New data on terrestrialisation of vertebrates

American researchers have discovered Kanadas Fossilien of a fish which had already partly performed the transition to the terrestrial animal in the north. The animal named Tiktaalik roseae lived in the flat shore waters of rivers about 383 to 375 million years ago and has both characteristics of a fish and characteristics of a four-legged country vertebrate. So his skull, his neck, his ribs and his front limbs already resemble these it strongly of terrestrial animals, lasting gleichzeitig shows fins, shacks and the primitive jaws of a fish. Tiktaalik partly closes at least the gap with that which gaped in the evolution between fish and country vertebrates.

Fig.1. Fossil of Tiktaalik roseae: Upper arm bone, forearm bone, parts of the hand, skull (www.Zeit.de)
Tiktaalik, Acanthostega and Ichthyostega, lives between water and country

The emergence of the Tetrapods indicates the transition of the aquatic way of life for a life ashore and therefore marks a key event in the evolution of the organisms. With fossilly received Reubfische like Eustenopteron and Panderichthys the emergence of the Tetrapoden can be reconstructed model-likely. The Tetrapods can therefore be derived from urtümlichen Fleischflossern, the so-called Sarcopterygier. This section of the phylogenetic development was accompanied by a number of transformations such as the restructuring of the skull, the bandolier and the region from which the middle ear formed later. Robust extremities which show carpus and finger a structure into upper arm, ulna and spoke of the forearm arose from the fish fins at the same time.

The emergence of the Tetrapodfeature was illustrated by Fossils only scantily till now, though. So the fish still show Eustenopteron and Panderichthys relatively little Tetrapodenmerkmale, those of primitive Tetrapod Acanthostega and Ichthyostega are more or less considerably already different from you morphologically during himself.

The predatory fish Tiktaalik, however, embodies an intermediate form which exactly fits into this evolutionary gap. The fish with the crocodile similar skull is in the phylogenetic system due to his unique feature composition between the predatory fishes Eustenopteron as well as Panderichthys and the oldest Tetrapoden Acanthostega and Ichthyostega.

General idea of Tiktaalik, Acanthostega and Ichthyostega:

Tiktaalik (big flat water fish):

He was a genre of the amphibienähnlichen Fleischflosser (Sarcopterygii), this one, Fossilien were discovered in sedimentary rocks of the head of Devon of the Ellesmere island (of Ellesmere Iceland) in the north of Canada. Only the kind of Tiktaalik roseae is known till now. As transition form Tiktaalik is a piece of evidence for this, in which order bone fish developed features of the country vertebrates (Tetrapoden) still before the first Uramphibien like Acanthostega and Ichthyostega resulted from them. As ancestors of Tiktaalik identify the Wissenschaflter Panderichthys like fish.

Tiktaalik is like other Sarcopterygii like the Quastenflossern and the lungfishes in the scales, in the fin beams as well as in the making of the lower jaw and the palate. Amphiebienartig are the abbreviated skullcap and the Ohrrregion, the nimble neck and the front limbs. Remind the pectoral fins of Tiktaalik of arms equipped with elbows and wrist, they ended, however, in fin radiate and not in fingers. The flat, longish muzzle of the up to 20 cm long skull gives the animal a crocodile similar appearance.

In opinion of the scientists Tiktaalik was a resident of offshore flat water because his remains were found in the deposits of a river delta. He used the pectoral fins for the locomotion on the waters reason. He could support himself under streching of the shoulder and the elbow like on forelegs in the sediment.

Fig.2.Tiktaalik (www.nsf.gov)
Acanthostega:

Acanthostega gunnari is the name of one of 1933 Fossils found in Greenland which belongs to the Tetrapods to the tribe group representatives, his complete lifetime however like a fish in this, land on water has spent. It is for the evolution biology of special interest since it stands near the origin's animal group important to the phylogeny of these. The anatomical making of his front limbs and back limbs proves that the typical four limbs of the country vertebrates must already themselves have developed in the water. The still far common assumption that the country vertebrates from Sarcopterygii have developed which her muscular fish fins used for occasional shore leaves is therefore questionable. Acanthostega already rather moved with four leg like limbs on the marshy ground overgrown with aquatic plants, the heitigen lungfishes do similarly like this also with her fleshy fins. A reconstruction of his extremity bones shows that they could have carried the heavy body in the country only for a short time. So he was mainly an aquatic animal which moved with four legs and not by fin blow in the waters.

Ichthyostega:

Ichthyostega is the earliest well known amphibian. It is a great, to partly still that life animal bound in the water. The body was long and there was the heavy skull from solid bones. The four firm limbs carried five toes each. A long tail fin and bone shacks over belly and tail still reminded of the fish ancestors. Of course a living being like this couldn't leave the water too far yet. It ashore moved awkwardly forward and led far protruding movements at it with the body through. His element was, still taken in the reason the water where it successfully hunted fish. Ichthyostega was also different from a fish by the fact that the upper jaw had grown into the skullcap tightly, except for the limbs. There was no more connection between head and bandolier and a short neck had taken shape. For the life in the country these qualities were quite useful. Ichthyostega had to be no more as streamlined as a fish; however, it was advisable for it if the animal could turn his head on the search for thieving and spoils animals.
As a support for the body set long, broad ribs at the spinal column, the each other overlapped. You formed a broad, barrel-shaped thorax which supported and protected the vital organs, the heart, the lungs and the digestive organs. The thorax was presumably so solid that he didn’t extend at the breathing. Ichthyostega breathed presumably by pumping out air by movements of the mouth floor into his lungs. The mouth of Ichthyostega was very broad and showed many broad, conical teeth. The palate was also strewed by teeth in which some of this were long canine teeth.

Anatomical details at fins, spinal column and skull of Eustenopteron remind of amphibians. So the later upper arm bones, ulna and spoke can be recognized at the front fin. This animal An ancestor of all country vertebrates could therefore be.

The teeth covered with glaze, the connection of ribs and moving advice as well as the lack the dorsal fin show a greater proximity of the Fleischflossers Panderichthys to the Tetrapods as Eustenopteron. Who lived rather of them doesn’t have to be decided due to the vague dating.

His anatomy expels Tiktaalik as a link between fish and Tetrapoden. The front fins show the same bones as the poor woman later Tetrapods, the ear is also built similarly. Moreover, Tiktaalik had lungs and nimble head one opposite the trunk rakes.
With his four legs and lungs Acanthostega already was part of the Tetrapods. He could creep also over country presumably, lived and ate, however, predominantly in the water. This nature had eight fingers instead of five like later Tetrapoden, his systematic position isn't clear since.

Ichthyostega was regarded as the first amphibian for a long time. After new researches, however, the contemporary still was adapted strongly by Acanthostega to the life with his paddelförmigen hind legs in the water. Moreover, he had seven toes unlike later Tetrapoden at the hind feet (the front toes aren't received).

Fig.4. As the four legs of the country vertebrates have developed from fins can be comprehended himself with Fossilien. Although no complete sequence of the transitions has to be covered -- tightly stands, however, that because of the low number of finds yet the limbs arose with aquatically living animals at first. (Geokompakt Nr.8)

The discovery Tiktaaliks

At the right time at the right place to be, three scientists of different well three in whom they burst to an inhospitable, heavily accessible region in the north of Canada again and again where they had the opportunity only for two months each to look for remains of a missing member suspected by them in the evolutionary chain of the development of the fish to the country living being doubted for years. They were but then, lucky at the beginning of the fourth research period. U of his lunch break sat down exactly one of the scientists to a point of which he could out see one from the species called rock layer of rising muzzle of a copy of the late Tiktaalik.

Edward B. Daeschler of the Academiy of Natural Science in Philadelphia, Neil H. Shubin of the university of Chicago and Farish A. Jenkins Jr. Years made one of the most interesting discoveries of paleontology from Harvard to the last one that way. But the find wasn't a chance. Before, Daeschler and Shubin had read rock formation in a textbook of a great, isolated which had the right age (ca.375 m. years) to contain Fossilien of devonischen living beings. Moreover, this rock formation was due to a delta where the sea emptied into a home lake. And exactly in flat ponds vermuteteten arising this way the researchers the day room for fish which tried the transition for the country life.
The Geological Setting and climate

Tiktaalik was found in the Canadian Arctic, at approximately 78° North latitude. The climate is extremely harsh for all but a few weeks of each year. During the time, the ground only thaws 6 cm below the surface, making it very difficult for large plants to grow. Consequently, there are no trees or even bushes in the high Arctic. Instead, there is tundra: a landscape of mosses, lichen, and hardy grasses that can cope with the short growing season and harsh temperatures.

It follows then, that the animals in the Arctic must be specially adapted to the extreme cold and long periods without a lot of food. Average winter temperatures are –28°C and since there are no trees, winds can reach speeds of 48-96 km/h. With such harsh conditions, it makes sense that there are only a few specially adapted animals living in the Arctic today.

How then is it possible that we are finding tropical species like Tiktaalik in the rocks if the Arctic? The answer has to do with the continental drift. Three hundred and seventyfive years ago in the Devonian, the world did not look anything like it does today. First of all, the climate was much warmer overall, so the north and south pole were not covered in ice. Secondly, the continents were not arranged in the same way as they are today. The continent Tiktaalik lived on was not located at 78° N. Instead, it was located almost entirely in the southern hemisphere. And the stream Tiktaalik probably lived was located in the Northern part of that continent, very close to the Equator.
The breathing ashore

Her damp, slimy skin is one of the most striking features of the amphibians still living today. But they are most considerably of her paläozoic ancestors different just in this feature. The modern amphibians breathe normally by lungs but a considerable part of the gas exchange is carried out directly over the skin. Narrow limits are set to both the size development and the way of life with that.

Many paläozoic amphibians had an armour-clad body and grew up to considerable sizes. Both facts indicate that the early amphibian didn't know any cutaneous respiration today existing the unlike. Had left water ledige or scaly skin, had an impermeable one the early amphibians, this one only short time ago to bend water loss forward that. It was the disadvantage of such a body covering that the animals only could slowly and clumsily presumably move.

One of the most essential prerequisites for the emergence has the education been of country vertebrates of nose throat walks and with that of back nose openings (Choanen) in the pharynx. These Choanen have arisen from processes of the nose bag to the oral cavity; the organ only intended for the photo of smell attractions out of the water originally received an additional task as a breath way through her now.
Development of the inside ear

With the fish the middle ear indicating so for the country vertebrates and thus of course also the eardrum is missing. Only the inside ear is trained but which served as a seat of the sense of balance whose original function, however, didn't consist in the photo of tones. So the hearing organ was an organ of equilibrium at first. The middle ear together with the sound leading apparatus developed only at the Tetrapoden; through this the organ of equilibrium becomes the right hearing organ.

Many developments and reorganizations caused this function change:
1) The spiraculäre abyss bag enlarges herself to the later middle ear space.
2) The former splashing hole of the fish changed itself to the Eustachischen tube, which one makes the connection to the throat.
3) The Hyomandibuläre belonging to the gill bend alters itself to the sound leading stirrup
4) The eardrum corresponds to the thin membrane between the spiraculären gill furrow and the abyss bag; it serves for the photo of the air vibrations.

The spinal column of the Tetrapods

The transition of the water life for the country life made new demands also to the spinal column. She still was serving the Anheftung of the limbs in addition now. Of course the limbs which are switched in between don't sit directly at the spinal column but at the bandolier and pelvis belt. Besides strength flexibility had to be available if be the spinal column of her new task of consolidating the body and serving the belt and limbs as an on hanging apparatus raked.

A bone full whirl developed from the cut whirls of the Quastenflosser which consist of a front plate and a back plate at the Tetrapoden.

One rib each fastens herself on the two sides of the whirl bodies. The task befits the ribs supporting the cover of the body and with that the body cave.

There was still a firm connection at the Quastenflossern between bandolier and skull back edge. With the oldest amphibians the skull back edge always loosens himself more in favor of a größerer Beweglichkeit of the skull. The neck section got longer by one string-pulling of new whirls at the same time.

Reason of the shore leave

Why did they leave the water and ventured on the mainland which showed substantially bigger temperature fluctuations and which held unknown danger of the end drying in the water? One used to assume, this phylogenetic change has taken place in a day room which periodically dried out. A fish which can leave his waters drying out and migrate on the search for another suitable biotope over country has better chances of survival here.

Another theory assumes, single fish would have arranged for the after-position on the part of rapacious sea residents to it ashore to go. So it is over conceivable to the danger that Fleischflosser escaped on sandbanks or to the beach and survived there thanks to her primitive lungs with the help of her fins was.

Today, after newer researches primarily after the discovery of Tiktaalik one assumes that the limbs of the Tetrapoden have developed in flat waters. They used her extremities for the locomotion on the waters reason. Was the decisive why the country of the amphibians was settled that luxuriant food supply which passed snails and other invertebrate from numerous insects, worms.
Country vertebrates point out the first shore leave of the Tetrapods to it qualities of most:

1) This one with the mouth room bandaged lungs arose from an instruction of this one Digestion apparatus.
2) The construction of the middle ear with the eardrum and the stirrup when Gehörknöchelchen are modified relics of gill elements of the fish.
3) The substance Keratin is in horn shacks, hair and claws as protection of the skin once resulted for drying out.
4) The bones of upper arm and forearm which Tiktaalik already had
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