Supplementary Information 2: Relative warp analysis

In order to quantify the basis for the perception that the skull roof shape of *Ventastega* is "more similar" to that of *Tiktaalik* than either *Acanthostega* or *Ichthyostega*, a relative warps analysis[43] was conducted on these four skull roofs using the software tpsRelw v. 1.39 [45]. The program tpsDig v. 1.40 [44] was used to digitalise 31 landmarks from recent skull roof reconstructions (Figure 1; see legend to Figure 4 of paper for further information). Eighteen sliding semi-landmarks were used (Figure 1: 2, 3, 6-9, 11-13, 15, 16, 21-25, 29, 30), since the contours of portions of the various heads should be homologous whereas some individual points may not.

In the first analysis landmarks were selected in such a way that the tabular horn of *Acanthostega* was represented in the shape estimate. In this run (Figure 2A, B) the first relative warp represents 50.83%, the second 35.97% and the third 13.19% of the total variance. Together these three relative warps estimates makes up the whole 100% of the total variance. *Ventastega* is closest to *Tiktaalik* among the tetrapods in both first and second warps; in the first warp, *Ventastega* is in fact much closer to *Tiktaalik* than to *Ichthyostega* or *Acanthostega*. The latter two genera cluster close together in the first warp but are widely separated in the second warp. (Figure 2A, B).

Because the tabular horn of *Acanthostega* is an isolated autapomorphy with a big impact on the position of semi-landmarks 18 and 19, we performed a second analysis where these semi-landmarks were positioned as if the tabular horn was absent (Figure 1, compare left and right sides of *Acanthostega*). In this analysis, the first relative warp represents 61.01%, the second 28.99% and the third 10% of the total variance (Figure 2C, D). *Ventastega* and *Tiktaalik* are still closest neighbours in the first warp, somewhat closer than *Ventastega* is to *Acanthostega*, with *Ichthyostega* far more distant. In the second warp, however, *Acanthostega* and *Ventastega* are close, whereas *Ichthyostega* falls between these two and *Tiktaalik*. From this analysis it is clear that the remote position of *Acanthostega* in the first analysis is due to the tabular horn. When excluding this feature, *Acanthostega* shows a much higher degree of similarity with *Ventastega*. In both analyses *Ventastega* is closer to *Tiktaalik* than *Acanthostega* in first and second warps. The subjectively perceived "similarity" of *Ventastega* to *Tiktaalik* thus has a measurable basis.

Figures

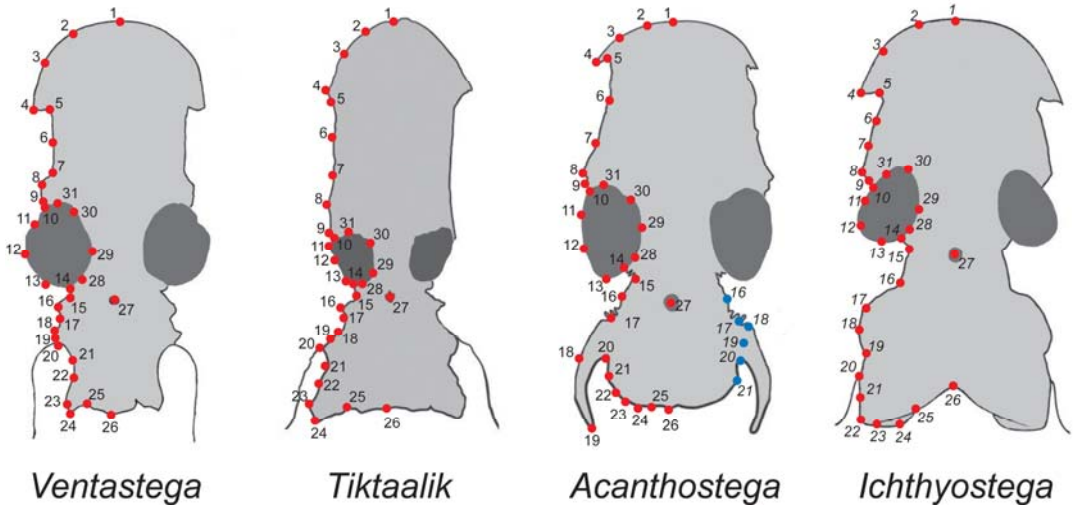

Figure 1. Skull roofs of taxa used in analysis, showing semi-landmarks. Not to scale.

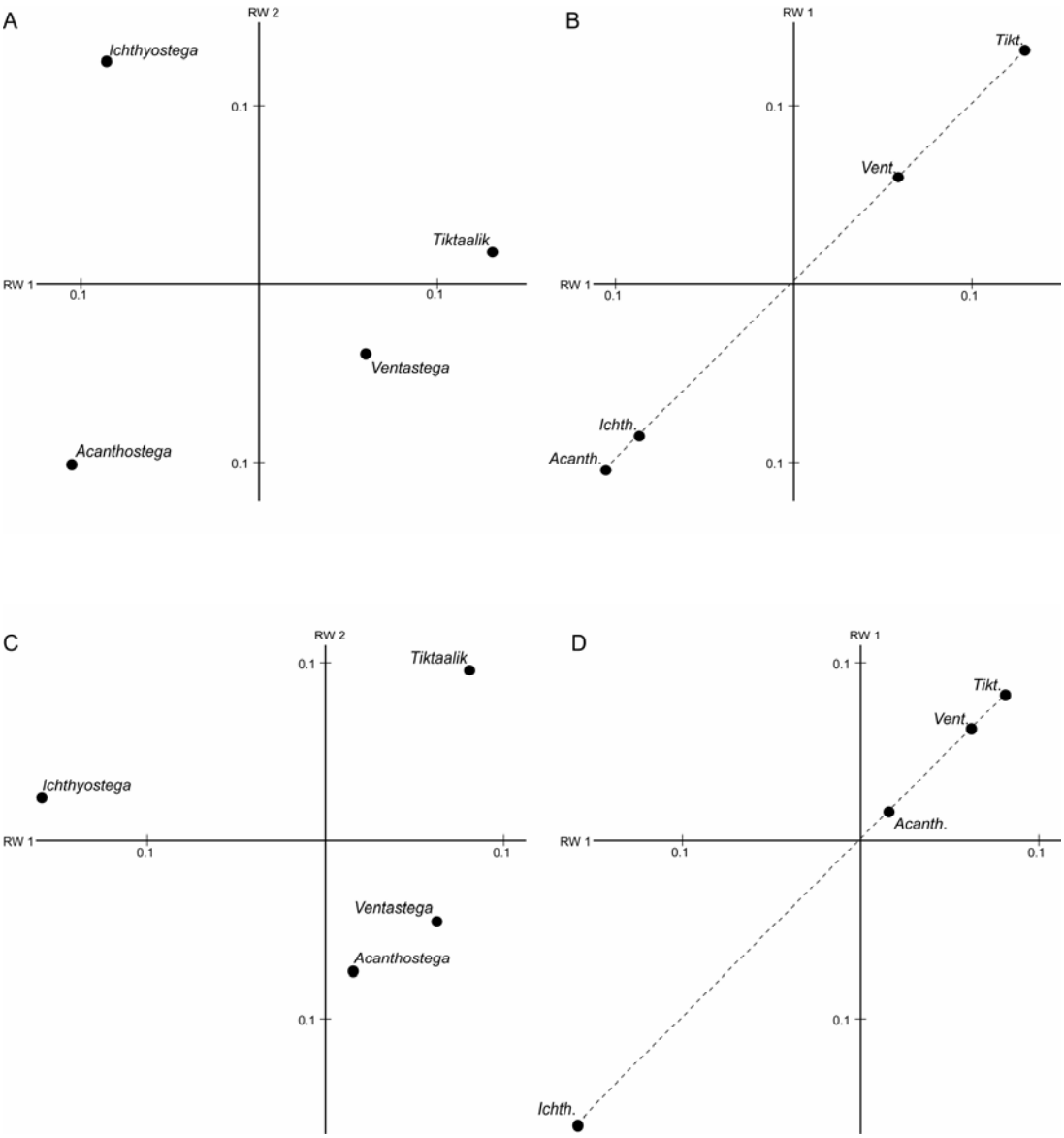

Figure 2. Plots of relative warps analyses. **A**, first analysis, first warp (horizontal axis) vs. second warp (vertical axis). **B**, first analysis, first warp shown on both axes. **C**, second analysis, first warp (horizontal axis) vs. second warp (vertical axis). **D**, second analysis, first warp shown on both axes.