= Tiktaalik =

Tiktaalik / t?k?t??l?k / is a monospecific genus of extinct sarcopterygian (lobe @-@ finned fish) from the late Devonian period , about 375 Ma (million years) ago , having many features akin to those of tetrapods (four @-@ legged animals) .

Tiktaalik has a possibility of being a representative of the evolutionary transition from fish to amphibians . It is an example from several lines of ancient sarcopterygian fish developing adaptations to the oxygen @-@ poor shallow @-@ water habitats of its time , environmental conditions which are thought to have led to the evolution of tetrapods .

It and similar animals may possibly be the common ancestors of the broad swath of all terrestrial fauna : amphibians , reptiles , birds , and mammals . The first well @-@ preserved Tiktaalik fossils were found in 2004 on Ellesmere Island in Nunavut , Canada .

= = Etymology = =

The name Tiktaalik is an Inuktitut word meaning " burbot " , a freshwater fish related to true cod . The " fishapod " genus received this name after a suggestion by Inuit elders of Canada 's Nunavut Territory , where the fossil was discovered . The specific name roseae cryptically honours an anonymous donor . Taking a detailed look at the internal head skeleton of Tiktaalik roseae , in the October 16 , 2008 , issue of Nature , researchers show how Tiktaalik was gaining structures that could allow it to support itself on solid ground and breathe air , a key intermediate step in the transformation of the skull that accompanied the shift to life on land by our distant ancestors .

= = Description = =

Tiktaalik provides insights on the features of the extinct closest relatives of the tetrapods . Unlike many previous , more fishlike transitional fossils , the " fins " of Tiktaalik have basic wrist bones and simple rays reminiscent of fingers . The homology of distal elements is uncertain ; there have been suggestions that they are homologous to digits , although this is incompatible with the digital arch developmental model because digits are supposed to be postaxial structures , and only three of the (reconstructed) eight rays of Tiktaalik are postaxial .

However , the proximal series can be directly compared to the ulnare and intermedium of tetrapods . The fin was clearly weight bearing , being attached to a massive shoulder with expanded scapular and coracoid elements and attached to the body armor , large muscular scars on the ventral surface of the humerus , and highly mobile distal joints . The bones of the forefins show large muscle facets , suggesting that the fin was both muscular and had the ability to flex like a wrist joint . These wrist @-@ like features would have helped anchor the creature to the bottom in fast moving current .

Also notable are the spiracles on the top of the head , which suggest the creature had primitive lungs as well as gills . This attribute would have been useful in shallow water , where higher water temperature would lower oxygen content . This development may have led to the evolution of a more robust ribcage , a key evolutionary trait of land @-@ living creatures . The more robust ribcage of Tiktaalik would have helped support the animal ? s body any time it ventured outside a fully aquatic habitat . Tiktaalik also lacked a characteristic that most fishes have ? bony plates in the gill area that restrict lateral head movement . This makes Tiktaalik the earliest known fish to have a neck , with the pectoral girdle separate from the skull . This would give the creature more freedom in hunting prey either on land or in the shallows .

Tiktaalik is sometimes compared to gars (esp . Atractosteus spatula , the alligator gar) of the Lepisosteidae family , with whom it shares a number of characteristics :

diamond @-@ shaped scale patterns common to the Crossopterygii class (in both species scales are rhombic , overlapping and tuberculated) ;

teeth structured in two rows ;

both internal and external nostrils ;

tubular and streamlined body ;

absence of anterior dorsal fin ;
broad , dorsoventrally compressed skull ;
paired frontal bones ;
marginal nares ;
subterminal mouth ;
lung @-@ like organ .

= = Paleobiology = =

Tiktaalik generally had the characteristics of a lobe @-@ finned fish , but with front fins featuring arm @-@ like skeletal structures more akin to those of a crocodile , including a shoulder , elbow , and wrist . The fossil discovered in 2004 did not include the rear fins and tail . It had rows of sharp teeth of a predator fish , and its neck could move independently of its body , which is not common in other fish (Tarrasius , Mandageria , placoderms , and extant seahorses being some exceptions ; see also Lepidogalaxias and Channallabes apus) . The animal had a flat skull resembling a crocodile 's ; eyes on top of its head , suggesting that it spent a lot of time looking up ; a neck and ribs similar to those of tetrapods , with the ribs being used to support its body and aid in breathing via lungs ; well developed jaws suitable for catching prey ; and a small gill slit called a spiracle that , in more derived animals , became an ear .

The fossils were found in the " Fram Formation " , deposits of meandering stream systems near the Devonian equator , suggesting a benthic animal that lived on the bottom of shallow waters and perhaps even out of the water for short periods , with a skeleton indicating that it could support its body under the force of gravity whether in very shallow water or on land . At that period , for the first time , deciduous plants were flourishing and annually shedding leaves into the water , attracting small prey into warm oxygen @-@ poor shallows that were difficult for larger fish to swim in . The discoverers said that in all likelihood , Tiktaalik flexed its proto @-@ limbs primarily on the floor of streams and may have pulled itself onto the shore for brief periods . In 2014 , the discovery of the animal 's pelvic girdle was announced ; it was strongly built , indicating the animal could have used them for moving in shallow water and across mudflats . Neil Shubin and Ted Daeschler , the leaders of the team , have been searching Ellesmere Island for fossils since 2000

We 're making the hypothesis that this animal was specialized for living in shallow stream systems , perhaps swampy habitats , perhaps even to some of the ponds . And maybe occasionally , using its very specialized fins , for moving up overland . And that 's what is particularly important here . The animal is developing features which will eventually allow animals to exploit land .

= = Classification and evolution = =

Tiktaalik roseae is the only species classified under the genus . Tiktaalik lived approximately 375 million years ago . Paleontologists suggest that it is representative of the transition between non @-@ tetrapod vertebrates (fish) such as Panderichthys , known from fossils 380 million years old , and early tetrapods such as Acanthostega and Ichthyostega , known from fossils about 365 million years old . Its mixture of primitive fish and derived tetrapod characteristics led one of its discoverers , Neil Shubin , to characterize Tiktaalik as a " fishapod " .

Tiktaalik is a transitional fossil ; it is to tetrapods what Aurornis is to birds , troodonts and dromaeosaurids . While it may be that neither is ancestor to any living animal , they serve as evidence that intermediates between very different types of vertebrates did once exist . The mixture of both fish and tetrapod characteristics found in Tiktaalik include these traits :

Fish
fish gills
fish scales
fish fins
" Fishapod "
half @-@ fish , half @-@ tetrapod limb bones and joints , including a functional wrist joint and

radiating , fish @-@ like fins instead of toes
half @-@ fish , half @-@ tetrapod ear region
Tetrapod
tetrapod rib bones
tetrapod mobile neck with separate pectoral girdle
tetrapod lungs

= = Phylogenetic position = =

= = = 2006 - 2010 = = =

The phylogenetic analysis by Daeschler et al. placed Tiktaalik as a sister taxon to Elpistostege and directly below Panderichthys preceded by Eusthenopteron . Tiktaalik was thus inserted above Acanthostega and Ichthyostega as a transitional form and a true " missing link " .

Such order of the phylogenetic tree was initially adopted by other experts , most notably by Per Ahlberg and Jennifer Clack . However , it was questioned in a 2008 paper by Boisvert at al. who noted that Panderichthys , due to its more derived distal portion , might be closer to tetrapods than Tiktaalik or even that it was convergent with tetrapods . Ahlberg , co @-@ author of the study , considered the possibility of Tiktaalik 's fin having been " an evolutionary return to a more primitive form . "

= = = 2010 - now = = =

In January 2010 , a group of paleontologists (including Ahlberg) published a paper accompanied by extensive supplementary material (discussed also in a Nature documentary) which showed that first tetrapods appeared long before Tiktaalik and other elpistostegids . Their conclusions were based on numerous trackways (esp . Muz . PGI 1728.II.16) and individual footprints (esp . Muz . PGI 1728.II.1) discovered at the Zache?mie quarry in the Holy Cross Mountains (Poland) . A tetrapod origin of those tracks was established based on :

distinct digits and limb morphology ;
trackways reflecting quadrupedal gait and diagonal walk ;
no body or tail drag marks ;
very wide stride in relation to body length (much beyond that of Tiktaalik or any other fish) ;
various size footprints with some unusually big (up to 26 cm wide) indicating body lengths of over 2 @.@ 5 m .

Track @-@ bearing layers were assigned to the lower @-@ middle Eifelian based on conodont index fossil samples (costatus Zone) and " previous biostratigraphic data obtained from the underlying and overlying strata " with subsequent studies confirming this dating .

Both Titaalik 's discoverers were skeptical about the Zachelmie trackways . Edward Daeschler said that trace evidence was not enough for him to modify the theory of tetrapod evolution , while Neil Shubin argued that Tiktaalik could have produced very similar footprints (in a later study Shubin expressed a significantly modified opinion that some of the Zachelmie footprints , those which lacked digits , may have been made by walking fish) . However , Ahlberg insisted that those tracks could not have possibly been formed either by natural processes or by transitional species such as Tiktaalik or Panderichthys . Instead , the authors of the publication suggested ichthyostegalians as trackmakers , based on available pes morphology of those animals . However , a 2012 study indicated that Zachelmie trackmakers were even more advanced than Ichthyostega in terms of quadrupedalism . Grzegorz Nied?wiedzki 's reconstruction of one of the trackmakers was identical to that of Tulerpeton .

Prof. Narkiewicz , co @-@ author of the article on the Zachelmie trackways , claimed that the Polish " discovery has disproved the theory that elpistostegids were the ancestors of tetrapods " , a notion partially shared by Philippe Janvier . There have been a number of new hypotheses

suggested as to a possible origin and phylogenetic position of the elpistostegids (including Tiktaalik) :

their phylogenetic position remains unchanged and the footprints found in the Holy Cross Mountains are attributed to tetrapods but as a result there are at least six long ghost lineages separating Zachelmie trackmakers from various elpistostegalian and ichthyostegalian species ;

they were " late @-@ surviving relics rather than direct transitional forms " ;

they were " an evolutionary dead @-@ end " ;

they were a result of convergent or parallel evolution so that apomorphies and striking anatomical similarities found in both digited tetrapods and elpistostegalians evolved at least twice .

It should be noted that convergency is considered responsible for uniquely tetrapod features found also in other non @-@ elpistostegalian fish from the period like Sauripterus (finger @-@ like jointed distal radial bones) or Tarrasius (tetrapod @-@ like spine with 5 axial regions) .

Estimates published after the discovery of Zachelmie tracks suggested that digited tetrapods may have appeared as early as 427 @.@ 4 Ma ago and questioned attempts to read absolute timing of evolutionary events in early tetrapod evolution from stratigraphy .

Until more data becomes available , the phylogenetic position of Tiktaalik and other elpistostegids remains uncertain .

= = Discovery = =

In 2004 , three fossilized Tiktaalik skeletons were discovered in rock formed from late Devonian river sediments on Ellesmere Island , Nunavut , in northern Canada . Estimated ages reported at 375 Ma ago , 379 Ma ago , and 383 Ma ago . At the time of the species ' existence , Ellesmere Island was part of the continent Laurentia (modern eastern North America and Greenland) , which was centered on the equator and had a warm climate . When discovered , one of the skulls was found sticking out of a cliff . Upon further inspection , the fossil was found to be in excellent condition for a 375 @-@ million @-@ year @-@ old specimen .

The discovery , made by Edward B. Daeschler of the Academy of Natural Sciences , Neil H. Shubin from the University of Chicago , and Harvard University Professor Farish A. Jenkins , Jr , was published in the April 6 , 2006 , issue of Nature and quickly recognized as a transitional form . Jennifer A. Clack , a Cambridge University expert on tetrapod evolution , said of Tiktaalik , " It 's one of those things you can point to and say , ' I told you this would exist , ' and there it is . "

After five years of digging on Ellesmere Island , in the far north of Nunavut , they hit pay dirt : a collection of several fish so beautifully preserved that their skeletons were still intact . As Shubin 's team studied the species they saw to their excitement that it was exactly the missing intermediate they were looking for . ' We found something that really split the difference right down the middle , ' says Daeschler .