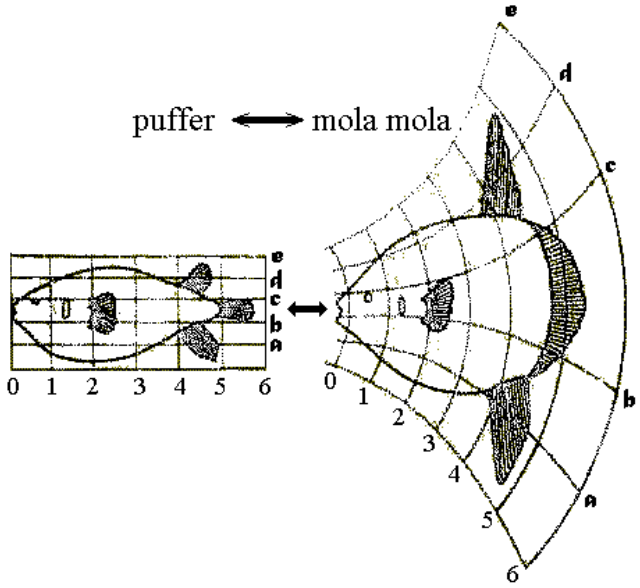
Morphometrics

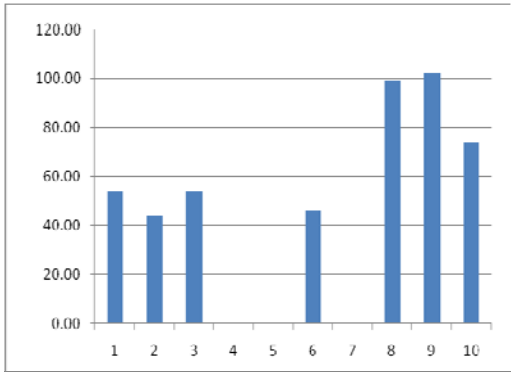
Morphometrics is the branch of mathematics studying the metrical and statistical properties of shapes and shape changes of geometric objects like molecules, fossils, brains, bird wings, ancient handcraft, modern cars, etc.

On Growth and Form Sir D'Arcy W. Thompson, 1917 - The mathematization of natural history. Thompson comes out punching with an array of arguments and stresses the importance of understanding the natural world quantitatively, but is limited philosophically to descriptive and classificatory methods (although embryology had already embarked on experimental manipulation).

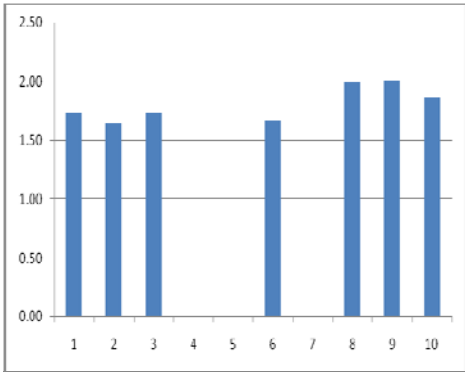


Traditional Approaches:

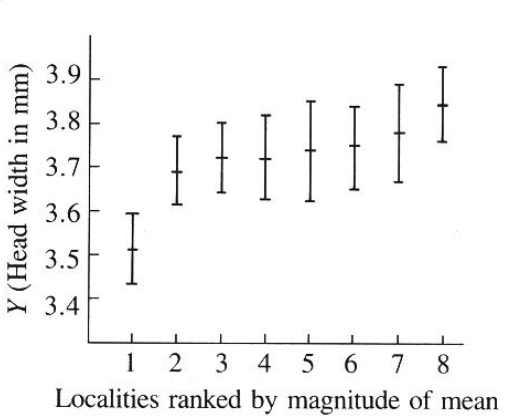
Univariant data plots (X) -- The distribution of the variance in character measurements should always be normally distributed, Data transformations -- why alter your data?



Raw Data



Log Transformed

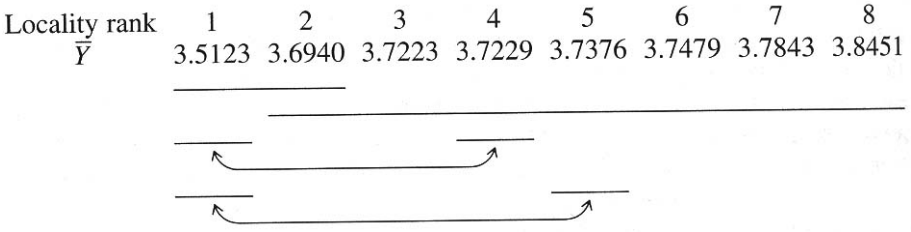


Multiple Comparison Tests

Student-Newman Kuels (SNK)
Tukey-Kramer
SS-STP

	Ranked localities							
	1	2	3	4	5	6	7	8
1	—	.1586	.1586	.1748	.1943	.1713	.1883	.1586
2	.1817*	—	.1586	.1748	.1943	.1713	.1883	.1586
3	.2100*	.0283	—	.1748	.1943	.1713	.1883	.1586
4	.2106*	.0289	.0006	—	.2077	.1864	.2021	.1748
5	.2253*	.0436	.0153	.0147	—	.2048	.2192	.1943
6	.2356*	.0539	.0256	.0250	.0103	—	.1991	.1713
7	.2720*	.0903	.0620	.0614	.0467	.0364	—	.1883
8	.3328*	.1511	.1228	.1222	.1075	.0972	.0608	—

Tukey-Kramer



SS-STP

Bivariant data plots (X,Y) -- Correlations between morphological characters. Data exploration -- should I plot everything? Two morphological values can be combined into a single variable or ratio, Ratios are excellent for removing size, weight, etc. from a term, but what happens to the variance? Is it still normally distributed in the new term?

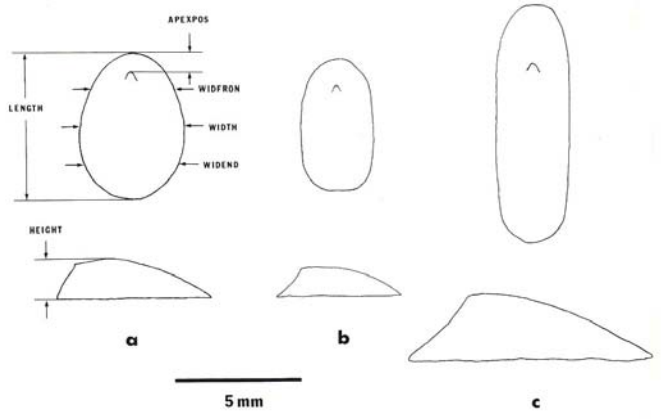


Fig. 1. Dorsal and lateral views of (a) the oval form of *Notoacmea depicta*, (b) *N. lepisma*, and (c) the compressed form of *N. depicta*.

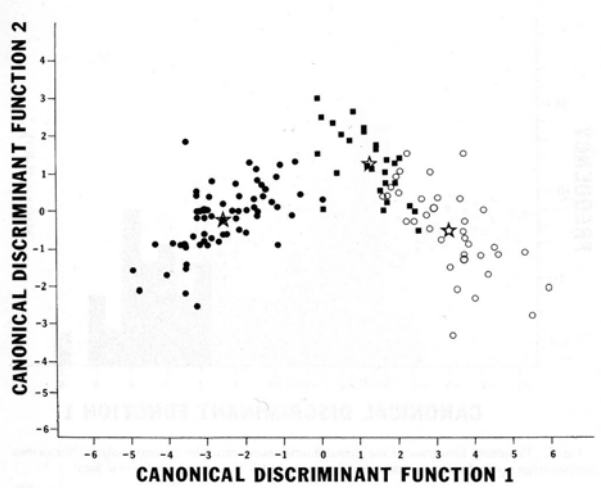


Fig. 2. Scatter diagram of individual discriminant function scores for 3 group analysis. ● = compressed form, ■ = *Notoacmea lepisma*, ○ = oval form, ☆ = group centroids.

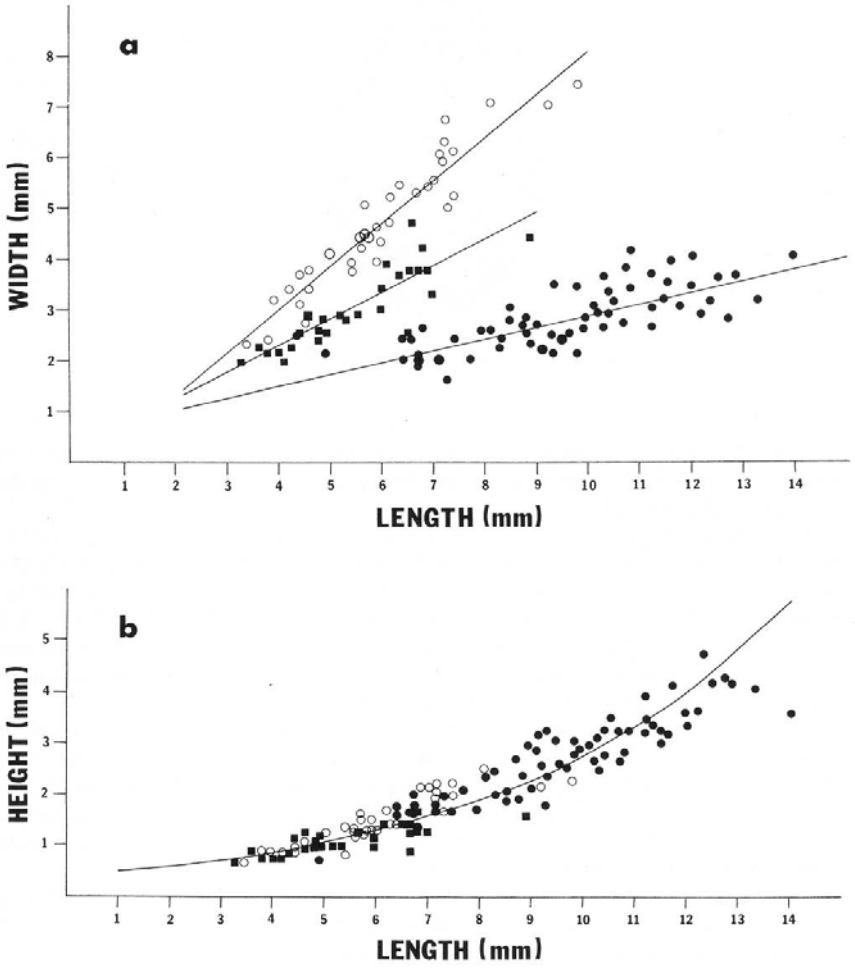


Fig. 4. Scatter diagram and fitted regression lines of length on (a) width and (b) height. ● = compressed form, ■ = *Notoacmea lepisma*, ○ = oval form. Correlation coefficients (a) ● = .7717, ■ = .9007, ○ = .9266; (b) .9307.

Procrustes analysis -- The shape of an object can be described by the coordinates of a set of well defined points or landmarks. Coordinate data from similar points across a group of individuals can be used to compare and contrast their shapes provided they have been superimposed (i.e., translated, rotated and scaled) in a common coordinate system In this coordinate system differences in the relative positions of the corresponding points on different configurations are directly reflected by the differences In their coordinates. Point selection.

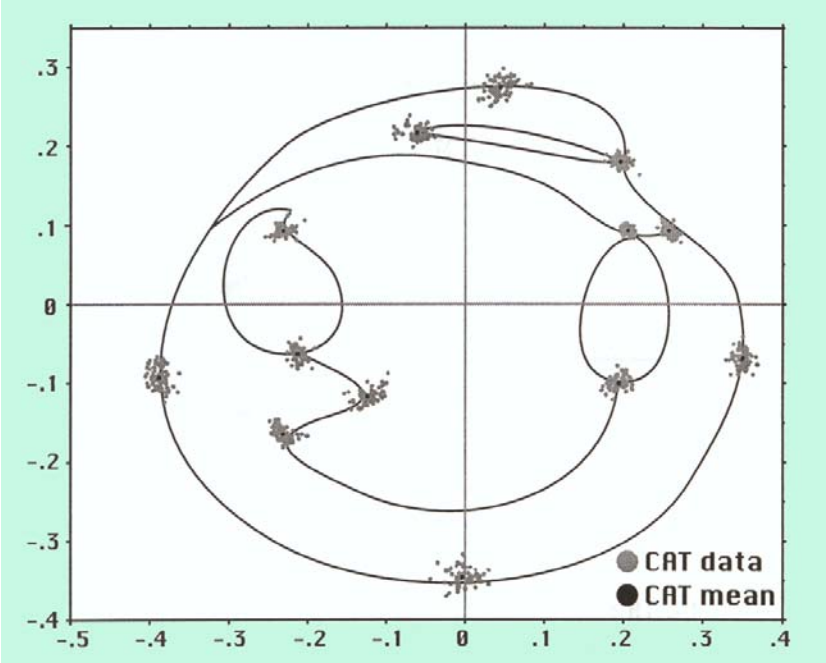
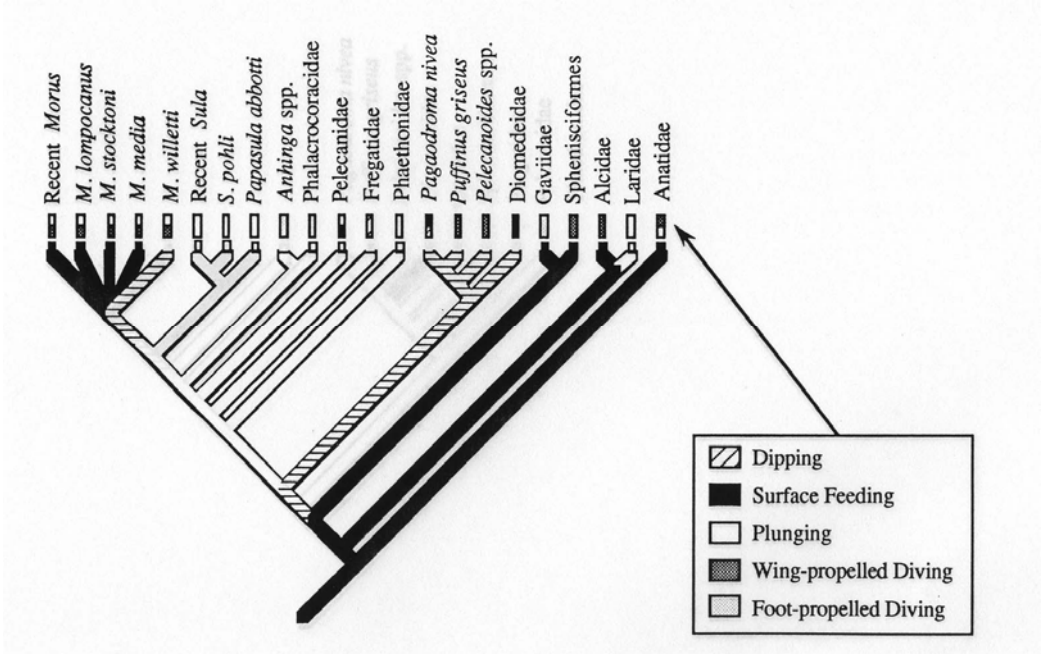
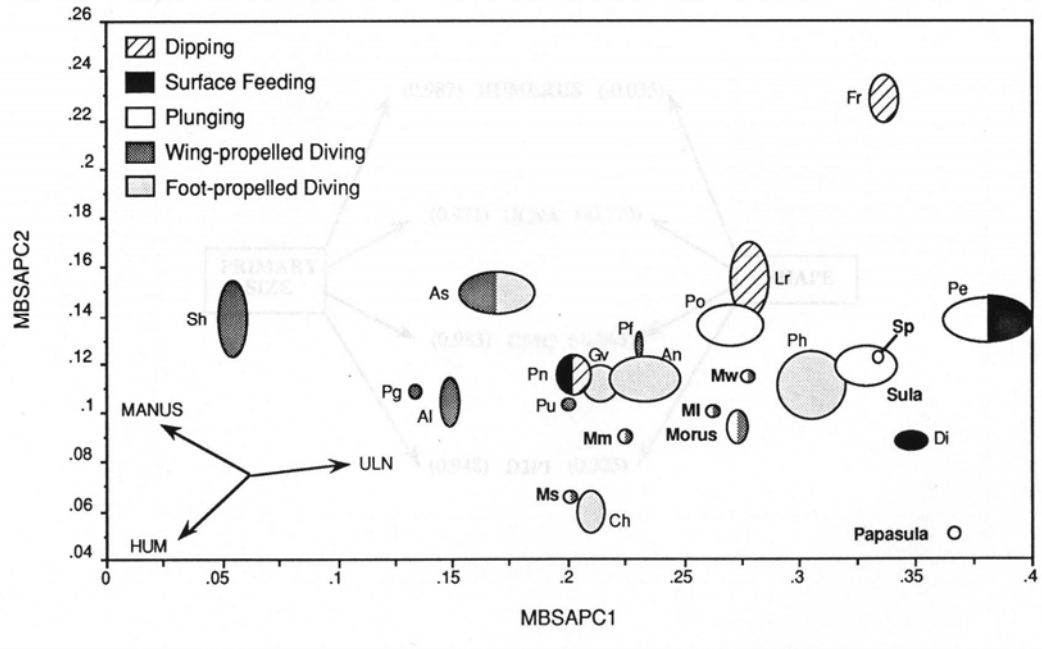


Figure 3. Full Procrustes fit of the bivalve mollusk *Mercenaria campechiensis*. Data are 13 landmarks for 52 shells (Bush, A. 1999, unpub. M.S thesis, Geological Sciences, VT)

Multivariant Methods – Principal component analysis (PCA) has been a commonly used mathematical procedure that transforms a number of (possibly) correlated variables into a (smaller) number of uncorrelated variables called *principal components*. The first principal component accounts for as much of the variability in the data as possible (typically size), and each succeeding component accounts for as much of the remaining variability as possible.

Principal component analysis is performed on covariance (scaled sums of squares and cross products), or, correlation (sums of squares and cross products from standardized data) matrices. A correlation matrix is used when the variances of individual variates substantially differ or the units of measurement of the individual variates differ.

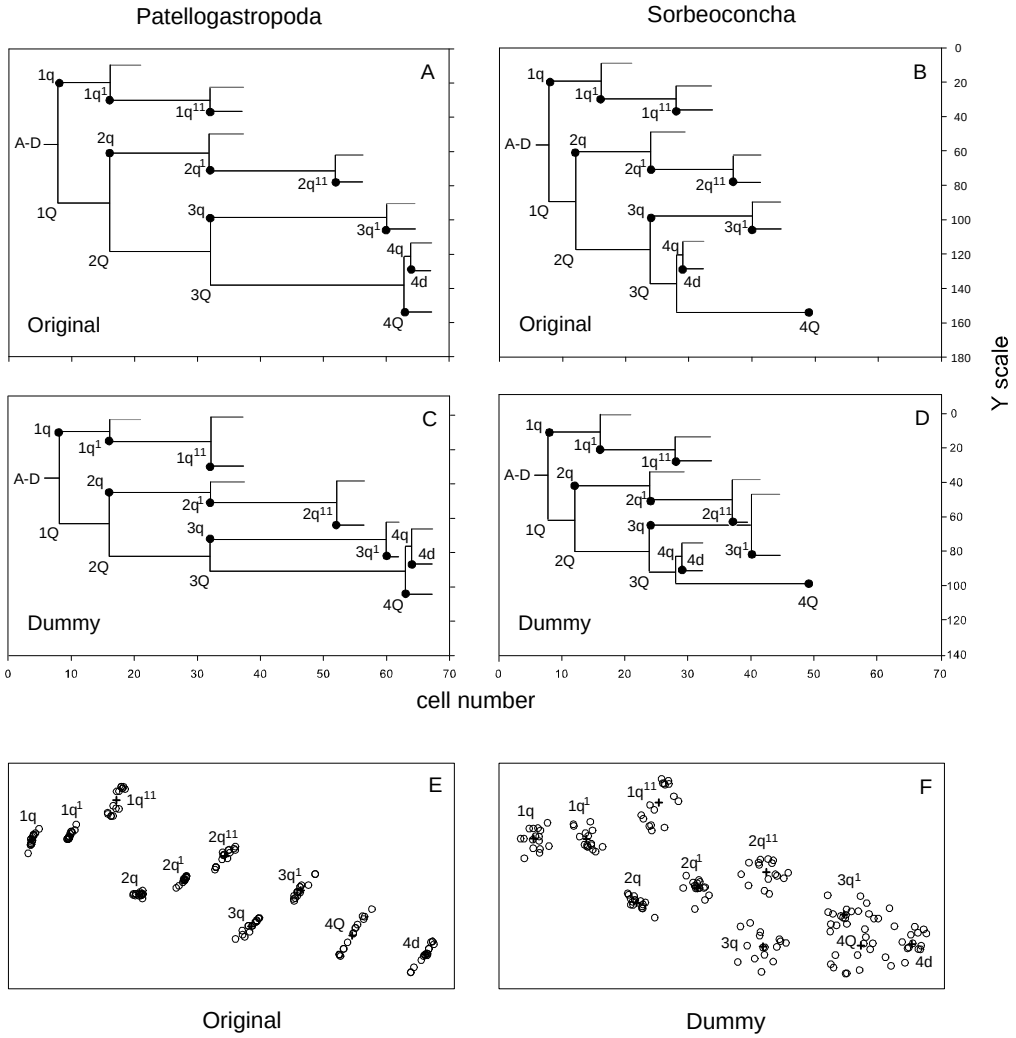


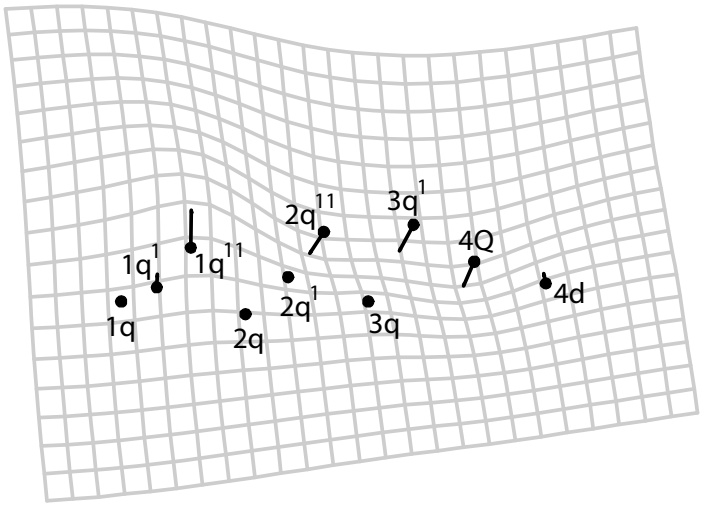


Geometric Morphometrics:

Geometric morphometrics is a collection of approaches for the multivariate statistical analysis of Cartesian coordinate data, usually (but not always) limited to landmark point locations. The "geometry" referred to by the word "geometric" is the geometry of Kendall's shape space: the estimation of mean shapes and the description of sample variation of shape using the geometry of Procrustes distance. The multivariate part of geometric morphometrics is usually carried out in a linear tangent space to the non-Euclidean shape space in the vicinity of the mean shape.

More generally, it is the class of morphometric methods that preserve complete information about the relative spatial arrangements of the data throughout an analysis. As such, these methods allow for the visualization of group and individual differences, sample variation, and other results in the space of the original specimens. (Slice et al. *http://life.bio.sunysb.edu/morph/*) and *www3.canisius.edu/~sheets/morphsoft.html*

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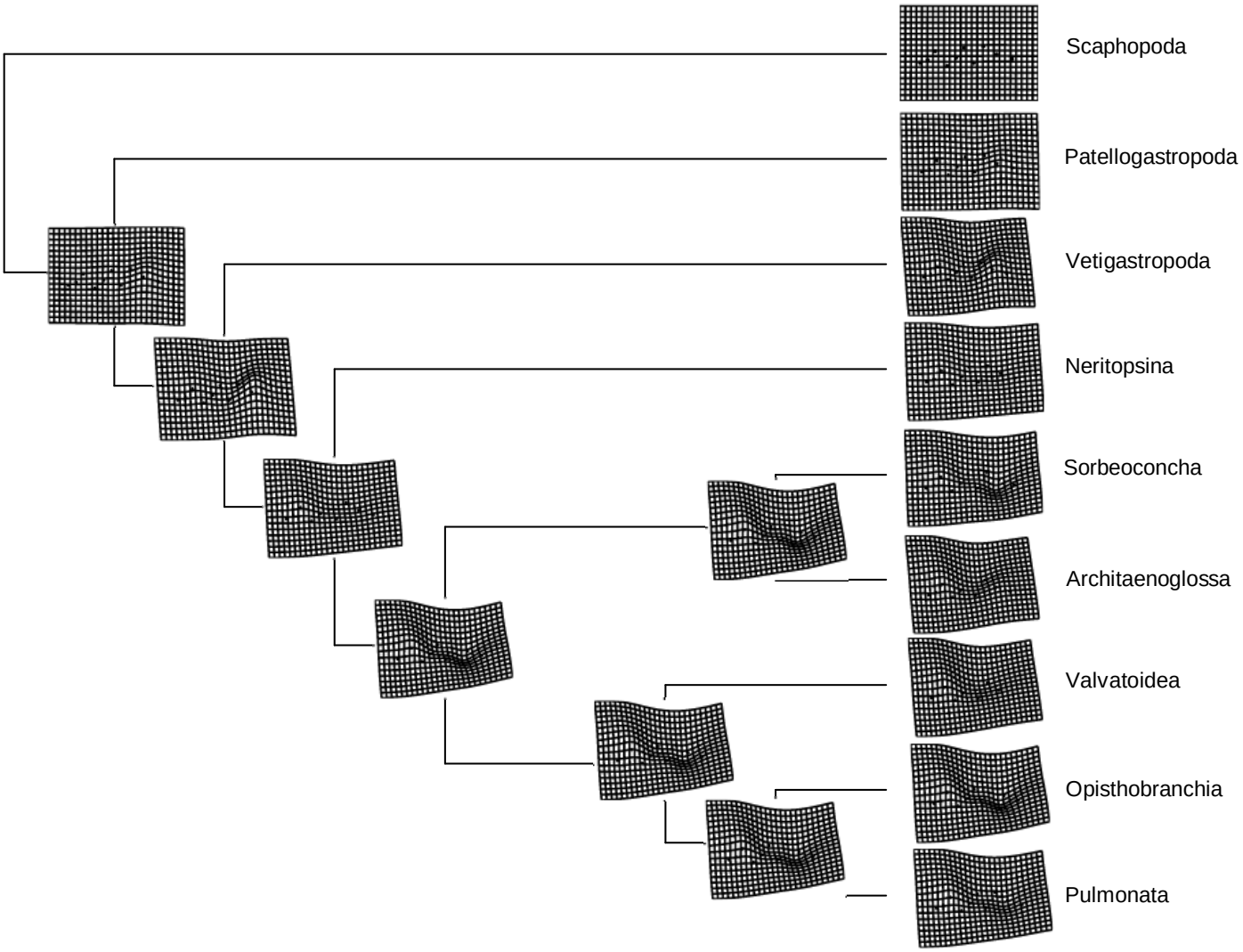
Scaphopoda
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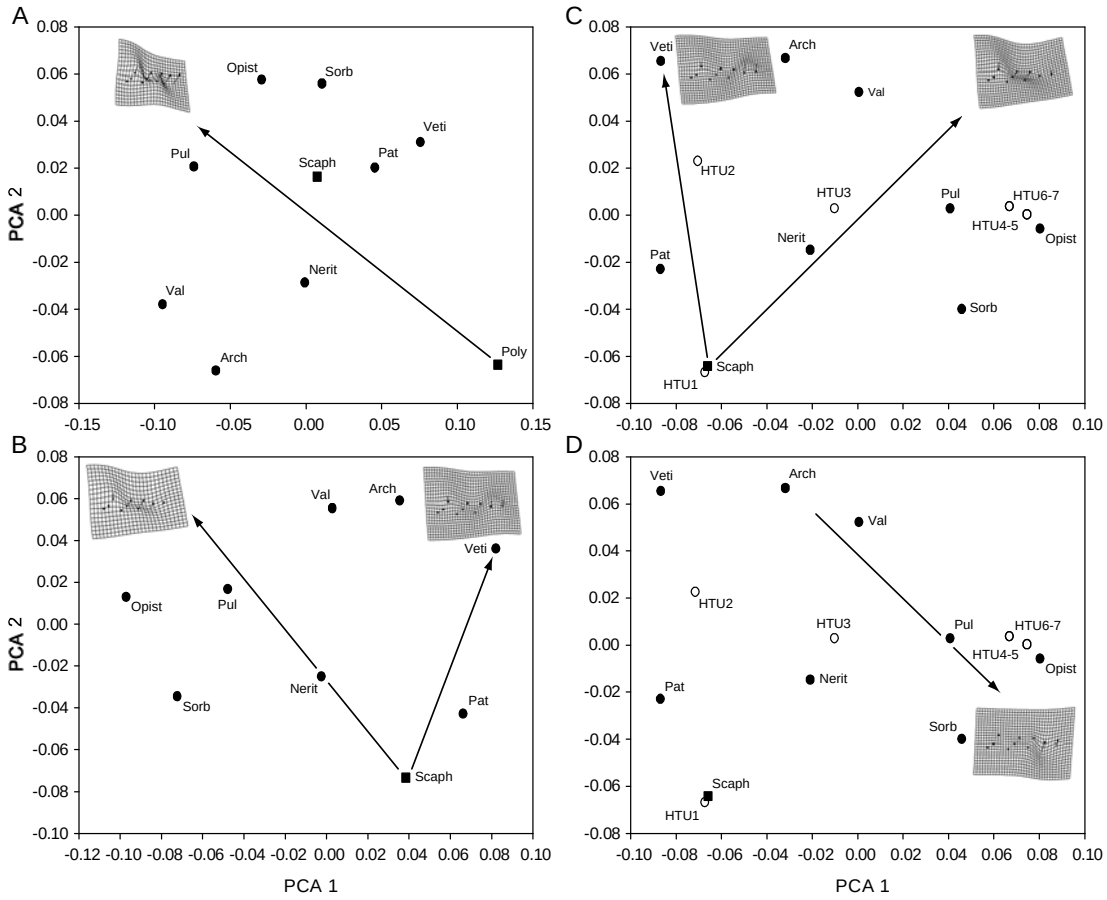
Sorbeoconcha
Architaenoglossa
Valvatoidea
Opisthobranchia
Pulmonata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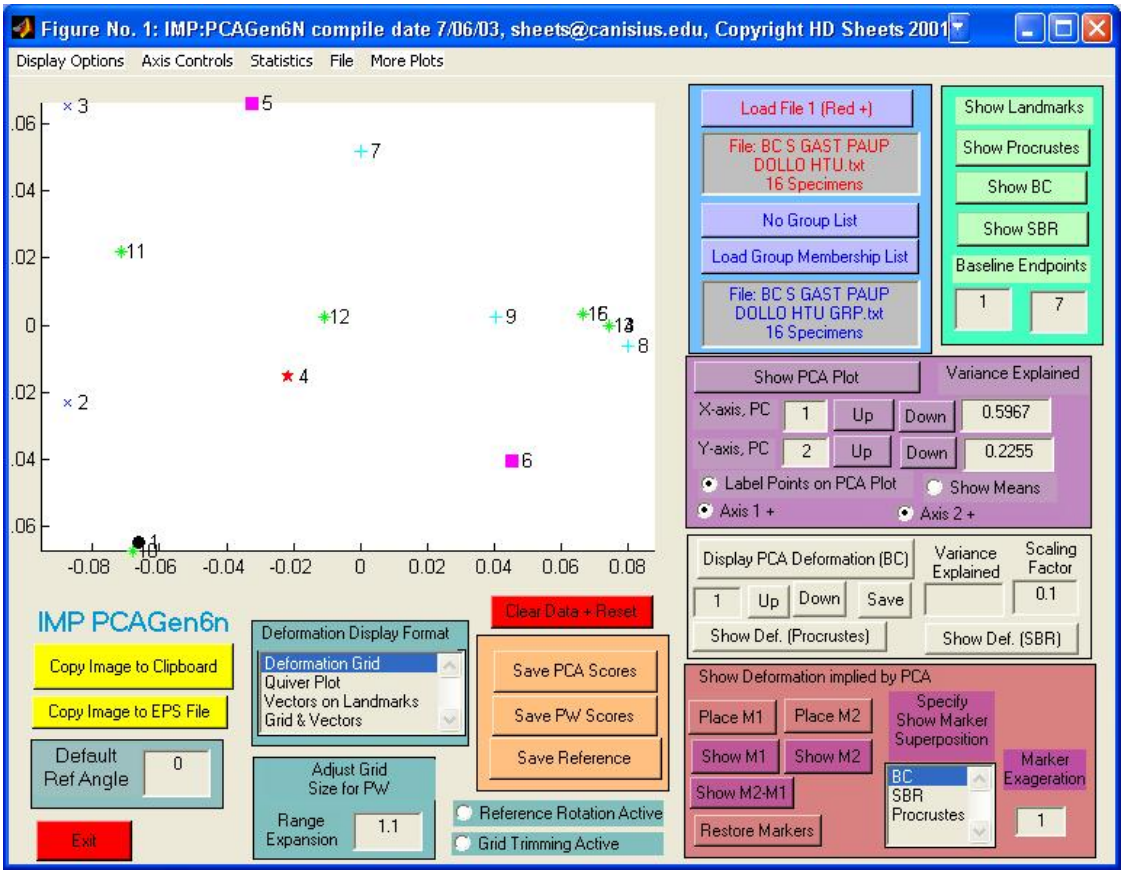
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