GOGO FISH REWRITES EVOLUTIONARY HISTORY

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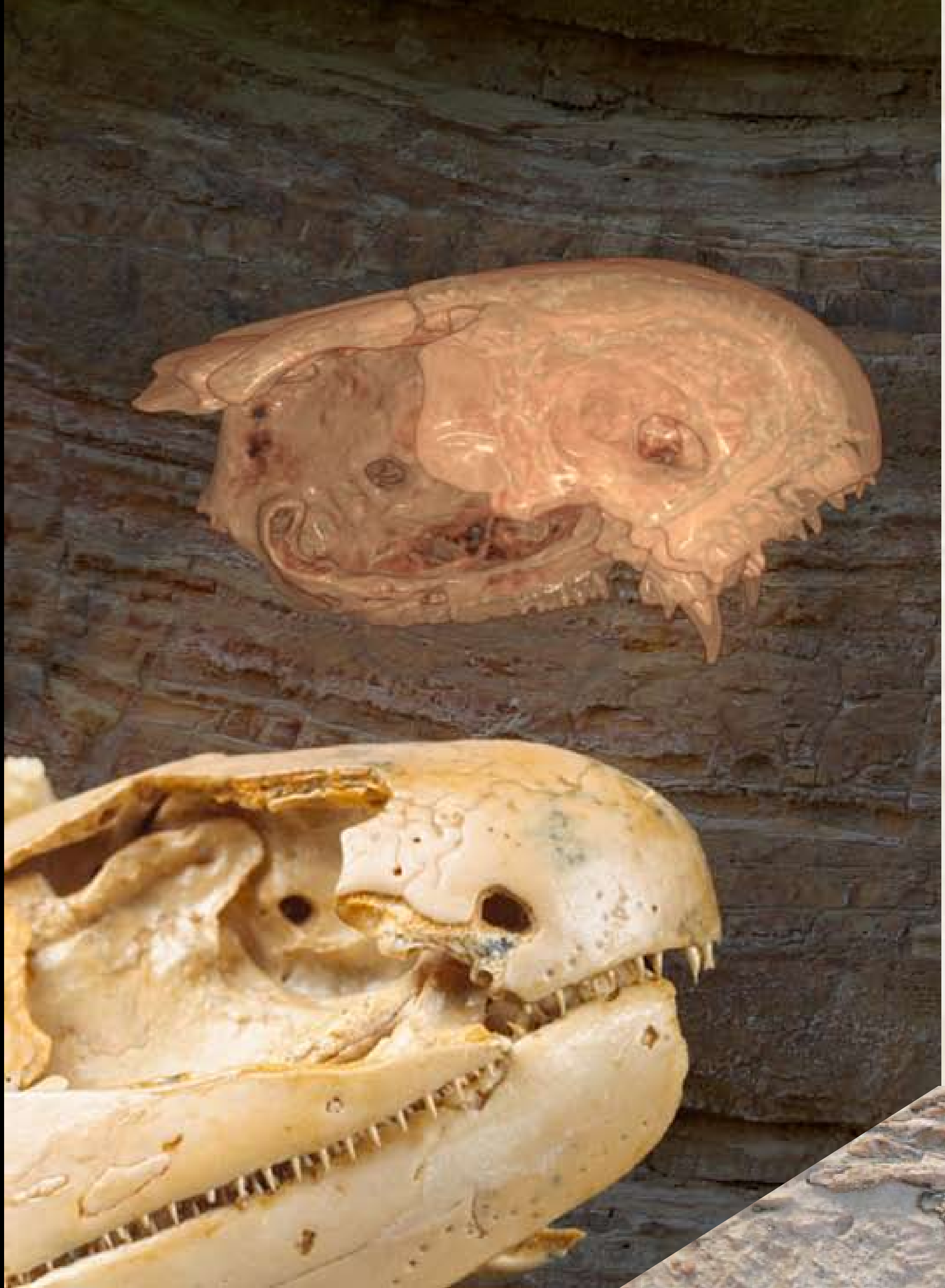
On a recent expedition to the Gogo formation in the Kimberley region of Western Australia a group of ANU scientists uncovered one of the most remarkable fossils of recent history. Partially emerging from one of the numerous limestone nodules that characterise the region, was the skull of a rare fish called Gogonasus. Only three Gogonasus skull fragments had ever been found before, so the largely intact fossil was a spectacular discovery.

Gogonasus is one of the most interesting fossils in the Gogo formation because it is the only one belonging to a major group called the tetrapodomorphs, an evolutionary branch that included early fish ancestors of the first four legged land animals, or 'tetrapods'. Tetrapodomorphs represent the very first steps that back-boned animals took to emerge from an aquatic existence onto dry land, ultimately evolving into all the amphibians, reptiles, birds and mammals that occupy the land today. By studying the brain and sense organs of these exquisitely preserved fossils, scientists can glean vital information about this pivotal process in the evolution of life on the planet.



One organ of special interest is the ear. Fish living in water have the semicircular canals of the inner ear for balance, but have no need for the middle ear with its tiny hammer, stirrup and anvil bones that transmit sound to the braincase from the outside. The first amphibians needed to adapt from hearing in water to the very different challenge of picking up sounds in the far less dense medium of air. This was achieved by modifying some of the bones supporting the gill cover into the middle ear. By studying the skull structure of tetrapodomorphs, scientists can unravel the intricate series of events that culminated not only in the development of modern mammalian ears, but also the complex brains that accompany them.

One difficulty in studying the ear is that its structures lie deep inside the bone of the skull. Two-dimensional x-ray radiographs are of limited value here and conventional CT scanners such as those used in hospitals, don't have anywhere near the spatial resolution to probe such very tiny objects.

This is where the revolutionary micro µCT scanner developed at ANU really came into its own. This instrument is able to perform three dimensional x-ray scans of objects with voxel (3D pixel) resolution of two micrometres. To put that into perspective, this is almost as fine as detail that can be seen in the optical microscopes. Using the µCT scanner, the team were able to build up a perfect 3D model of the tetrapodomorph skull.

The spectacular find and its subsequent analysis has turned some aspects of accepted theory on evolutionary history on their heads suggesting that tetrapods were beginning to evolve some 30 million years earlier than had previously been thought

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