Phylomorphospace Theory Citations:

Gerber, S. (2019). Use and misuse of discrete character data for morphospace and disparity analyses. *Palaeontology*, *62*(2), 305–319.

Keywords: Character space, disparity, macroevolution, missing data, morphological hypercube, phylogenetic data matrices

Exploration of the intricacies of morphospace. Has a short critical section on the use of phylomorphospace. Presents a good explanation of the historical studies that have been incorporated intio modern phylomorphospace representations.

Stayton, C. T. (2020). Are our phylomorphospace plots so terribly tangled? An investigation of disorder in data simulated under adaptive and nonadaptive models. *Current Zoology*, *66*(5), 565–574.

Keywords: adaptation, character displacement, early burst, optima, OU model

Evaluates the readability of phylomorphospace plots. Investigates the appropriateness of phylomorphospace diagrams as an evolutionary model.

Stone, J. R. (2003). Mapping cladograms into morphospaces. *Acta Zoologica*, *84*(1), 63–68.

Keywords: Cladistic analysis, mathematical model, phylogenetic systematic analysis, theoretical morphology

Key paper that first discussed the usage of phylomorphospaces.

Landmarking Theory Citations:

Koehl, M. A. R. (1996). WHEN DOES MORPHOLOGY MATTER? *Annual Review of Ecology and Systematics*, 27(1), 501–542.

Keywords: constraint, ecomorphology, novelty, performance, Reynold's number

This is the foundational paper for many modern morphological studies. Discusses what makes a meaningful morphological study.

Valeri, C. J., Cole, T. M., III, Lele, S., & Richtsmeier, J. T. (1998). Capturing data from three-dimensional surfaces using fuzzy landmarks. *American Journal of Physical Anthropology*, *107*(1), 113.

Keywords: measurement error, coordinate data, craniofacial skeleton

Anthropology paper that created the methods used for determining fuzzy landmarks.

Wärmländer, S. K. T. S., Garvin, H., Guyomarc'h, P., Petaros, A., & Sholts, S. B. (2019). Landmark Typology in Applied Morphometrics Studies: What's the Point? *The Anatomical Record*, 302(7), 1144–1153.

Keywords: Bookstein, craniometrics, landmark classification, measurement precision, morphometrics, shape analysis

A critical review of the current approaches to landmarking and a revision to Booksteins initial theories on Type 1-3 landmarks.

Application Citations:

Chitwood, D.H., Klein, L.L., O'Hanlon, R., Chacko, S., Greg, M., Kitchen, C., Miller, A.J., Londo, J.P. (2015) Latent developmental and evolutionary shapes embedded within the grapevine leaf. *New Phytologist*, 210(1): 343-355.

Keywords: development, grape (*Vitis vinifera*), leaf morphology, leaf shape, phenotype

Example of different applications of landmarking in a non-vertebrate system.

Da Silva, F. O., Fabre, A.-C., Savriama, Y., Ollonen, J., Mahlow, K., Herrel, A., Müller, J., & Di-Poï, N. (2018). The ecological origins of snakes as revealed by skull evolution. *Nature Communications*, *9*(1), 376.

Keywords: Cranial morphology, evolution, lizards, morphometrics, snakes, phylomorphospace

This is the first paper that we discussed in class looking at the application of phylomorphospace across a large group including fossil data.

Palci, A., Lee, M. S. Y., Crowe-Riddell, J. M., & Sherratt, E. (2023). Shape and Size Variation in Elapid Snake Fangs and the Effects of Phylogeny and Diet. *Evolutionary Biology*, *50*(4), Article 4.

Keywords: diet, disparity, ecomorphology, Elapidae, evolution, fangs, geometric morphometrics, phylomorphospace

This is the second paper that we investigated, looking at a narrow application of phylomorphospace to a singular structure in elapids.

Sidlauskas, B. (2008). Continuous and arrested morphological diversification in sister clades of characiform fishes: a phylomorphospace approach. *Evolution*, *62*(12), 3135–3156.

Keywords: Comparative methods, disparity, morphological evolution, morphometrics, phylogenetics, tempo and mode

This paper is an interesting application of phylomorphospace and became the underpinnings for the current function in R. Investigates several lineages of characiform fishes and utilizes two scenarios to classify their distribution in the morphospace.