Supplementary section S3

Additional methods.

**Accounting for separation of the maxilla**

Several of the odontocete specimens (in particular the *Delphinus delphis* and *Tursiops truncatus* specimens) exhibited lateral separation of the anterior portion of maxilla and premaxilla; to correct for this the affected landmarks were moved medially in Rhinoceros V5 (McNeel) by the distance measure from the midline of the skull to the medial surface of the premaxilla. Only landmarks from the right mandible were used so that mandibles separated along the mandibular symphysis could be incorporated in the analysis.

**Methodological approach**

Because of fundamental differences in the bones composing the jaws of crocodilians and odontocetes we were unable to use a traditional geometric morphometrics approach where developmentally homologous locations are used as landmarks. These types of points would cloud the analysis with phylogenetic signal and prevent meaningful quantification of the functional and overall shape similarity of each species. For example, the articular and quadrate bones of the crocodilian jaw joint are anatomically homologous with two of the mammalian auditory ossicles, the malleus and incus, respectively, and so landmarking the same bones in these groups would not be informative unless the analysis was trying to focus on phylogenetic differences. Because we are interested in the skulls as functional units that are used to resist loads we propose that an approach focusing on functionally relevant analogous landmark locations will better quantify variation in the shape of the skull related to its biomechanical performance.

We incorporated selected landmarks on the ventral, dorsal, medial and lateral margins at set percentage distances along the rostrum and mandible to quantify aspects of robustness (Figure 2). In general landmarks are classed as Type 1, Type 2 or Type 3 [1]. Type 1 landmarks are locally defined by structures at their location (e.g., the intersection of three sutures on a skull); however, when comparing disparate taxa these types of landmarks are often scarce. Furthermore, regions of the structure that perform the same function may be composed of anatomically different bones. Type 3 landmarks are defined by the position of structures far from themselves, for example, a landmark placed at a point half way between two joints. These types of landmarks are often derived geometrically [2]. Type 2 landmarks are intermediate, being defined as local minima or maxima [1]. Even though variation in Type 3 landmarks is normally restricted to one direction [2], in the case of this analysis, they represent useful data points because they are more easily placed at positions that quantify aspects of shape related to performance, such as depths and thicknesses of the bones a set distances along the length of the rostrum. This landmark set quantifies the general thickness and depth of the rostrum and mandible rather than the position of the bones that compose them, thus quantifying aspects of skull shape are important for determining the load bearing capabilities and hydrodynamic properties of the skulls.

The methodological approach used here shows that it is possible to quantify variation in morphology relevant to biomechanical function in disparate taxa using geometric morphometrics. Landmark selection must be undertaken so that functionally relevant information about shape is maximised. By doing this phylogenetic signal in the results is minimised so that functional convergence can be analysed. The methodology applied here provides a framework for future studies which may wish to examine the morphological convergence of phylogenetically disparate groups.

**References**

1. Bookstein F.L. 1991 *Morphometric tools for landmark data*. Cambridge, Cambridge University Press; 435 p.

2. Zelditch M. 2004 *Geometric morphometrics for biologists: A primer*, Academic Press.