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Drs. Ted Daeschler and Jason Downs are available for media interviews. Contact above.

NEW STUDY REVEALS DETAILS OF EVOLUTIONARY TRANSITION FROM FISH TO LAND ANIMALS

Head skeleton sheds light on intermediate steps

PHILADELPHIA—New research by scientists at The Academy of Natural Sciences provides the first detailed look at the internal head skeleton of *Tiktaalik roseae*, the 375-million-year-old fossil animal that represents an important intermediate step in the evolutionary transition from fish to animals that walked on land.

The study, published in the Oct. 16 issue of *Nature,* shows that the transition from aquatic to terrestrial lifestyles involved complex changes not only to the appendages (fins to limbs), but also to the internal head skeleton. This is the first report on *Tiktaalik roseae* since the original description in 2006 made international news.

A team co-led by the Academy's Dr. Ted Daeschler discovered *Tiktaalik roseae* (tik TAHL ik RO zay) in 2004 within Devonian-age rock on Ellesmere Island in Canada, more than 700 miles above the Arctic Circle. The creature was a large aquatic predator with a flattened head and body. The body plan and nature of the deposits where the fossils were found suggest an animal that lived on the bottom in shallow water and perhaps even out of the water for short periods. *Tiktaalik roseae* has features of the skull, neck, ribs and appendages that are shared with the earliest limbed animals (tetrapods), as well as fishlike features such as scales and fin rays. This mosaic of features makes it a textbook example of a transitional fossil

Dr. Jason Downs, a postdoctoral research fellow at the Academy and lead author of the latest study, said the examination of the internal head skeleton further demonstrates the intermediacy of *Tiktaalik roseae*. "The braincase, palate and gill arches of *Tiktaalik* help reveal the pattern of evolutionary change in this part of the skeleton," said Downs. "We see that cranial features once associated with land-living animals were first adaptations for life in shallow water."

"The new study reminds us that the gradual evolutionary transition from fish to tetrapod and the transition from aquatic to terrestrial lifestyles required much more than the evolution of limbs," said Daeschler. "Our work demonstrates that the head of these animals was becoming more solidly constructed and, at the same time, more mobile with respect to the body across this transition."

Along the lineage of lobe-finned fish that leads to tetrapods, trends in head shape include a flattening of the skull and a lengthening of the snout. With several well-preserved specimens of *Tiktaalik* *roseae*, this study helps document the relative timing of the particular skeletal changes associated with these changes in head shape.

"We used to think of this transition of the neck and skull as a rapid event largely because we lacked information about the intermediate animals," said Dr. Neil Shubin of the University of Chicago, who co-lead the team that discovered *Tiktaalik roseae*. "*Tiktaalik* neatly fills this morphological gap, and so it helps to resolve the relative timing of this complex transition."

During this time of transition, the interactions among the different parts of the head skeleton also were changing. An example is the gradual reduction of the hyomandibula, a bone that, in fish, links the braincase, palate and gill skeletons and coordinates their relative motions during underwater feeding and respiration. In the transition to life on land, the hyomandibula gradually lost these functions, and the bone became available for an eventual role in hearing. In humans, as in other mammals, the hyomandibula, or stapes, is one of the tiny bones in the middle ear.

"The bony part of *Tiktaalik*'s hyomandibula is greatly reduced from the primitive condition," said Downs. "This could indicate that these animals, in shallow-water settings, were already beginning to rely less on gill respiration." Correlated with the changes to the hyomandibula was the dramatic loss of rigid gill-covering bones; this allowed for increased mobility in the neck region.

"Fish in deep water move and feed in three-dimensional space and can easily orient their body in the direction of their prey," said Dr. Farish Jenkins, Jr., a Harvard University evolutionary biologist and a co-author of the study. "A mobile neck is advantageous in settings where the body is relatively fixed, as is the case in shallow water and on land."

It took more than a year for fossil preparators C. Frederick Mullison, of the Academy in Philadelphia, and Bob Masek, of the University of Chicago, to expose and preserve the delicate details in the head skeleton of *Tiktaalik roseae*. The Academy has co-led six expeditions to the Arctic sites, including this past summer. The public can see a cast and a reconstruction of *Tiktaalik roseae* on permanent display in the Academy's museum.

The fossil research in Nunavut is carried out with authorization from the Department of Culture, Language, Elders and Youth, Government of Nunavut. All fossils are the property of the people of Nunavut and will be returned to Canada after they are studied. The research was supported by private donors, The Academy of Natural Sciences, the Putnam Expeditionary Fund (Harvard University), The University of Chicago, The National Science Foundation, and The National Geographic Society Committee for Research and Exploration.

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