Using Spatial Analysis Techniques to Identify Patterns in Captorhinid Dermal Ornamentation

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ABSTRACT

The dermal ornamentation of reptiles and lower vertebrates is a largely untouched field of research, and thus common patterns or a specific purpose for the ornamentation has yet to be identified and/or agreed upon by paleontologists.

This study strives to use various spatial and image analysis techniques to identify any patterns in the ornamentation on the skulls of both 'lower' vertebrate captorhinids to better understand the purpose of such ornamentation and why it has persisted from lower vertebrates to modern-day reptiles. Any information that can be derived from the research may aid modern understanding of the evolution from lower vertebrates to modern reptiles.

BACKGROUND

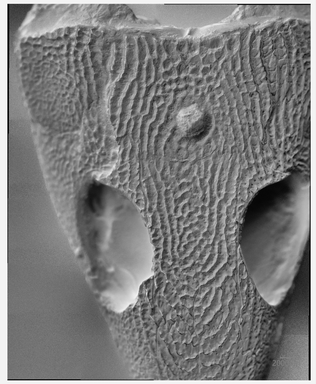
Despite the frequency of dermal ornamentation in both early and modern reptiles, the purpose of such ornamentation remains unknown. There is little in the way of past research on this topic and even less on the possible function of dermal ornamentation.

OBJECTIVE

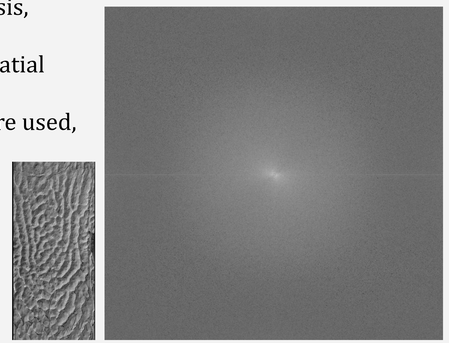
I do not anticipate solving the mystery of why dermal ornamentation has persisted nor its function. Rather, I aim to identify any patterns or trends in the ornamentation.

DATA

The Captorhinid skull used for this project's analysis was provided by Dr. Arthur Busbey from his fossil collection at TCU. The photos used were taken using a Keyence VHX-7000 digital microscope, provided by TCU planetary geologist and professor, Dr. Rhiannon Mayne.



METHOD

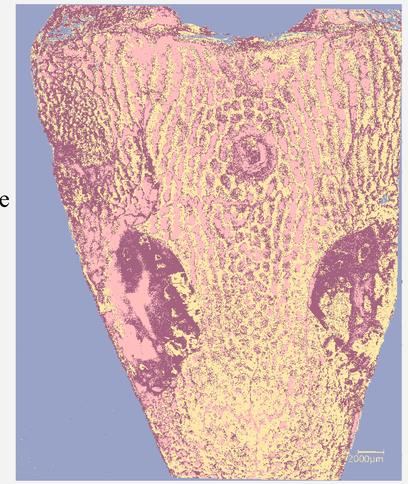


To conduct the analysis, multiple image and spatial analysis programs were used, primarily ArcGIS Pro and ImageJ on Fiji. Initially, I performed an optic fourier transfer on an image of the skull's cranial surface. I then decided to sharpen and increase contrast of the image before inserting and geocoding as a raster image on ArcGIS Pro. To maintain a scale, I fit the image to the west boundary of Tarrant County and translated the boundary height to image height.

To try and get a clearer vision of the ornamentation patterns, I classified the image into four classes: ridge, indent, background, and unrelated. Additionally, I geocoded and then digitized the image to create a shapefile outlining the ornamentation ridge pattern. From there, I attempted to observe any patterns in terms of shape and clustering.

RESULT

Going into this project, it was made very clear that I was not guaranteed to find any conclusive results due to the highly experimental nature of the work. However, there was one significant pattern I had found in my work. When looking at the result image of the optic fourier transform, a strong horizontal component can be observed. Initially, I found this to be strange due to the pattern in the image appearing to run vertically down the skull. Upon further observation, however, I made a startling realization: while the ornamentation may stretch vertically down the skull, the shape of the ornamentation changes along the horizontal axis.



In the center of the skull, the ornamentation is comprised primarily of small, more circular indentations clustered together. As you move to the left an right of the center, the ornamentation becomes more linear, stretching into vertical lines rather than circular indents. We know that reptiles are not born with the ornamentation– it is developed as they grow. Based on my observations, I would propose that the ornamentation develops in the center of the skull, pushing previously-developed ornamentation towards the edges of the skull and thus stretching the pattern.. I've included the image of my classification result to allow easier observation of this trend.

CONCLUSION

While I may not have solved the mystery of dermal ornamentation's function in reptiles, I do believe I have identified a pattern of the ornamentation's development. The ornamentation is developed in the skull's center and pushed outwards by the continued development of new ornamentation.