Turtle evolution turns turtle

Turtles as Hopeful Monsters: Origins and evolution

Olivier Rieppel

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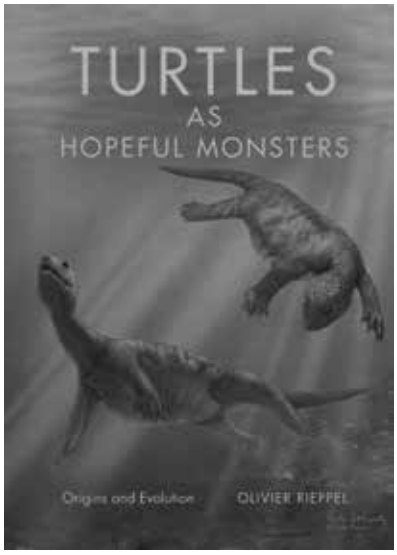

John Woodmorappe

Author Olivier Rieppel is identified as the Rowe Family Curator of Evolutionary Biology at the Field Museum in Chicago. He has more than 350 scientific papers and eight books to his credit, and is on the editorial board of several peer-reviewed scientific journals.

This book is about much more than the alleged evolution of turtles. It touches on various aspects of evolutionary theory, and candidly entertains positions on the philosophy of science that are quite similar to those of scientific creationists.

The rebirth of evolutionary 'hopeful monsters'

The 'hopeful monster' idea posits that major evolutionary changes occur not from long-term step-by-step alterations, but from massive changes, in multiple organ systems, in an organism, within a single generation. Most of these monstrosities quickly die out, but (supposedly) a few live on as radically new organisms.

In accordance with Rieppel's jargon, the transformationist perspective closely maps with the traditional neo-Darwinian view of evolution as a step-by-step process of the accumulation of beneficial mutations by natural selection—an adaptationist chain of long-term, generally gradual events that eventually lead to a novel organism. In other words, given enough time, microevolution becomes macroevolution. The transformationist perspective emphasizes paleontology in the understanding of (presumed) evolutionary change, and focuses on the (presumed) transformation of one organism into another over time. This is best exemplified by the (presumed) transition-filled evolutionary sequences, notably the therapsid-to-mammal and theropod-to-bird ones.

By contrast, the emergentist perspective sees evolution as primarily the changes that occur in the developmental programs that regulate the development of adult traits. Because these (presumed) changes can happen simultaneously, 'instant' macroevolution of a new organism can (presumably) take place, without transitional states from the ancestral organism, thus fulfilling Richard Goldschmidt's old 'hopeful monster' hypothesis (hence the title of this book). The emergentist perspective emphasizes embryology in the deduction of how these (presumed) changes have taken place in the distant past. However, as elaborated below, embryological clues to (presumed) evolution are not self-evident: They rely on a good dose of special pleading.

The transformationist and emergentist perspectives overlap considerably. Rieppel comments:

> "One of the major differences between the emergentist and transformationist paradigm is that the latter, but not necessarily the former, allows, or even seeks, to arrange adult organisms in a transformation series of ancestral and descendant conditions to form putatively documented continuous morphological change. That way the ancestral and descendant conditions of form are bridged by an unbroken series of intermediate steps, as is required according to the Darwinian theory of evolution through variation and natural selection. Such intermediate steps in evolutionary change may *sometimes* be gleaned from the fossil record and *sometimes* from embryonic development [emphasis added]" (p. 152).

The splitjaw snake: hopeful monster or wishful thinking?

An unusual, rare bolyeriid snake, *Casarea dussumieri*— at one time grouped with the boas— has, instead of the usual single upper jawbone (maxilla), two disconnected upper jawbones connected by a hinge. Although now many decades old, the splitjaw snake is brought up by Rieppel as an iconic example of the evolutionary hopeful monster mechanism in action.

A close examination of the evidence shows that this unusual intramaxillary joint is not synovial, and that it contains no articular cartilage. The abutting edges of the bones are not shaped for a precise fit, and the now-two bones are loosely connected by a strap ligament.[1] It appears that, far from qualifying as a 'second jaw' (in some way), much less a hopeful monster, the splitjaw morphology is a greatly overhyped feature.

There is suggestive (not conclusive) evidence that the splitjaw morphology gives its bearer a selective advantage. It enables the upper jaw to 'curl around' (encircle) the skink prey, held transversely in the jaw, which could otherwise slip away.[2] Is this profound or trivial? What if some other craniofacial defect—such as heritable forms of cleft palate in humans and animals—sometimes conferred a selective advantage to its bearer?

Let us, for the sake of argument, imagine that the freak splitjaw morphology is both anatomically and functionally a 'second jaw'. The reader is asked to imagine a human born with an extra set of functional knees: the regular knee that joins the femur with the tibia/fibula, along with a second full-fledged knee, superior (headward) to the first, and forming a hinge within the femur. Moreover, what if this 'second knee' gave its bearer an advantage in certain circumstances—as, for example, a stellar career in acrobatics?

Would the 'second knee' mean that the person having it is no longer human, and is now a 'hopeful monster' that belongs to its own, new, higher taxonomic category? Hardly. In like manner, no one even tries to suggest that the splitjaw belongs to its own, higher taxonomic category. It is still a snake, and is universally recognized as one.

Finally, any would-be 'second jaw', just as the hypothetical 'second knee', is a duplicated structure, not a novel structure. It hardly qualifies as a 'hopeful monster' in the customary sense of the word, much less as anything comparable to the reorganization in development that would hypothetically transform a non-turtle into a turtle in one generation!

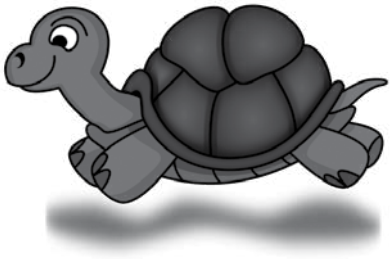

Figure 1. A cartoon version of the turtle, exemplifying the ways this unusual reptile captures the human imagination.

By citing the bolyeriid snakes as 'hopeful monsters', it appears that evolutionists are clutching at straws. Here we are, some 65 years after their discovery, and the bifurcated upper jaw of bolyeriid snakes actually passes, in Rieppel's own words, as the "most frequently cited example of hopeful monster in vertebrates" (p. 119). If this is the best that evolutionists can do, then evolutionary theory in general, and the 'hopeful monster' mechanism in particular, must be intellectually poor indeed.

Contradictory 'phylogenetic signals' on the relative placement of turtles

Molecular data places the turtles as a sister group to the Archosauria (that is, Aves and Crocodylia), while micro RNA data instead places turtles as a sister group to the Lepidosauria (*Sphenodon punctatus* (the tuatara) and Squamata (lizards and snakes)).[3] Rieppel seconds this conclusion, and makes no attempt to belittle its significance:

> "There is an obvious discrepancy in the signals concerning turtle relationships generated by comparable anatomical versus molecular studies—a discrepancy that still has no satisfactory explanation today" (pp. 59, 187).

In the past, creationists were ridiculed for questioning the ancestor-descendant relationships shown in textbooks as fact. Now the cladistic revolution has induced evolutionary thinking to catch up, in this respect, with creationism: "The search for ancestors was rejected as dilettante science; instead the search for sister groups became all the range" (p. 4).

Odontochelys: outstanding evolutionary evidence, or over-hype?

The author claims that the recently discovered Chinese Late Triassic *Odontochelys* is a dramatic find, in that it has a plastron (figure 2) but not carapace, proving that the plastron evolved first, and that this plastron-first appearance is exactly what we see in modern turtle embryos.

However, even within the confines of evolutionary ideation, the alleged 'half-turtle' *Odontochelys* can be interpreted in a decidedly less exciting manner—as an unremarkable, aquatic-specialized turtle that moreover does retain elements of the carapace, in a manner similar to that of some modern aquatic turtles. Reisz and Head[4] comment:

> "Thus, an alternative interpretation is that the apparent reduction of the carapace of *Odontochelys* resulted from lack of ossification of some of its dermal components, but that a carapace was indeed present. This interpretation of *Odontochelys* leads us to the possibility that its shell morphology is not primitive, but is instead a specialized adaptation.

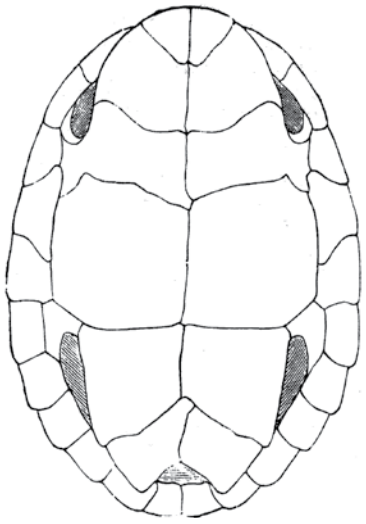

Figure 2. The plastron, the ossified underside of the turtle, is, according to both embryology and the Upper Triassic *Odontochelys*, supposed to have evolved before the shell (carapace) itself.

> *Reduction of dermal components of the shell in aquatic turtles is common*: soft-shelled turtles have a greatly reduced bony shell and have lost the dermal peripheral elements of the carapace. Sea turtles and snapping turtles have greatly reduced ossification of the dermal components of the carapace, a condition similar to that seen in *Odontochelys* [emphasis added]."

What about the role of *Odontochelys*, the presumed evolutionary origins of turtles? Not much, as it turns out. In order to avoid getting caught up in semantics about so-called evolutionary transitional forms, I let Rieppel speak about the status of *Odontochelys*:

> "The mystery of mysteries that still awaits resolution concerns the sister group relationships of turtles among reptiles, diapsids in particular. Such sister group relationships are generally revealed through shared evolutionary innovations. It is thus not the many primitive characteristics of *Odontochelys* that promise to reveal the sister group characteristics of turtles, because many other reptile groups may share the same primitive features—teeth on the upper and lower jaws, for example. What would be required for the resolution of the sister group relationship of turtles would be for *Odontochelys* to share some evolutionary innovation with some other reptile group outside turtles. In that respect, *Odontochelys* remains silent. Those evolutionary innovations that it does have are the same that characterize later, as well as modern, turtles" (p. 187).

A closer look at evolution in the light of the embryology of turtles

What of the presumed fulfilled embryological prediction concerning the plastron-first *Odontochelys*? Apart from the ambiguous interpretation of *Odontochelys*, elaborated in the previous section, the reader must remember that those evolutionists who held to other theories of turtle origin were evidently not impressed with the plastron-first embryological development in turtles. Therefore, the sudden attention to the plastron-first embryology appears to be more an after-the-fact 'discovered significance' than a prediction. In any case, it bears repeating that "Such intermediate steps in evolutionary change may *sometimes* be gleaned from the fossil record and *sometimes* from embryonic development [emphasis added]" (p. 152). Clearly, the invoking of embryology, for the inference of presumed one-time evolutionary stages, even those seen in the fossil record, is more in the realm of special pleading than sound methodology[5].

Let us now consider the putative embryological evidence for the presumed evolutionary degree of the relatedness of the turtles to various extant reptile groups. For decades, the modified fifth metatarsal in turtles (hooked element) has been used as a synapomorphy to group turtles with certain other reptiles. Recent embryological analysis suggest that, rather than being the fifth metatarsal, it is instead an enlarged fifth distal tarsal. However, the same evidence can actually be interpreted as supporting the original metatarsal identity.[6] Note also that distal tarsals generally ossify endochondrally (through replacement ossification) while metatarsals ossify perichondrally (through non-replacement ossification). However, this does not necessarily resolve the issue, because exceptions to this generalization are known. All of the foregoing, at the very least, shows that deductions from embryological evidence are quite interpretive in nature, and that they partake of deductive reasoning that assumes the fact of evolution.

The following statements by Joyce *et al.*[7] are especially revealing:

> "It is apparent, however, that primary homology is not deduced from the absolute timing of chrondrification or ossification, *but rather from changes in this sequence relative to ancestral conditions*, as inferred through outgroup analysis [emphasis added]."

Clearly, then, embryology, on its own terms, is not a line of evidence that is independent of phylogeny: it assumes both the fact and the veracity of the phylogenetic reconstructions, and moreover requires a 'shopping around' for presumably relevant evidence.

As is the case with adult traits, when all else fails, the evolutionist can always invoke convergence for traits in the embryo. As evolutionists debate the presumed significance of the embryological evidence, they are willing to contemplate such things as the independent origins of the hooked element in unrelated reptiles or the secondary reversal of this trait in reptiles that presumably once had them.[8]

Given enough instances, and looking hard enough while manipulating the evidence diligently enough, one could eventually 'see' an evolutionary development in all sorts of embryological developmental pathways. In conclusion, embryology can be like palmistry. Given enough imagination, combined with enough selectively chosen anecdotes of success, one can reasonably deduce that the creases in one's palm are 'signposts' of one's situation in life. In like manner, embryological events can inventively be made into 'signposts' of past evolutionary events.

The new emergentist just-so stories join the old transformationist just-so stories

By way of introduction to this subject, Rieppel comments:

> "The tools in this case are the genes, but as the case of turtles illuminates, the same genes can do different things in different contexts or locations. It is obviously entirely

possible to recruit old genes, which, in a different context and location, can perform new tricks … . Old genes performing new tricks in a different context or location is a classic mechanism of evolutionary innovation ... . Innovation here does not mean the mere transformation of an ancestral structure into a modified, descendant one, but rather means the emergence of an evolutionary novelty through the reprogramming of embryonic development, resulting in the formation of a carapace, the hallmark of a novel body plan" (p. 151).

We again are dealing with evolutionspeak, otherwise known as evolutionistic 'cover words'. Is this 'old genes doing new tricks' meme something that is known to happen, or is it something that is *assumed* to have happened? The answer is rather obvious. Recall that, in classical neo-Darwinism, 'survival of the fittest' (an obvious truism) is confused with 'arrival of the fittest' (a supposition), and moreover 'an organism is adapted' (an obvious truism) is confused with 'an organism is adapted because of endless mutations filtered by natural selection' (a supposition). Now it is more of the same. Only this time, 'the same genes perform different functions in different organisms' (an obvious truism) is confused with 'the same genes perform different functions, in different organisms, because of one or more radical reorganizations of developmental pathways in the past' (a supposition).

Finally, Rieppel (p. 146) is candid about the fact that known embryological anomalies tend to be stereotyped in terms of their outcomes, which points to 'forbidden pathways' in development. Although not mentioned as such, this weakens the argument that errors in embryological development could serve as a viable mechanism for viable and novel hopeful monsters.

Creationists are right about comparative anatomy, homology, and inferred ancestor-descendant relationships

Although evolutionist Rieppel is in no sense supporting creationism, his helpful historical survey confirms what creationists have long been saying. I focus on three items.

To begin with, the practice of comparative anatomy not only is compatible with creationism, but actually began under creationism, and moreover with evolution very much a latecomer. Rieppel tacitly recognizes as much:

"At the time of Linnaeus's writing, the term 'affinity' was meant to express degrees of structural similarity, not evolutionary relationships, the latter a connotation that the term 'affinity' acquired only later, most prominently through the influence of Charles Darwin" (p. 33).

Now let us ponder the fact that homology is not evidence of evolution. Homology *assumes* the existence of evolution. Moreover, even within the mental box of evolutionary thinking, homologies cannot be proved; only supposed. Rieppel comments:

"A prerequisite for all classifications that are meant to represent evolutionary (phylogenetic) relationships is certainly the correct identification of homologies. That depends on the one hand on a comparative method that allows us to pinpoint corresponding parts, or organs, in two or more organisms that could be homologues. Beyond that, however, homology implies common ancestry, and *in the absence of a time machine, the latter implication cannot be confirmed through observation.* The relation of homology therefore does not obtain from raw observation alone. Instead, while ultimately rooted in a comparative analysis of anatomy, *it nevertheless remains to a large degree a hypothetical relation* [emphasis added]" (p. 64).

Macroevolution is not just microevolution writ large

One implication of inferred evolutionary 'hopeful monsters' is as follows:

"In light of these discussions, it became obvious that the reconstruction of evolutionary relationships in essence boils down to the study of the evolutionary transformation of characters, that is, of those characters that mark out taxonomic units of lower or higher rank may be subject to different evolutionary mechanisms" (p. 103).

Are evolutionary theories testable?

This book has a fascinating section on evolutionary theory in the light of the philosophy of science. In many ways, it echoes creationists.

The hallmark of science is the testability (falsifiability) of its theories. Decades ago, creationists (e.g. the immortal Duane T. Gish) had noted that evolutionary theories cannot, strictly speaking, be tested, at least not the same way that the effects of a chemical can be tested in the laboratory. Interestingly, author Rieppel comes to much the same conclusion. He writes:

"Because experimental sciences, such as chemistry and physics, deal with processes that—in general and within certain limits—are reproducible, such testing of published results is routine, especially if they are deemed suspicious for one reason or another. In sciences that are not experimental, the confirmation or falsification of any purported insight or theory is much harder" (p. 154).

Evolutionary theories are admittedly subjective and imagination-driven

Rieppel continues:

"Testing theories of comparative anatomy or comparative

> embryology is likewise hugely messy. Comparative anatomy weighs the degrees of similarity or dissimilarity of organs or organ systems in the plants or animals under comparison, but many say that similarity ultimately lies in the eye of the beholder. What looks similar to one investigator may look dissimilar to another … . But how similarity should be measured—this is where the disagreement arises … . Comparative anatomy is notorious for carrying on endless debates about potential homology relations and their significance for the reconstruction of the tree of life. The endless debates about the evolutionary relationships of turtles are just one notorious example among many" (pp. 154, 155).

Groupthink and politics behind evolutionary theories

The reader who supposes that evolutionary theories are 'all about the evidence', as dogmatically claimed especially by anti-creationists, is in for a rude awakening upon hearing what Rieppel has to say. His words are also a stinging rebuke to those who say that "Presuppositions do not matter". Not only do they matter, they are crucial! Thus, Rieppel writes:

> "In sketching the history of the alternative theories invoked to explain the evolution of the turtle shell, it is important to understand that this (still ongoing) debate is not fueled by whatever observations have been made or are being made or are being made by the use of ever more sophisticated techniques. The debate is also, and just as much, fueled by *the way the observer looks at nature in search for evidence bearing on the problem* of the origin of the turtle shell—whether from a transformationist or an emergentist perspective [emphasis added]" (p. 125).

As if trying to make sure that he is not making an understatement, author Rieppel makes his foregoing conclusion even stronger as he says:

> "But methods, and the rules and rulers they prescribe, are not things observed in nature. They are instead things that scientists, or groups of scientists, collectively agree on, then collectively apply to nature. Remember science philosopher Karl R. Popper, who compared the scientific community, or competing parts thereof, to a jury. In the cladistics revolution, competing groups of scientists—the conservative and the progressive—would form adverse juries: they would get on the telephone, lobby to form interest groups, and establish new professional societies that would publish new journals, in defense and support of their competing views. Put that way, the picture that science paints of the world is one that is no longer only and entirely determined by objective observation. *This is because those observations will be evaluated, and will gain significance, only in light of methods that are subject to political maneuvering among scientists and their struggle for financial support from foundations and granting agencies* [emphasis added]" (p. 155).

And yet we still hear complaints that "creationists do no real scientific research"!

Evolutionary theories as social constructs

Author Rieppel drives the final nail in the coffin of the "value-free nature of evolutionary science", as he concludes:

> "At the end of the day, what counts is a collective agreement among groups of scientists to use one but not the other method in the evaluation of observations. What this all boils down to is the idea, forcefully defended by a number of philosophers of science, that *the picture that some sciences paint of the world is certainly not entirely, but sometimes to a remarkable degree, socially constructed* [emphasis added]" (p. 155).

Conclusions

The presumed evolutionary affinities of turtles remain enigmatic. Embryological data, assuming its relevance to presumed evolution in the first place, is fraught with interpretative subjectivity and special pleading. The highly touted 'half-turtle' fossil *Odontochelys*, rather than a vindication of evolution, may be little more than a specialized aquatic turtle.

The new emergentist view of evolution is no better, from an evidentiary point of view, than the old transformationist view. Both rely on *post-hoc* reasoning, and assume, rather than demonstrate, the evolutionary outcomes that they are asserting.

Questions about the scientific nature (or deficiency thereof) of evolutionary theory, the testability or non-testability of evolutionary deductions, etc., have long been raised by scientific creationists. Now evolutionists are catching up and asking them also.

Evolutionary thinking is governed by groupthink as much as it is by the presumed evidence. No wonder that scientific creationists generally do not get a fair shake in academia!

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