

Limbs: Gains and losses

Life has evolved because organisms are selfishly opportunistic and will take advantage of the slightest gain to broaden their sphere of influence. As diversification continues through time, several forms evolve which have a blend of characters intermediate between their ancestral stock and their descendants – the so-called “missing links”. As the rock record in which such organisms are preserved is not temporally continuous, not all missing links are preserved as fossils. However when such rare discoveries are recorded, it is a time for justifiable recognition for the scientists who have made them. Neil H Shubin of the University of Chicago, Edward B Daeschler of the Philadelphia Academy of Natural Sciences and Farish A Jenkins, a Harvard evolutionary biologist have recently reported one such discovery (Daeschler *et al* 2006) of a 375 million year old transitional form between fish and tetrapods representing four-footed land vertebrates from Ellesmere Island in the Canadian Arctic Circle. This find adds exciting new data to the long chain of events that has eventually shaped our own destiny as humans. Indeed, apart from the fact of the origin of life itself, the conquest of land by animal, plant and microbial life nearly 380 million years ago must rank as one of the greatest landmarks in our evolutionary history. In recent years, the iconic status of fossils such as *Archaeopteryx* and new icons such as Eocene Indian and Pakistani “walking whales” have again re-emphasized the role of gradual evolutionary change. Startling discoveries in China in the last 15 years have confirmed how small feathered theropod dinosaurs may have taken to flight and these studies have changed our concepts so much that now the basal Aviales are included in the Dinosauria (Padian 2004). Even more remarkable and closer to home in our own sub-continent, a wonderful series of fossils have shown how once land-living mammals arose from artiodactyls (a group which includes hippos, pigs, deer and other even-toed mammals) and transformed themselves with the loss of graviportal limbs into whales, the present denizens of the deep (Thewissen and Bajpai 2001).

The current find, reported in *Nature* and christened *Tiktaalik*, has been hailed as a “missing link”. Named so by the elders of the native Nunavut locals to represent a “ large shallow-water fish”, it combines all the transitional features one would expect in a ‘fishtopod’, that is, a conjectured transitional form between swimming fishes and land-moving tetrapods. This event can now be placed somewhere between 380 and 360 million years. The transition of animals living in water to land-roamers is not an easy one as it involves several anatomical changes starting from the development of limbs, flexible articular facets between the skeletal elements, changes in the auditory apparatus, rotation of the head and in general, respiratory, reproductive and other sensory complexities.

The three specimens recovered of *Tiktaalik* provide some idea of the length of these creatures which ranged from over 1 m to about 2.5 m. *Tiktaalik* is associated with many other fishes but was the top predator and so adapted: the head could swivel to mark out prey and the eyes stuck out of the skull as in many modern-day crocodiles which lie in ambush for unsuspecting prey. The structure of the arms and shoulder girdles and rudimentary rib case allowed the animal to have the necessary leverage to raise its body from the ground and move on mud flats and river banks. Till now the development of tetrapod limbs from fish fins was not properly understood as this involves the formation of flexible articular surfaces in the shoulder girdle, back- and fore-arms and proto-wrists (Shubin *et al* 2006). Unfortunately, the hind limbs and the pelvic apparatus is not preserved in any of the presently described specimens.. The taxon shows affinities to sarcopterygian fishes in the possession of body scales, fin rays, gills, the structure of the lower jaw and palate but the shortened skull roof, a modified ear region, movable neck and functional wrist joints suggest that it was an aggressive, land-roaming carnivore that also had air-breathing capabilities.

Tiktaalik was recovered in Arctic Canada about 900 kilometers from the present North Pole from the Fram Formation which is an extensive continental facies consisting of sediments derived from meandering streams and river systems. Fossil pollen associated with the specimens suggest that the beds are of Late Devonian age.



Figure 1. Reconstruction of *Tiktaalik roseae* based on published material (graphics: R Patnaik)

At the time when this creature lived, Ellesmere Island was part of the super-continent Pangaea which straddled the equator, the climate was much warmer and equable than now and devoid of polar ice caps. Land plants had just begun to take stock of their new conquests by inhabiting available terrestrial environments; scorpion-like invertebrates and insects followed in a co-evolutionary battle that is still being fought today. It has been conjectured by one of the authors (NS) that *Tiktaalik* may have fed upon the more than half meter long fossil scorpions. Associated fishes include antiarch placoderms, lungfishes and osteolepidids.

Tiktaalik has a great story to tell as it bridges a wide gap between water-based swimming fish and land-roaming tetrapods. The find, welcomed by evolutionary biologists, has already come under the firing crosshairs of creationist websites. Till now, the early whales of the Indian subcontinent were their main targets as the fairly complete series of fossils from India and Pakistan show in detail how anatomical changes (reversed in the sense of *Tiktaalik*) from land to sea dwelling habitats could have taken place about 53 million years ago. In parts of the US and some other countries, school science has suffered because of the influence of people who have been successful in removing the subject of evolution from curricula on the basis of religious conservatism. The discovery of missing-link fossils such as the *Tiktaalik* will do a lot to dispel any doubts that the common man may have of the fact of evolution.

References

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