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**VERTEBRATE ORIGINS AND DIVERSIFICATION:
AN ALTERNATIVE HYPOTHESIS**

by

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Introduction

Questions about whether faith and science oppose each other or can productively interact may seem almost irrelevant to those in disciplines like biochemistry or physiology or engineering, because no conflict arises between their faith and their science (Brand 2007). Those disciplines work with currently active biological, chemical, and physical processes. But parts of zoology, geology and paleontology study histological events that cannot be merely observed but must be reconstructed from meager evidence. These disciplines, as practiced by most professionals, are heavily dependent on certain assumptions, especially the worldview of millions of years of evolutionary history without divine intervention (Brand 2007). This naturalistic worldview can introduce extremely pervasive biases into scientific inquiry.

Biology textbooks, especially those dealing with zoology, are purely based on evolutionary theory (Darwinian theory). Authors of college and university biology textbooks claim to have found satisfying natural explanations to replace everything assumed to be the result of direct divine causes. The reading of these textbooks portrays a story based on the premise that life originated spontaneously, and that the array of living things, including humans, evolved over millions of years as the result of entirely natural processes. On the other hand, there is the Christian insight that the study of biology – as it deals with the origins of life, of the vast array of living organisms, and of humankind – is to study an important part of God's creation. Included in the Christian insight is the belief that there has been intelligent intervention in earth history including the subsequent biological changes and geological history after creation (Interventionism, *sensu* Brand 2006). My definition for 'interventionism' embodies the following biblical anchor points that are supported by Scripture: (1) In a literal week of six consecutive, 24-hour days, God prepared the Earth's surface and created living things (Genesis 1, 2). (2) At the end of the Creation week, a complete ecosystem was in place, including invertebrates (creeping things), birds, aquatic animals, mammals and plants (Genesis 1). (3) At some

time after Creation, a global flood destroyed many of earth's life forms. (4) The creation week occurred only a few thousand years ago. (5) After sin, the biological world began to change (Genesis 3:14-19), e.g., thorns and thistle began to appear. Therefore, the term interventionism covers not only the original creation of life forms and their habit by God but also His intelligent intervention in the subsequent biological changes and geological history after Creation. The reader should note that my definition for interventionism does not lend support for Theistic Evolution.

These apparently contradictory issues and perspectives in the Darwinian model and the Christian insight can perplex the inquiring student. Yet a great contrast exists between the internal intellectual battles of the academic community, as found in the published research literature, and the simple authoritative style of textbooks. Some simplification in the textbooks may be helpful in facilitating learning, but laypeople and students should be made aware of the varied views within Darwinism in the origins debate.

One of the hallmarks of Darwinian theory in biology is the claim that the origin and early evolution of vertebrates (animals with backbone) took place in water millions of years ago before transition of life from water to land. The Bible-believing Adventist biology teacher has the challenge of explaining to his or her students, most of whom are sometimes perplexed by some of these issues, how it is possible to be a biologist and also to believe the Bible.

Darwinian theory has been hailed as being central to vertebrate biology because it supposedly helps to connect extinct organisms with living ones. It is important to note that the account of vertebrate life through millions of years of earth history is based on the remains (fossils) that are found in the sediments of the earth's crust. The late paleontologist Alfred Romer once poetically referred to the grandeur and sweep of vertebrate evolution as the "vertebrate story." The vertebrate story is a narrative spoken partially from the grave; because of all species ever to exist most are now extinct. The evolutionary biologist and paleontologist G. G. Simpson once estimated that of all animal species ever to evolve, roughly 99.9% are extinct today. So in this story of evolution of early vertebrates, most of the cast of characters are dead. What survive are their

remnants, the fossils and the sketchy vignettes these fossils tell of the structure and early history of vertebrates.

In this essay, I evaluate two competing hypotheses on the origin and early evolution of vertebrates. From both the fossil record and extant species, we recognize seven classes in the vertebrate group. These are Agnathans (jawless fishes), Chondrichthyes (cartilaginous fishes), Osteichthyes (bony fishes), Amphibians, Reptiles, Aves (birds) and Mammals. I will emphasize three classes: Agnathans, Chondrichthyes and Osteichthyes. Using the kidney as an example, I revisit the debate about whether vertebrates have freshwater or marine origins. The reader needs to recognize that even the adherents of Darwinian theory do not always agree on the origin and early evolution of vertebrate groups. I then take a position that an alternative interventionist hypothesis can explain the same evidence of early vertebrate origin and diversification. The best way to proceed with this endeavor, I believe, is to first take a brief look at the scientific method.

Modern Scientific Concepts

According to Brand (2006) modern scientific thinking depends on several concepts. These concepts include (1) Living things and physical phenomena are controlled by mechanisms that can be studied and understood by experimentation. (2) Neither living organisms nor the physical universe is static. New species and basic body plans of animals and plants have arisen over time, and geologic structures have changed. (3) No higher power has ever intervened in the functioning of the universe. This third concept based on naturalistic philosophy seeks to preclude the alternative interventionist philosophy which does not rule out the possibility that an intelligent being has intervened in biological and geological history of the earth, especially in relation to the origin and diversification of life forms. The question is why do Darwinists seek to limit the production and testing of alternative explanations, an important step in the development of any scientific theory?

Scientific Method

Empirical Science

The scientific method involves observation and description of natural phenomena, development of hypotheses or explanations and testing the predictions of these hypotheses. Empirical science has often proceeded with three scientific methods. (1) The **Inductive** method is used to establish reliable associations among sets of facts. We would be using induction if we declared a law of association; the more trials observed, the more reliability we would attribute to the law. However, this method has a limitation: It does not explain the processes that drive nature. For example, in the study of ecology we may observe that there is an association between the numbers of peregrine falcon chicks surviving and shell thickness. Even though we may see a *pattern*, this method cannot answer the question, what is the *process* that causes the pattern? (2) The **Retroductive (or Deductive)** method is used to establish research hypotheses about observed associations. Of course, this method is not always reliable, because alternative hypotheses can often be generated from the same set of facts. To answer the question; “what is the *process* that causes the pattern,” we turn to retrodution. Our research hypothesis about the association between the number of chicks surviving and shell thickness could be that *DDT use causes egg-shell thinning*. The problem with this method is that there could be alternative hypotheses such as too little calcium in diet of peregrine falcon causes egg-shell thinning. (3) The **Hypothetico-Deductive (HD)** method is a means for testing research hypotheses. This method complements the method of retrodution. Experiments are conducted to confirm or reject the predicted outcomes. Thus, the H-D method is a way of gauging the reliability of research hypothesis. If we decide to test the question; “does DDT use cause egg-shell thinning,” we turn to the H-D method. We predict that egg shells become thinner with increased concentration of DDT in peregrine diet. We need to design a good experiment to test this prediction. Once the data from the experiment are in and the statistical tests have been applied, our results may provide support for our hypothesis. When a particular hypothesis is supported over and over, and successfully explains many observations, we call it a “theory.” This is the

method first described by Francis Bacon over 400 years ago. Of course, sometimes the results of an experiment may “refute” the hypothesis.

According to Romesburg (1981) scientists, in the process of discovery, have realized that there is no single all-purpose scientific method. Instead, there are several methods, each suited to a different purpose.

Historical Science

The historical science is different is different from the empirical science in a fundamentally important way. Unlike the disciplines of physics or chemistry or much of biology, the study of zoology, paleontology and geology involve historical science where practitioners come up with hypotheses to explain evidence that is left from some event in the past. In other words, historical scientists collect data in the field, and use those data to reconstruct the past in a way that incorporates and makes sense of as much of the evidence as they have available. Usually, no single hypothesis can accommodate every single piece of evidence at hand. There is often more than one story that scientists find appealing and that explains the data more or less well. Even more than in empirical science, in historical science a scientist’s beliefs or prejudices (worldview) can influence the hypothesis he/she prefers. Scripture also can suggest hypothesis to be tested by the historical methods of science. This approach does not discourage research, but can stimulate more careful research in both science and faith. Therefore, it is questionable that many scientists interpret nature within the framework of naturalism but allow no alternative hypothesis that would imply any divine intervention at any time in history. Also, there is no way to test some hypotheses in a definite manner. For example, science cannot test the hypothesis “God created the first life forms.” How could science test the alternative hypothesis “The first life forms were not created by any god”? Both hypotheses are based on faith in a particular philosophy. Everyone has faith in something – that is, we (Darwinists and Interventionists) all have a worldview, a set of beliefs that are not dependent on the evidence, but that operates as a “lens” through which we look at, and interpret the evidence. Adherents of both hypotheses have reasons for choosing their philosophy, but science cannot verify or refute either one. Thus, in the “historical

sciences,” we can never “know,” in the Baconian sense, that any particular story is correct or wrong. We have to convince people, and this can be a difficult proposition. And no one has the right to deny another of the opportunity to make an alternative hypothesis to explain the data left from some event in the past. In fact, virtually all of the “fights” or “debates” or “controversies” you hear about in the sciences are in the historical sciences.

Origin of Vertebrates

To most interventionists, according to Genesis 1, at the end of the Creation week, a complete ecosystem was in place, including plants, invertebrates, aquatic, aerial and terrestrial vertebrates, etc. The list indicates that God created the major life forms, including humans; they did not evolve over millions of years as a result of entirely natural processes. However, the story in zoology textbooks is different: Naturalist theories of origins begin with abiogenesis – the spontaneous development of living organisms from nonliving chemicals many million years ago. Darwin’s theory then attempts to explain how mutation and natural selection “created new genes, structures, and behavioral adaptations, enabling life to branch out into diverse body plans: microorganisms, plants, mollusks (snails, clams and their relatives), arthropods (insects, spiders, crayfish, etc.). If Darwinian theory is correct, then all of this occurred through random mutation plus natural selection, without any planning or direction. Comparative biology has its foundations in the work of Greek philosopher Aristotle (384-322 B.C.). Aristotle first postulated gradual transitions from inanimate to animate objects: from plants to animals, and from quadrupedal animals to man.

Darwinian theory asserts that mutation and natural selection “created” new genes, structures, and behavioral adaptations, enabling life to branch out into diverse body plans: microorganisms, plants, invertebrates and vertebrates. One such branching of life or diversification presented in textbooks is the origin and early evolution of vertebrates that supposedly took place in oceans at least 350 million years ago before organisms made the transition from water to land.

Zoology Textbooks' Account

Early Evolution of Vertebrates

In Zoology textbooks we are told that the early evolution of vertebrates was characterized by an active lifestyle, hypothesized to proceed in three major stages (Fig. 1). Step 1 comprised a suspension-feeding pre-vertebrate (resembling amphioxus) stage. The pre-vertebrate deployed only cilia to produce a food-bearing current. Step 2 comprised an Agnathan, an early vertebrate lacking jaws but possessing a muscular pump to produce food-bearing water current. Step 3 comprised a gnathostome, a vertebrate with jaws that evolved from the agnathans.

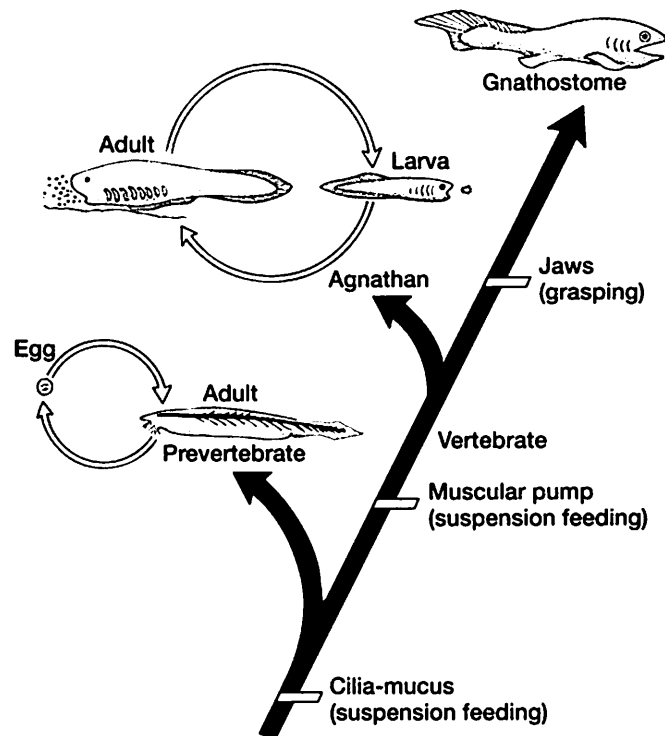


Fig. 1. The evolution of early vertebrates. (Adapted from Kardong 2006).

Do all Darwinian scientists agree on a single hypothesis regarding vertebrate origin? No. There are two opposing hypotheses, especially regarding environment within which they evolved.

Freshwater origin

At one time, fossil and physiological evidence seemed to point to a freshwater origin of vertebrates. It is reported that the earliest known vertebrates appear at the beginning of the Ordovician period, about 470 million years ago. The story goes like this: many early vertebrate fossils were recovered from what appeared to have been freshwater or delta deposits. Some of these earliest fish fossils consist of fragments of bony armor worn smooth, as if upon death the bodies were washed and tumbled down freshwater streams. Eventually they came to rest in the silt and sand that collect in deltas at the mouths of rivers.

In the 1930s, Homer W. Smith, who spent a lifetime in the study of kidney physiology, argued that the vertebrate kidneys were so well designed for freshwater that vertebrates must have evolved in that environment and only later entered salt water. His reasoning was like this: the kidneys of vertebrates are filtration kidneys that can produce large volumes of glomerular filtrate. Such a design would be a liability in marine environments in which water must be conserved, but it would be an asset in freshwater environments in which fishes must rid their bodies of influxes of excess water.

Smith reasoned that if vertebrate ancestors lived in freshwater, evolution of filtration kidneys and low solute level would be adaptive to cope with water influxes an animal experienced in such an environment. However, when these vertebrates later radiated from freshwater to salt water, their filtration kidney was disadvantageous and modifications were required. The Darwinian biologists explain that these required modifications came about through evolution in millions of years. For example, it is believed that in Chondrichthyans and coelacanths, solute levels rose in the blood to address this problem. Other fishes developed adaptations such as drinking seawater that recovered water, and salt glands and gills that eliminated excess salt along with loss of glomeruli and distal tubules. Smith thought that the fossil record known in 1931 also

supported a freshwater origin for the earliest vertebrates. For a time, most scientists agreed with Smith's hypothesis.

Marine origins

Other scientists have taken issue with Smith's hypothesis and favor a marine origin for vertebrates. They make three arguments to support their case. The first line of evidence for a marine origin of vertebrates is paleontological – the earliest vertebrate fossils are found in marine sediments. Re-examination of the early vertebrate fossil deposits or as others put it, the discovery of still older fish fossils (Cambrian) suggest that they came from marine seas and not from freshwater habitats as Smith supposed. The second line of evidence comes from comparative physiology – all nonvertebrate chordates and deuterostome invertebrate phyla are exclusively marine forms. The filtration kidney is not unique to vertebrates. Crustaceans and many other invertebrates possess filtration kidneys, yet clearly they evolved from marine ancestors. Third, the filtration kidneys of vertebrates are characteristically high-pressure kidneys that produce large volumes of glomerular filtrate. Large volumes of fluid moving from blood to kidney tubules give the kidneys a greater chance to act on the constituents within the circulating fluids of the body. A high pressure system produces a high volume of filtrate, which aids in processing nitrogenous wastes. Thus, the filtration kidney could represent an efficient system for eliminating nitrogenous and other wastes by moving large volumes of filtrate through the kidney; the kidney was pre-adapted to freshwater, but did not arise in freshwater.

We will make a few comments about the concept of preadaptation before we proceed to discuss problems with both hypotheses. If Smith's hypothesis (freshwater origin) was to be rejected, how was the marine origin hypothesis going to reject the explanation of the filtration kidney? Proponents of the marine origin explain that, contrary to Smith's views, the filtration kidneys of the marine vertebrates were pre-adapted (or exadapted) to freshwater, but it did not arise there. Preadaptation as an evolutionary term means that a structure or behavior possesses the necessary form and function before (hence pre-) the biological role arises that it eventually serves. In other

words, a preadapted part can do the job before the job arrives. Darwinists explain that the concept of preadaptation does not imply that a trait arises in anticipation of filling a biological role sometime in the future. Adaptive traits serve roles of the moment. If there is no immediate role, selection eliminates the trait. The marine habitat origin has become so popular that a phrase like the following is now found in most modern zoology textbooks: "Today, few scientists insist that the very first vertebrates were products of freshwater environments."

The problems with both freshwater and marine origin hypotheses

In this debate, the hagfish poses a problem for everyone. Hagfishes are Agnathans, the class of vertebrates said to have evolved from the pre-vertebrate stage. Hagfishes are osmoconformers. Thus, the levels of salts in their blood are close to those of seawater, making them isosmotic to their environment like most marine invertebrates. They are members of the surviving vertebrate group, the cyclostomes, and possess a filtration kidney, yet they live in salt water. They are in no danger of dehydration; however, this is not true for most other marine vertebrates. Compared with marine invertebrates, the levels of salt in the blood of marine vertebrates is almost two-thirds lower. Consequently, vertebrates are hyposmotic to sea water and can become dehydrated.

If Smith were correct, then these ancient vertebrates would live in freshwater. They do not, of course, contrary to Smith's freshwater hypothesis. If marine origin of vertebrates is to hold, then hagfishes should be osmoregulators like other vertebrates. Of course, they are not. Darwinists explain that although hagfish is a representative of the earliest group of vertebrates, it is very ancient and may have diverged significantly in its physiology from an ancestral condition.

Both freshwater and marine hypotheses have other problems. All hypotheses have underlying pre-suppositions. Darwinian theory proposes that mutation and natural selection "created" new genes, structures, and behavior adaptations, enabling life to branch out into diverse body plans: plants, microorganisms, invertebrates and vertebrates. The fossil record that underlies the said early evolution and diversification of vertebrates

cannot demonstrate whether Darwinian mutation and natural selection evolved genuine biological new structures or body plans. That conclusion requires some other evidence – preferably, genetic evidence. If such evidence exists, we might expect a good evolution textbook to provide it. Two of the most well-respected evolution textbooks – Douglas J. Futuyma's *Evolution* and Mark Ridley's *Evolution* do not provide any convincing evidence for a genetic process to evolve new information and new structures. So the fact is that, there is a lack of evidence for a genetic process to evolve new information and new structures in evolutionary texts. This lack of evidence is significant. It suggests that Darwinian theory merely assumes the existence of a genetic process that can evolve new structures or gene complexes, but there is no convincing evidence of such a process (Brand 2006). This lack of evidence encourages us to take an open-minded look at origin of vertebrates.

Interventionist alternative hypothesis

We can suggest a third hypothesis, that each group Agnathans, Chondrichthyes and Osteichthyes were created separately; one did not evolve from the other over millions of years. This hypothesis predicts that after the global flood, resultant mixing of seawater and freshwater could put fishes in all sorts of environments including freshwater, marine and brackish waters. This interventionists approach has several biblical anchor points including the fact that God created all living things including vertebrates, rivers and seas and that at some time after creation, there was a global flood in which some of the earth's life forms were saved in an ark and others destroyed.

We need to explain the survival of these groups during the flood. According to the Bible, air-breathing terrestrial animals were saved only in Noah's ark. So, the invertebrates and aquatic vertebrates survived the flood, perhaps providentially, and their natural movements over the earth explain their biogeographical distribution after the flood. Accordingly, if through the studies of physiology we see that hagfishes did not 'evolve' in sea water, we can explain that the global flood changed their original environment; hence their survivability in such 'unlikely' environments until now. Thus, the interventionist hypothesis can explain each scenario: why some vertebrates lived in

freshwater and others lived in marine environments, and still others survived in brackish waters.

There are other extant examples that support this interventionist hypothesis. Let's look at the example of anadromous fishes that hatch in freshwater, migrate to marine water where they mature, and then return to freshwater to spawn. Depending on species, anadromous fishes spend one to several years at sea feeding and growing, and then return to their natal stream where they breed. Salmon are an excellent example. These fishes are said to be euryhaline; they tolerate wide swings in salinity as they migrate between fresh and salt water. When these fishes swim into freshwater, the major physiological challenge is coping with salt loss across the gills. As euryhaline fishes pass part of their lives in fresh water and part in salt water, a period of adjustment, usually involving several weeks (not millions of years) in brackish water, is often required to allow acclimation.

Catadromous fishes, on the other hand, migrate in the opposite direction, from salt to fresh water. They mature in streams and migrate to the ocean to breed. European and American eels are examples. Again, these fishes often require acclimation over a few weeks (not millions of years) to adjust. In both anadromous and catadromous fishes the interventionist hypothesis of creation of fishes, streams and seas and redistribution due to global flood explains the data better than Darwinian theory of evolution and pre-adaptation. What is the mechanism involved in the survival under the interventionist model? The interventionist model predicts that the original pre-flood freshwater and marine environments were mixed and redistributed during the global flood; creating new environments and adaptations for different fishes. Indeed, if we believe that the fish were created, they could have been designed with the genetic information to adapt to changing water conditions. One wonders if Darwinists know how long it takes for selection to favor or remove a trait that was pre-adapted.

Is there fossil evidence for intermediate forms?

Darwinian evolution predicts abundant morphological transitions between groups at all taxonomic levels. If we are to accept the Darwinian view of evolution of early

vertebrates, then we should have abundant evidence of fossil intermediates from one group to the other. The reader should recall that the emphasis of this paper is on the said evolution of early vertebrates. Therefore, we seek the evidence for intermediates from pre-vertebrate to Agnathans (jawless fishes) to Gnathostomes (jawed fishes). The following are what the fossils tell us: (1) Phylum level intermediates: there are no known intermediates between the chordates (Craniates + Hemichordates + Urochordates + Cephalochordates) and other deuterostomes. When chordates first appear in the Cambrian they are fully formed. Within the Evolutionary paradigm, the sister groups (evolutionary term; in phylogenetics, two taxa connected through a single internal node) of the chordates are hotly debated. (2) Class level intermediates: within the vertebrates (Craniata), several classes lack intermediates: e.g., Agnatha to Gnathostomes, Chondrichthyes to Osteichthyes, Amphibia to amniotes (old Reptilia). However, others have intermediate fossils: fish to amphibians, reptiles to mammals, reptiles to birds. In my opinion, this difficulty can be explained by the interventionist hypothesis which posits that God created all living things including vertebrates, rivers and seas and that even though there have been minor changes within created organisms with time, these changes do not require millions or years.

Conclusions

Darwinists originally supposed that vertebrates evolved millions of years ago in freshwater. This was because the vertebrate kidney is clearly advantageous in that habitat, acting to rapidly remove excess water entering the body by osmosis. However, a marine origin of vertebrates is now widely accepted by Darwinists; it is considered that the kidney was pre-adapted for this role in fresh water rather than specifically evolved for that purpose. It is important to remember that reconstructions from the fossil material bring animals and their presumed environments of the past back to life. These reconstructions are hypotheses that are subject to error and biases. Hence other alternative hypotheses looking at the same data should be examined. I argue that science cannot fight against one of the tenets of scientific method, viz. alternative hypothesis by limiting explanation of the same data with hypothesis that incorporates divine

intervention. Therefore, using both extant and fossil examples I offer an alternative interventionist hypothesis to explain the origin and diversification of early vertebrates. I have described some fossil and some living creatures, and asserted that they were created and their extant environments could have been produced through intervention. What is the mechanism involved in this interventionist model? Each group of vertebrates was created at the beginning and has only experienced minor variations since then. I have suggested that marine, freshwater, and both anadromous and catadromous fishes were created by God during the Creation week and then were buried where we find them by the global flood.

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