Do camel types exhibit geometric variation in torso shape?
Insights from social media

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Introduction

- Camels have unique morphological and behavioral adaptations to deserts that make them scientifically and culturally important.
- There are different camel 'types', including groups bred for racing, others for milk production, as well as types bred for various other purposes.
- Each camel type is characterized by certain features, such as a particular coat color and texture, unique hump position, as well as distinctive limb dimensions.
- Few studies use detailed morphometric measurements to assess the extent and the direction of variation across camel types; to our knowledge, none use geometric morphometric data to assess this variation.
- We obtained images of various camel types from various camel breeder social media accounts, which we use to quantify overall shape variation across types.
- We assessed torso shape variation based on a sample of 2D landmarks—homologous anatomical loci—analyzed using geometric morphometrics.

Objectives

1. Identify 12 landmarks that adequately capture overall torso shape.
2. Study shape variation across camel bodies using image-based geometric morphometrics—a method that generates size-independent shape variables that can be used to assess variation in camel types.

Materials and Methods

- Camel images (n = 104) were acquired from publically available camel breeder social media accounts. Only photographs in which camels were positioned parallel to the camera plane were retained and analyzed.
- The chosen camel photographs represent seven camel types (Onafi, Omani, Sudani, Mejaheem, Maghateer, Kenani, and Pakestani (**Fig.1**).
- Six dorsal and six ventral torso landmarks were digitized in a standardized manner (**Fig.2).**
- Landmark coordinates were then subjected to generalized procrustes analysis (GPA), in order to obtain size-independent shape variables (procrustes coordinates), that were used to compare camel type shapes.
- Shape variation was then summarized to a smaller set of variables by performing principal component analysis on the procrustes coordinates.
- The retained principal components (determined by the broken-stick criterion) were then visualized using a boxplot (PC1), with the individual camels divided based on type**(Fig.3**).
- The magnitude of the differences in torso shape among the geometric mean of each camel type were visualized using the UPGMA clustering method (based on Euclidean distance) (**Fig.4)**; the locations of the aforementioned differences were visualized using thin-plate spline deformation grids (**Fig.5)**.

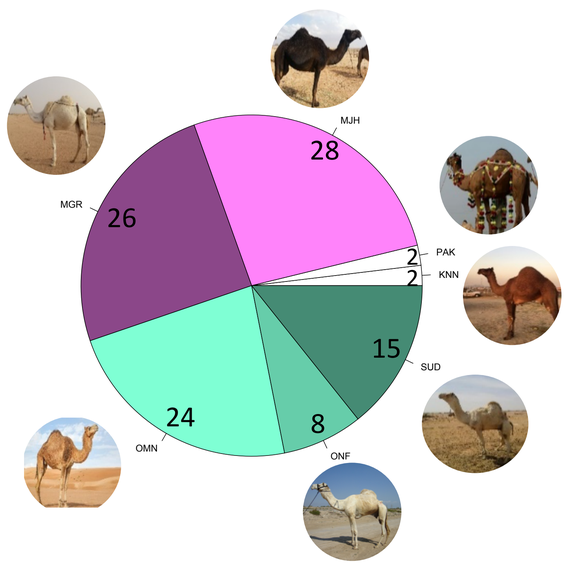

Fig.1: Summary the camels sampled in this study (104 camels from seven types). MJH: Majaheem, PAK: Pakestani, SUD: Sudani, KNN: Kenani, ONF: Onafi, OMN: Omani, and MGR: Maghateer.

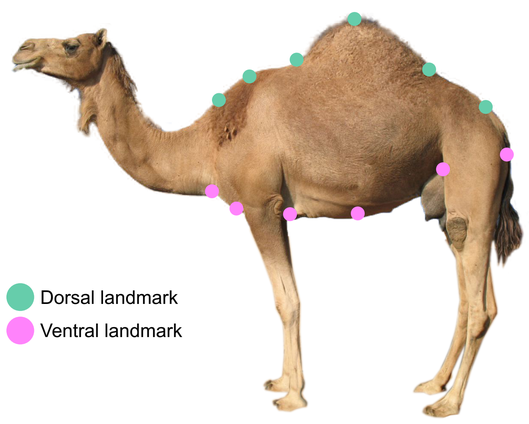

Fig.2: Positions of 2D landmarks used in this study. Sandy circles represent dorsal landmarks. Brown circles represent ventral landmarks. Circles represent positions on a Cartesian coordinate system.

Conclusion

1. We were successful in quantifying overall torso shape variation among camel types based on images extracted from social media.
2. While at this point we can conclude that overall torso shape among camel types does vary, the statistical significance of this variation needs to be assessed after the dataset sample size is increased.

Acknowledgments: This project would not have been possible without images posted by camel breeders on their social media accounts, including: ime1111, hjn_uae, alotaibi_654, smsrbywshr, djekv493hf, rashed1209, ahmedreshidi, aljhaam, 3lag_al7lal, camel.kw, theking2050, al_nahab, alsultan38, nsas669, zmool_alarab, o.77_, osaamah23, _a_qatar_9033, shr2222, swaihaan).

30 seconds Summary

Develop a protocol to study shape variation among camel types.

1. Retrieve publically available camel images.
2. Digitize torso landmarks.
3. Summarize landmark shape variation among types using geometric morphometrics.

Substantial variation in the torso shape exists among camel types.

5. Results

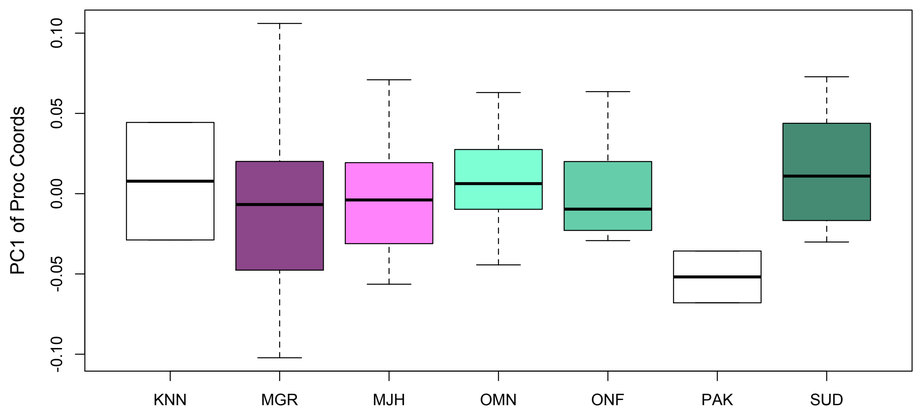

Fig.3: Boxplot generated by procrustes coordinates. Boxplot was performed on the procrustes coordinates, and shows the variation in torso shape across camel types.

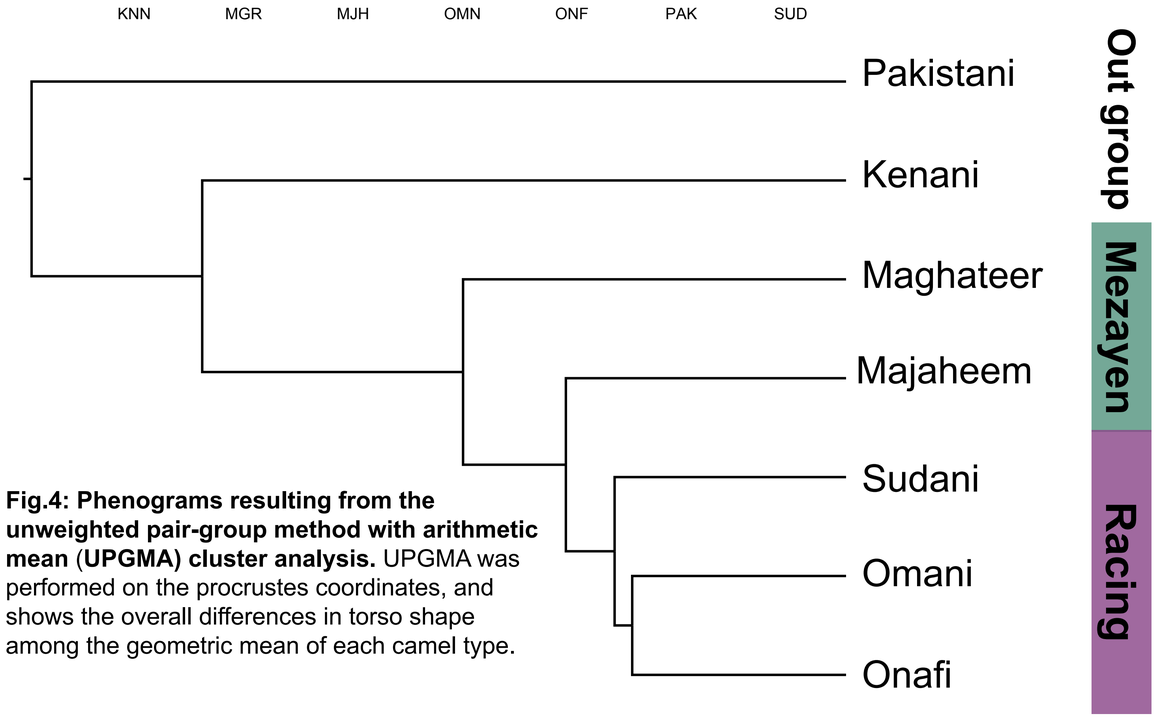

Fig.4: Phenograms resulting from the unweighted pair-group method with arithmetic mean (UPGMA) cluster analysis. UPGMA was performed on the procrustes coordinates, and shows the overall differences in torso shape among the geometric mean of each camel type.

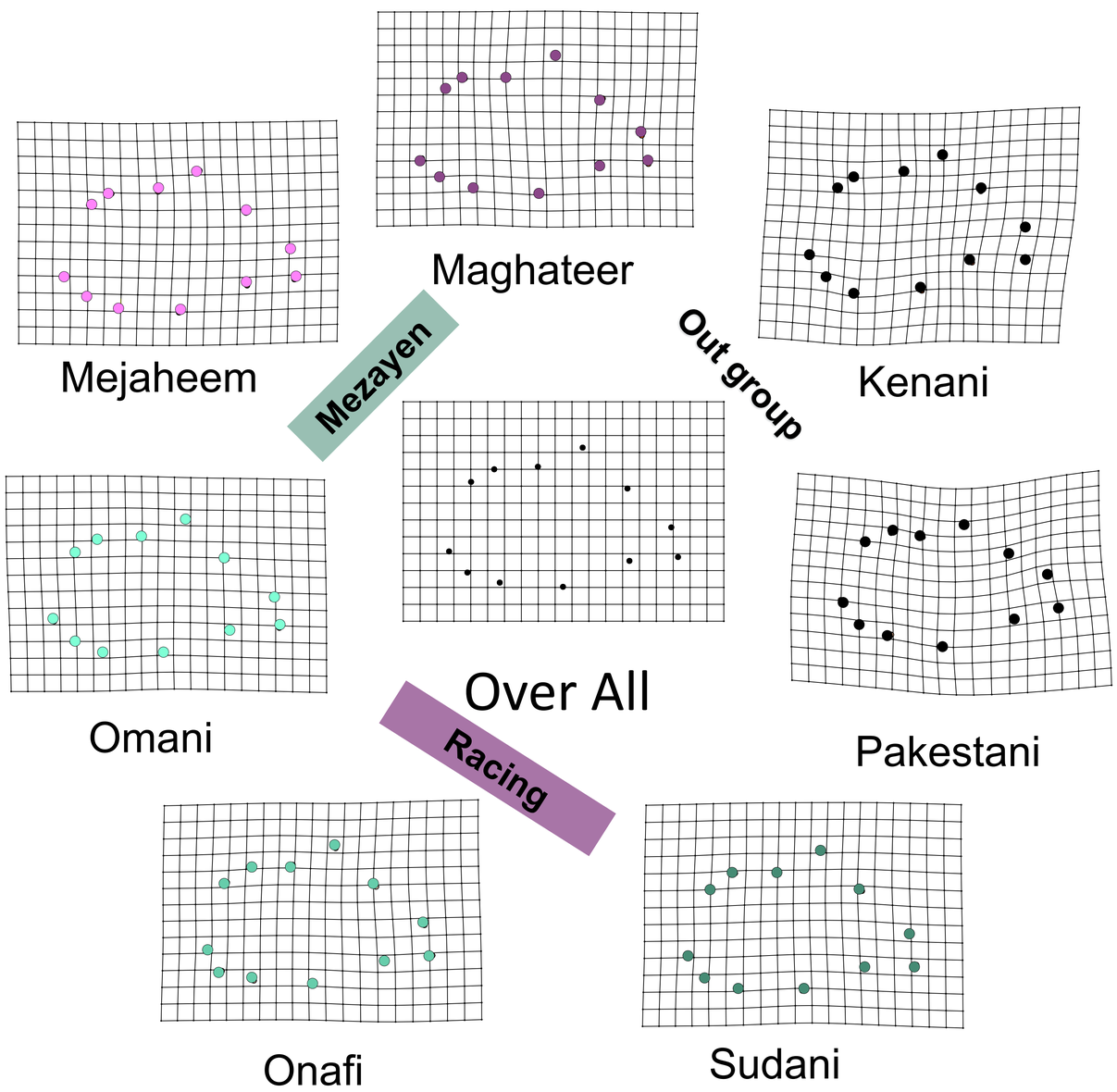

Fig.5: Thin-plate spline deformation grids. These grids depict the main shape differences between the consensus landmark configuration of each camel type vs. the consensus landmark configuration of the whole sample (all camel types combined, shown in the center).

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