

BRIEF COMMUNICATIONS

Skull morphology of giant terror birds

These monstrous birds were probably more agile and less portly than previously thought.

The phorusrhacids ('terror birds') are an extinct lineage that includes the largest birds known^{1–3}. Reconstructions of these Cenozoic carnivores have consistently highlighted a very high beak, round orbits and vaulted braincase, although minimal information is actually available for the skull of the largest species^{1–5}. An important new fossil of a gigantic avian skull has been discovered from the middle Miocene of Patagonia (Comallo, Argentina), which reveals significant differences between the skulls of large and small phorusrhacids. We conclude that reconstructions of the skull of gigantic phorusrhacids on the basis of their smaller relatives are unwarranted, and that the long-established correlation between their corpulence and reduced cursorial agility needs to be re-evaluated.

The enormous skull of specimen BAR 3877-11 is virtually complete. Its length (tip of rostrum to sagittal nuchal crest) is about 716 mm, making it the largest known avian skull. It is triangular in dorsal view, with a very long and hooked rostrum (exceeding half the length of the skull) and a dorsoventrally compressed caudal portion. The small external nares and larger antorbital fenestra are, respectively, rectangular and quadrangular in shape. The orbits are low and subrectangular, and their ventral margin is formed by a stout and very tall jugal bar. The skull roof behind the orbits is flat and distinctly scarred by the extensive development of the temporal musculature. The occipital table is wide and low, giving the skull a rectangular appearance in occipital view.

The enormous size, laterally compressed and strongly hooked rostrum, and convex culmen support the assignment of BAR 3877-11 within the phorusrhacids^{3,6}. Its skull resembles that of the poorly preserved and slightly smaller *Devincenzia pozzi*³. However, the discovery of BAR 3877-11 reveals that these birds show significant differences with respect to their smaller and more gracile relatives⁷. Particularly evident are the proportionally much lower and longer rostrum, rectangular orbit, notable height of the jugal bar, flat cranial roof, and the proportionally low and rectangular-shaped occipital table characteristic of the skull of gigantic phorusrhacids such as BAR 3877-11 (Fig. 1).

Before the discovery of BAR 3877-11, knowledge of the cranial morphology of large-bodied phorusrhacids — those with skulls exceeding 600 mm in length — was limited to the fragmentary *D. pozzi*^{3,8} and a sketch of the

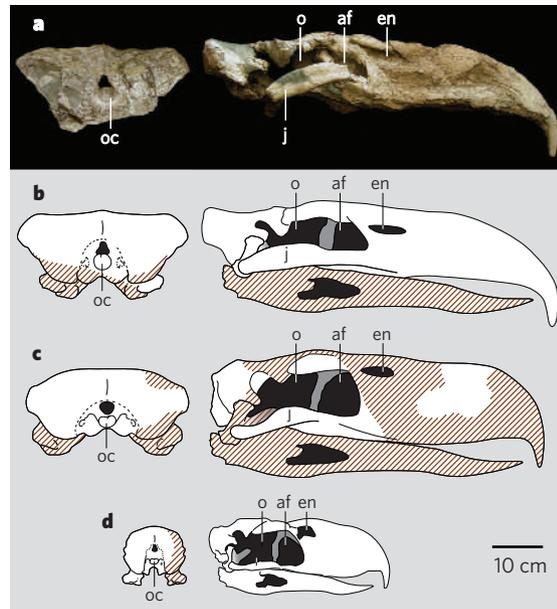


Figure 1 | Skulls of terror birds. **a**, Photograph of the skull (specimen BAR 3877-11; Museo Asociación Paleontológica Bariloche, Río Negro Province, Argentina). **b–d**, Reconstructions of BAR 3877-11 (**b**), *Devincenzia pozzi* (**c**) and *Patagornis marshi* (**d**) in occipital (left) and lateral (right) views. The skull of BAR 3877-11 was found by Guillermo Aguirre-Zabala, adjacent to a tarsometatarsus and fragments of pedal phalanges. Abbreviations: af, antorbital fenestra; en, external nares; j, jugal; o, orbit; oc, occipital condyle. (Figure courtesy of S. Abramowicz.)

skull of *Phorusrhacos longissimus*, which was destroyed during collection⁹. Perhaps influenced by the latter, a sketch largely inspired by the morphology of the much smaller *Patagornis marshi*^{3,10} (skull length about 350 mm), the skull of gigantic phorusrhacids has been consistently interpreted as a scaled version of those of their much smaller and better-known relatives^{1–3,5}. However, the discovery of BAR 3877-11 and our reinterpretation of the skull of *D. pozzi* suggest that this widely accepted notion is incorrect.

BAR 3877-11 also bears on a long-standing view about the evolution of phorusrhacids. The broad range of sizes and inferred agility of phorusrhacids — from maximum standing heights similar to the 0.9-m red-legged seriama to birds that would have stood close to 3 m high — has been traditionally subdivided into groups of increased corpulence and proportionally reduced agility^{1–3,11–13}. On the basis of length measurements of the skull and tarsometatarsus, BAR 3877-11 is estimated to be 10% larger than the largest phorusrhacids previously known (*P. longissimus* and *Bron-tornis burmeisteri*)³. However, the long (437 mm) and rather slender (midshaft width/length ratio of about 0.11) tarsometatarsus of BAR 3877-11 indicates that this bird may have been substantially swifter than the graviportal *B. burmeisteri*. Therefore, the discovery of BAR 3877-11 indicates that the traditional inverse

correlation between body size and cursorial agility^{1–3,11–13} needs to be reconsidered.

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