

Egyptian Gods and the evolution of beak

Filipe Oliveira da Silva

Centuries ago the Egyptians idealized creatures with the face of a falcon and the body of a crocodile, which represented the combination of Horus, the God of the sky, and Sobek, the God of fertility. The temple Kom Ombo was constructed starting around 180 BC in Egypt for celebrating these Gods. Biologists might call it alternatively by “The Archosaurian Temple”, as Arkhat Abzhanov himself did once. A temple celebrating the fusion of a falcon with a crocodile is, in fact, indirectly paying homage to the only two extant lineages of Archosaurs.

However, while the Egyptians had only idealized the fusion between animals, it has been done in modern times with the transfection of, for instance, neural folds from quail to duck, and *vice versa*. The outcome was the formation of the beak in the recipient animal that highly resembled that of the tissue donor. We nevertheless conceptualized for this work a different way of obtaining modified animal faces. We manipulated the expression of genes in certain facial tissues in chicken because we know that the pattern of gene expression is generally linked with the specification and placement of morphological structures. For example, *Wnt* pathway contains genes that control tissue growth. This pathway is expressed in the maxillary prominence of, for instance, mouse, which are typified by having a large snout. On the other hand, in chicken the same pathway is not expressed in the maxillary prominence, but in the frontonasal prominence, and it is surely no coincidence that the face of chicken – i.e. the beak – is much narrower.

I researched then the formation of the facial differences in tetrapods (like mouse and chicken), particularly focusing on beak evolution, for that, I artificially induced the expression of the *Wnt* pathway in the maxillary region of chicken. We hypothesize, and based on what is seen in rodents, would produce a large maxillary region if it were. For this experiment, I performed microsurgery in the maxillary prominence of chicken embryos to implant small beads soaked in a molecule that would be gradually released in the surrounding tissue, and induce there the ectopic expression of the *Wnt* pathway. Embryos developed with the bead implanted for about two weeks (pre-hatchling), and then I checked the shape of the beak by quantitative means, 2D morphometry, and compared with the beak/snout shapes of a broad sample of other extant and extinct archosaurs, that included among other avian and non-avian dinosaurs, crocodiles, and their all together more distant and close relatives. As expected, treatment led to the formation of an enlarged maxillary region, and the beak resembled more that of ancient birds in the morphospace. An enlarged maxilla is also seen in the crocodile rostrum, thus treated embryos resembled somewhat the snout of those reptiles by the maxillary bone. We have produced by modern scientific means a reversed-Egyptian God, a chicken with more crocodile-like maxillary components, but more than that, and more importantly, we have empirically shed light on the genetic mechanisms linked with the evolutionary transition of the snout to the beak.

Degree project in Biology, Master of Science (2 years), 2012

Examensarbete i biologi 30 hp till magisterexamen, Uppsala Universitet, 2012

Biology Education Center, Uppsala University and Harvard University.

Supervisor: Dr. Prof. Graham Budd (Uppsala University) and Dr. Prof. Arkhat Abzhanov (Harvard University)