Tetrapods from Fish?

Gaining Ground: The Origin and Evolution of Tetrapods, 2nd edn
Jennifer A. Clack
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This work is somewhat technical in nature, and is packed with anatomical details. It surveys not only the presumed evolutionary origin of tetrapods, but also their inferred adaptive radiations in the Carboniferous. Because this subject is rapidly undergoing study, I include a more recent publication.[1]

This review considers the highly touted transitional *Tiktaalik*, and other 'fishapods'. It then entertains evolutionary arguments based on such things as stratomorphic intermediates and the alleged explanatory power of evolutionary interpretations.

To avoid confusion, I use the term 'ambling' to refer to unspecified forms of locomotion across land, and restrict the term 'walking' to refer specifically to locomotion across land by the use of jointed, weight-bearing limbs. This distinction is important, as further noted, though it is my term for purpose of reference, and not actual scientific terminology.

Tiktaalik—not a leg to stand on

Pardon the pun in the title. When *Tiktaalik* was first discovered, there was a great media hullaballoo about this 'legged walking fish', and evolutionistic triumphalism about it waxed eloquent. A whole series of cartoons were drawn to lampoon creationists, and to do so with no small amount of sarcasm (see the Google Images on *Tiktaalik*).

Although Clack does not describe it in this manner, she points out that *Tiktaalik* had a number of specializations, including a large number of vertebrae, which was atypical of either fish or tetrapods (p. 82). It thus appears that *Tiktaalik* was an 'oddball', and therefore a rather poor candidate for a transitional form between fish and tetrapods.

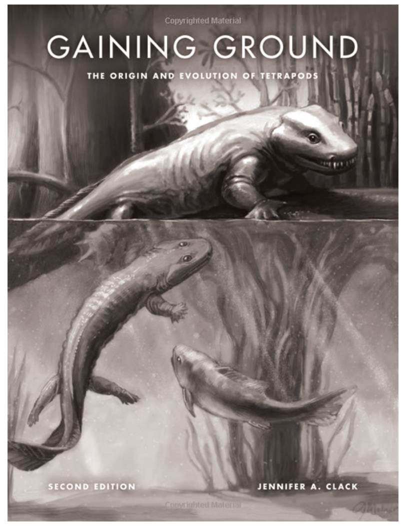
What could *Tiktaalik* actually do? It turns out that the incipient tetrapod-like properties of *Tiktaalik* fins are a matter of interpretation, not fact (pp. 214, 441). Clack notes:

> "It appears that the 'wrist' was able to rotate and flex in a way similar to that of a tetrapod, and that suggests a supportive role, raising the forequarters out of water. Additionally, the long imbricating ribs presumably must have borne muscles to keep the body rigid as it did so. Whether it could actually leave the water using its fins as 'legs' is not certain. Crucially, the pelvic fin and girdle remain unknown" (p. 84).

Other parts of *Tiktaalik's* skeletal anatomy are little more definitive. Clack comments,

> "It might be supposed that one of the parts of the skeleton to have been most affected at the fish-tetrapod transition would be the vertebral column … . The information now coming from creatures like *Tiktaalik* and *Ichthyostega* are giving mixed messages about the early evolution and functioning of the axial skeleton during the transition, and it is no longer so easy to determine what kind of axial morphology is primitive" (pp. 416–417).

What about progress towards the eventual tetrapod condition? (I am using, of course, the word 'progress' in terms of outcomes, not goals.) Ironically, *Panderithys*, which is less derived towards the eventual tetrapod



condition than *Tiktaalik* (p. 88), had a more tetrapod-like skeleton than *Tiktaalik* (p. 214).

That should settle it. *Tiktaalik* is hardly an earth-shaking milestone in the presumed evolution of fish to tetrapods. By no stretch of the imagination is it a proven legged walking fish!

Returning to the malicious lampooning of creationists in the wake of the discovery of *Tiktaalik*, perhaps a little nemesis is in order for the intellectual hubris of the evolutionists (see figure 1). *Tiktaalik* thus joins the Piltdown Man, *Archeopteryx*, etc. as greatly-overhyped 'missing links' that are somewhere between questionable and bogus.

More advanced 'fishapods'—dubious 'legs' for walking

As if *Tiktaalik* was not enough, fossils that are more derived than *Tiktaalik*, cladistically speaking, and more recent stratigraphically (see pp. 60, 88), additionally lack compelling evidence of full-fledged tetrapod locomotion. This includes the crucial evidence of limbs that have weight-bearing capabilities. Clack points out that

> "Unfortunately, in almost all very early tetrapods, wrist and ankle bones tend to have been poorly ossified and hence were

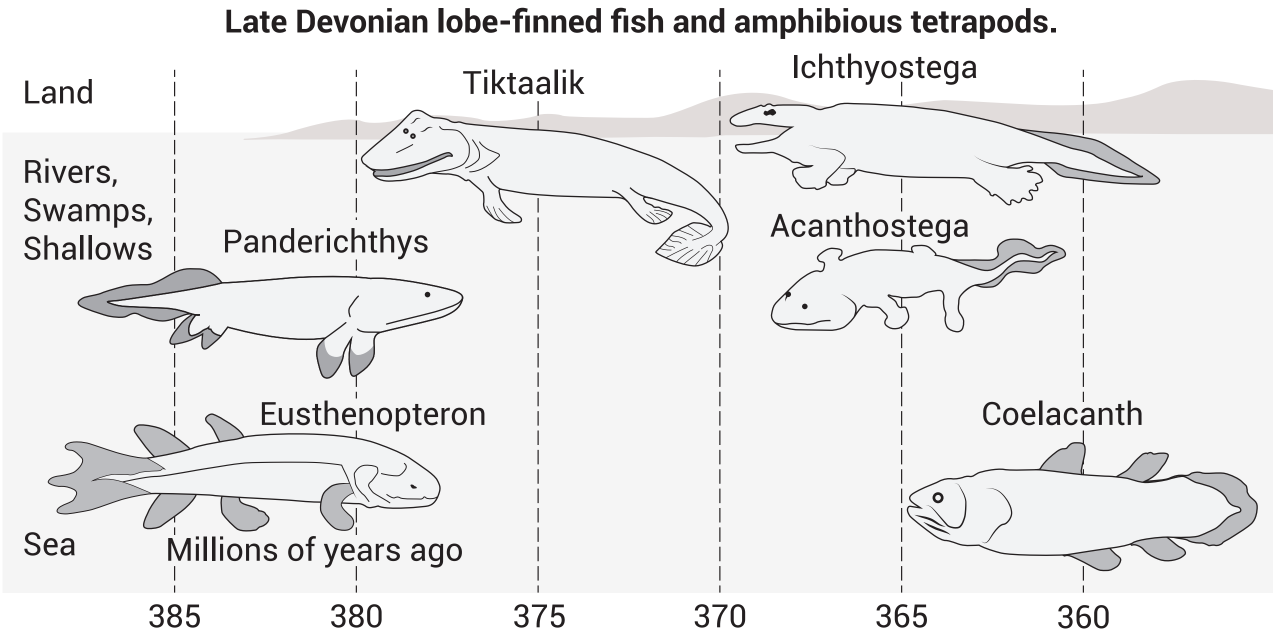


Figure 1. The phylogeny of tetrapods presumably evolving from fish.

poorly fossilized. The ankles of *Ichthyostega* and *Acanthostega*, and both ankle and wrist of *Tulerpeton* … constitute conspicuous exceptions to this observation. The ankles of *Ichthyostega* and *Acanthostega* are consequently known to be rather different from those of tetrapods known from the mid-Late Carboniferous, having fewer bones and no obvious lines of flexibility that would have allowed the foot to be placed flat on the ground for weight bearing …" (pp. 442–443).

She adds, "Even in *Tulerpeton*, it is not clear that the joints would have been as flexible as those of later, more terrestrial tetrapods" (p. 443).

She adds that

> "*Acanthostega*'s wrist was quite unlike the wrist of subsequent tetrapods. Because the radius and ulna were such different lengths, the ends could not have formed an effective bearing surface on which the animal's weight could be balanced … . Similarly, the ankle joint was also unsuitable as a weight-bearing joint, being rather inflexible …" (p. 173).

In conclusion, the gap between ambling fish and walking tetrapods not only still exists, but also remains rather large. Clack tacitly admits as much:

> "Because of circumstances such as these, the transition from the earliest and presumably non-weight-bearing joints to those that were more fully terrestrial is still poorly understood. Once these features are more clearly reflected in the bony skeleton, it becomes possible to say more about terrestrial adaptation of limbs and vertebrae …" (p. 443).

What an evolutionary transitional form is not

A transitional form is not merely a mosaic consisting of an assortment of features normally typical of different forms of life. Thus, in the context of this review, a fossil that exhibits a mosaic of reputed piscine and reputed tetrapod features (even if validly interpreted) does not, by itself, qualify as a transitional form.

One obvious example of mosaicism, and inconsistent mosaicism at that, is found in *Acanthostega* and the more derived *Ichthyostega* (figure 2). In terms of lower jaw morphology, *Ichthyostega* comes out as more primitive than *Acanthostega*. The results are further contradictory when more traits are considered. Clack concludes that the phylogeny of Devonian tetrapods is unstable, and invokes the standby of parallel evolution to explain (or explain away) this situation (p. 184).

Nor does the fossil organism qualify as transitional form if it is intermediate in some traits, while singularly discordant in others (in other words, it is specialized). Clack, though no creationist, recognizes the magnitude of this problem:

> "In the past, a temnospondyl such as *Eryops* would have been featured in the role of primitive tetrapod, and *Ichthyostega* would have been seen as an intermediate between *Eusthenopteron* and *Eryops*. Recent analyses, however, have suggested that *Ichthyostega* has some highly specialized features that may make it unsuitable as a representative Devonian tetrapod; it is now also clear that *Eryops* is a higly specialized and unrepresentative temnospondyl.

Although *Eusthenopteron* is not as close a relative of tetrapods as used to be considered, it still provides good information about basal tetrapodomorph structure" (p. 187).

What, then, is an evolutionary transitional form?

Far from backpedalling on 'transitional forms' in the face of successive discoveries of fossils, as often accused, scientific creationists have always been consistently and perfectly clear about what they do mean by genuine transitional forms. For example, back in 1974, Duane T. Gish wrote a booklet titled "Have You Been Brainwashed?" In it, he specified what genuine evolutionary transitions should look like, if they existed. Consider the fish evolving into a tetrapod. Immediate ancestor-descendant relationships, which are next to impossible to infer, are not required. However, one should see a series of very gradational intermediates on all the traits that differentiate the fish from the tetrapod. The series should show a fossil with 100% fin, succeeded by a fossil that has a structure that is 90% fin and 10% leg, succeeded in turn by a form that has a structure that is 80% fin and 20% leg … through a fossil that is finally 100% leg. Much the same fine progression should be exhibited by other traits, such as a fossil whose skull is 100% fish, through fine successive intermediates, to one whose skull is 100% tetrapod.

Using cladistic language, the foregoing definition of transitional forms can be expressed as follows: a series of ever-more-primitive sister groups, each of which is discontinuity-free, towards both its stemward and the crownward forms, none of which has any specializations.

The facts are clear. Nothing that evolutionists have found in the 40 years since the immortal Duane T. Gish defined transitional forms comes close to fulfilling this challenge!

Stratomorphic intermediates?

Some evolutionists, including those who may concede the failure of morphological transitions, have now claimed that, given the known fossil record, there is a close correspondence between the stratigraphic appearance of fossils and their relative positions in fish-to-tetrapod phylogeny. This, at best, is a half-truth. Friedman and Brazeau comment:

> "Before the Polish trackways highlighted the missing pre-Givetian record of 'elpistostegalians' and digited tetrapods, there were already indications of outstanding stratigraphic gaps in the Devonian tetrapod record. Most major piscine branches in tetrapod phylogeny (rhizodonts, osteolepidids *sensu stricto*, megalichthyids, canowindrids and tristichopterids) make their debut in the Eifelian-Givetian. Unlike more crownward stretches of the stem, where clade rank and FAD [First Appearance Datum] are tightly correlated, these deep branches show no clear relationship between stratigraphy and phylogeny."[2]

One must ask, in addition, if the agreements that do exist are at least partly the result of subtle preconceptions. Could evolutionists be subtly influenced in their choice of traits for use in their cladograms by the order of stratigraphic appearance of the fossils that they are working with?

Some evolutionists have made much of the fact that chains of inferred evolutionary changes occur at highly constrained stratigraphic intervals in the Phanerozoic geologic column. "Just where we need them, that is where they are", say the evolutionists. Let us examine this argument in light of the fish–tetrapod transition. Friedman and Brazeau have used quantitive evolutionary methods to factor the unexpected early appearance of the Zachelmie trackways in Poland in terms of the first appearance of the tetrapods.[3] Their three scenarios (good choice of word) all require considerable ghost lineages—wherein putative 'fishapods' existed but left no fossil record. Depending upon such input information as assumed probability of fossil preservation, the 95% confidence intervals span not only most of the Devonian, but, according

Image: Tim Newcombe

Figure 2. The fate of Tiktaalik.

to one set of assumptions, even down to the mid-Silurian![4] What's more, this does not factor in the additional uncertainties of 'tetrapodness' well into the Carboniferous. (The earliest recognized terrestrial tetrapod, *Casineria* (p. 443), does not appear until the early-mid Visean stage of the Early Carboniferous (p. 260).) Thus, the inferred fish-to-tetrapod evolutionary makeover smears over as many as three geologic periods, and, in any case, is hardly 'constrained' stratigraphically at all.

Is it not significant, however, that the so-called fishapods have tetrapod features at all, implying at least a crude evolutionary and stratigraphic progression towards the eventual tetrapod condition? Not necessarily. Clack quips:

> "Apart from possession of limbs with digits, a number of the supposed tetrapod-like characters found in *Acanthostega* that are often linked with terrestriality can actually be found among modern fishes that have no reputation as land dwellers" (p. 173).

This matter can be extended into the broader context of the entire fossil record, and to the present. There are various fishes that can amble across land (as from one pond to another), or which have bony fins of various types, yet no one suggests that they are 'stratomorphic intermediates' of some sort. As an example, consider the modern Sargassum frog fish (for drawing, see p. 137; for a frog fish in general, see figure 3). Its pectoral and pelvic fins, according to Clack, exist as jointed, digitlike fingers and toes.

Evolution's 'explanatory power'—origin of legs

Evolutionists usually claim that Special Creation is not scientific, not only because of supernaturalism, but also because 'The Creator can do anything', and so the creation explanation is unconstrained and untestable. This argument, among other things, assumes that evolutionary explanations are highly constrained and testable. This, in turn, implies that evolutionists can make very specific predictions (actually, deductions), and then locate highly specific evidences that uniquely correspond to these predictions. All this is supposed to endow evolutionary theory with great explanatory power.

Clack considers evolutionary predictions, but prefers the word scenario to prediction (p. 135). In addition, she frankly admits that, for one reason or another, many evolutionary scenarios are untestable (pp. 173, 242).

Consider the inferred evolutionary processes that transformed fish fins into tetrapod legs. Since evolution lacks foresight, and always modifies structures that existed previously, what could be more intuitively obvious than the land-ambling fish subjected to natural selection that favours increasingly distant, increasingly rapid, and increasingly efficient land-based locomotion, culminating in the tetrapod leg? What could be more reasonable than the emergence of a stiff, bony fin? This would naturally favour improved weight bearing and then improved ambling on land, eventuating in a full-functioning tetrapod leg.

As it turns out, not only did this evolution prediction fail, but also, as if to spite the evolutionist, the evidence shows the *exact opposite*. Clack comments:

> "Before it [the modern coelacanth] was studied in its natural environment, many people predicted that its fin structure would mean that it used fins for walking on the bottom of the sea or among the coral reefs where it lived. However, film of the fish in action shows that this is never the case; it uses its paired fins for slow paddling … . The lungfish Protopterus has been observed to prop itself up on the substrate using thin whiplike appendages that are most unlimblike" (p. 136).

The boniness, or lack thereof, in modern fish fins, also is the very opposite of evolutionary predictions. Clack points out that

> "The first thing to notice is that these two groups are almost mutually exclusive—that is, those with digitlike fin rays by and large are not those that venture unto land, and conversely, those that do venture onto land do not necessarily do so by means of digitlike or limblike fins" (p. 136).

Clack then discusses factors that may have led to the origin of tetrapods, and concludes:

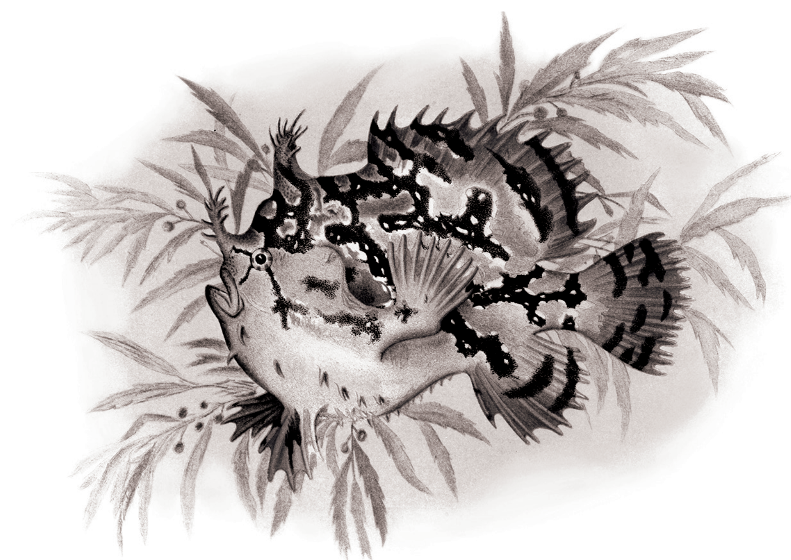


Figure 3. An example of a frog fish—a modern fish that can amble on its bony fins.

"Nonetheless, it is difficult to tease apart all the influences that were at work in the Devonian to produce the appearance of tetrapods. Ideas are numerous, but evidence is equivocal. Most ideas can be countered by objections or alternative suggestions, or they are difficult or impossible to test. Without a much more complete fossil record, they must remain speculative" (pp. 140–141).

So much for the wonderful explanatory power of evolutionary theory!

'Tests' of evolution—comparative anatomy, *Hox* genes, and embryology

There has been, in recent years, a revival of a form of the old embryological recapitulation idea among evolutionists. Clack assesses information from embryology as follows:

"Part of the problem of posing such theoretical ideas is that they are based on the study of such a limited sample of experimental animals. Zebra fish, mice, chickens, and the frog *Xenopus*, the most commonly studied laboratory animals in developmental biology, all belong to species that are highly specialized members of their vertebrate groups. This means that they may not always be representative of tetrapods as a whole, and they certainly cannot account for many of the extreme specialization that some tetrapods show" (pp. 252–253).

Obviously, information from embryology is not self-evident or empirical. It is not only a matter of interpretation, but also a matter of *post hoc* evolutionary reasoning.

Clearly, data from embryology and *Hox* genes, like that from comparative anatomy and paleontology, is a matter of integration and interpretation, as is obvious from the following statement by Clack:

"The second major objection to the fin-to-limb scenarios is that recent discoveries show that the earliest tetrapods were not pentadactyl after all, and the evolution of joints and digits did not proceed in the order of fashion that early theoretical studies assumed …" (p. 136).

Furthermore, current interpretations of what aspects of 'tetrapodness' evolved first (including that based on clues from embryology and comparative anatomy) could admittedly be completely overturned with the discovery of new and earlier 'fishapod' fossils (p. 257). Obviously, if extra-paleontological evidence was conclusive, this could not be so.

Let us examine this in a bit more detail. Fossils can refute deductions of presumed evolution based on embryological development. For instance, a forbidden morphology implied by embryological evidence (the shortest digit must be at the end of the five, not the middle), has been refuted by fossil evidence (p. 252). It is obvious that evidence from embryological development is in no sense diagnostic. Instead, it is 'juggled' with other evidences.

Evidence from *Hox* genes, at least at this stage, is conjectural. For instance, Clack (p. 253) points out that there is no explanation for why we have five fingers and five toes. Is the constraint developmental, functional, or some combination of the two? Early vertebrates sometimes had more than five, as Clack had noted previously (above). If early evolutionary 'experimentation' allowed for non-pentadactyl limbs, then why did it not happen thereafter? Clack speculates that *Hox* genes may be at least partly responsible for the 'canalization' of development into pentadactyl limbs only. Regardless, it refutes the evolutionary icon of the pentadactyl limb as the classic example of homology, supposedly proving common ancestry, since the proposed candidates for common ancestor were not pentadactyl.

Testability of evolution?

What, then, do evolutionists mean when they say that evolution is testable? Obviously, they are not talking about experimental verification, since we are dealing with the unobservable past. Nor are they talking about the overall evolution explanation, of living things, itself being testable. They are talking about specific evolutionary scenarios being testable. The test involves whether or not some scenario clashes with incontrovertible evidence, as that from fossils. Obviously, evolution is not being read out of the evidence. Evolution is being read *into* the evidence. No matter what turns up, some kind of *post hoc* evolutionary reasoning (or storytelling) is imposed upon the data.

Conclusions

The discontinuity between fish and land-walking tetrapods remains. The 'walking fish' *Tiktaalik* has busted as fast as it had boomed. Other 'fishapods' are just as unconvincing. The inferred evolutionary progression from fish to tetrapods is inconsistent from morphology to morphology. In addition, it smears over a considerable stretch of inferred geologic time. Evolutionary arguments about stratomorphic intermediates and the predictive powers of evolutionary explanations are of dubious validity.

References

1. Friedman, M. and Brazeau, M.D., Sequences, stratigraphy and scenarios: what can we say about the fossil record of the earliest tetrapods? *Proceedings of the Royal Society (Biological Sciences)* **278**:432–439, 2011.
2. Friedman and Brazeau, ref. 1, p. 437.
3. Friedman and Brazeau, ref. 1, p. 433.
4. Friedman and Brazeau, ref. 1, p. 435.