ANATOMICAL NETWORKS OF THE SKULL ROOF OF PLACODERMS

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Connections among the component parts of complex anatomical structures are key sources of information in macroevolutionary studies identifying homologies or assessing morphological changes in vertebrates. The pattern of connections (e.g., the particular arrangement of bones connected by sutures) is established during development; variations of this pattern promote morphological changes under developmental constraints.

Network Theory is the mathematical field that studies complex systems of interacting parts, based on their pair-wise relations between elements. It is widely used in many disciplines form ecology to genomics, including palaeontology. The analysis of anatomical networks (AnNA) has proved ideal to study the connectivity patterns of the skull of tetrapods. However, it has never been applied to early vertebrates.

Here, we use the AnNA to quantitatively characterize the connectivity patterns of the skull roof of placoderms, the earliest jawed vertebrates. Our results show that three connectivity modules is the most widespread condition, whereas in specific groups such as Ptyctodontida and Antiarchi there are only two modules. Interestingly, a fourth module appears in *Entelognathus primordialis* and *Qilinyu rostrata*, whose mandibles present osteichthyan-like bones. Therefore, we consider that the appearance of these bones could be related to a reconfiguration of the skull architecture. We also evaluated phylogenetic trends in the variation of network parameters (used as proxies of morphological complexity). We found an increase in the anatomical complexity of the skull as the number of bones decreases between the most basal and most corwnward of the placoderms, as previously reported in tetrapods by recent studies of Williston's Law.