns’ into CV space



BODY MASS

- Body mass data is freely available from the PanTHERIA database

- Relationship between body mass and snout centroid size shows that browsers may be more ecologically disparate in terms of feeding strategy

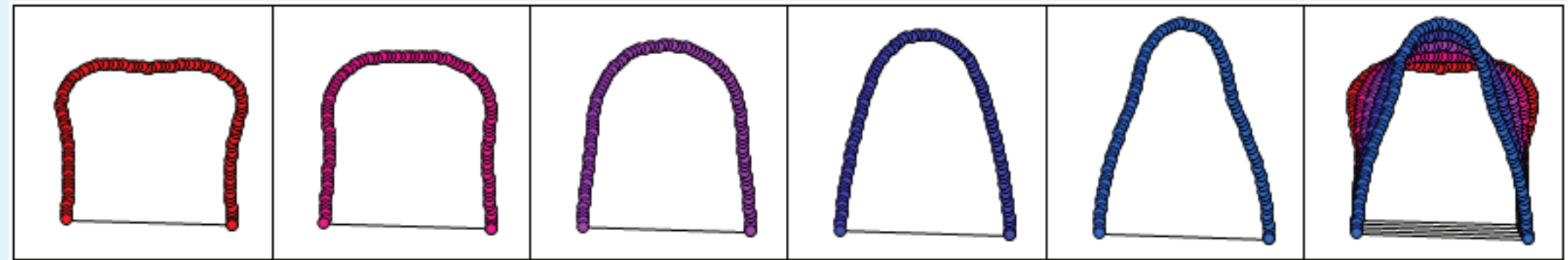
CANONICAL VARIATES ANALYSIS

- Grazers occupy a much broader discriminant space than browsers

- Modelling the CV-axes in PC space shows the geometric deformation of ‘grazer-type’ to ‘browser-type’ snouts

- Snouts are progressively distally shortened and disto-laterally constricted

- Group dispersion structure is non- random (likelihood ratio test, $p=0.0$)



KEY FINDINGS:

1. Browsers and grazers can be delimited with almost 80% confidence based on the geometry of their snout shapes

2. This relates to a distinct geometric progression related to ecology

3. This morphospace can be used to classify specimens of ‘unknown’ ecologies (e.g., ‘intermediates’)

4. This morphospace may further prove useful in determining the palaeoecology of extinct megaherbivores

ORNITHOPODS AND THE NEXT STEPS

- The data set used to construct the ornithopod snout was from second-hand profile outlines

- It was also taxonomically constrained, the ontogenetic stage of specimens was unknown, and also included some duplicate taxa with high variability

- We want to create a new data set using first hand specimens, and what is available in the literature, to broadly sample all ornithopod taxa possible, and use this ruminant morphospace to infer their ecologies. The same applies to other megaherbivore groups (e.g., extinct ruminants, sauropods)

