PERAMORPHOSIS IN THE PTEROSAURIAN NECK VERTEBRAE – ELLIPTIC FOURIER ANALYSIS SHOWS DIFFERENT PATTERNS OF SHAPE CHANGE AMONG THE CERVICAL VERTEBRAE BETWEEN GROUPS

Gauweiler, J.[1] & Haug, J.T.[1]

[1]Ludwig-Maximilians-Universität München, Department Biology II, Munich, Germany, joshua.gauweiler@yahoo.de

Regionalization of the vertebral column and heterochrony are commonly studied in most ingroups of Vertebrata, Pterosauria being no exception. This study attempted to quantitatively resolve shape differences in the vertebrae of pterosaurians to detect possible patterns of shape change between cervical vertebrae. The material for this study comprises images of specimens from museum collections in Germany, recorded with cyan-red-fluorescence photography, and reconstructions from publications. Elliptic Fourier Analyses were performed to quantify the shape of the individual vertebrae using their outlines as shape proxies. When testing for differences within the spine of specimens, between species, and between ontogenetic stages of the same species, four distinct patterns were found: Pattern 0, found in *Preondactylus bufarini* and partially in an immature *Rhamphorhynchus muensteri*, shows the cervicals forming two shape groups, 1–4 and 5–7. Pattern 1, found in other early non-pterodactyloideans and some pteranodontoideans, shows a drastic change of vertebral shape from the early towards the middle cervical vertebrae largely based on elongation. Pattern 2, found in *Anurognathus ammoni*, immature archaeopterodactyloideans and some pteranodontoideans, shows a more gradual elongation with a clear peak around vertebra 5. Pattern 3, found in adult archaeopterodactyloideans and azhdarchoideans, shows a drastic shape change from vertebra 2 to 3 and a grouping of vertebrae 3–7 based on extreme elongation of the latter. In all groups, vertebrae of position 8 or further posterior are more similar in shape to anterior vertebrae. Thoracic vertebrae show comparably little differentiation. All immature specimens show a more plesiomorphic condition in their vertebral shape indicating heterochrony (peramorphosis). The distribution of pattern 2 and 3 throughout phylogeny is likely the result of convergent evolution. This combined with the shape recapitulation in immature specimens implies these patterns are likely the result of a morphological constraint based on the degree of proportional elongation in the cervical vertebrae.