The Evolution of Teeth: A Major Problem for NeoDarwinism

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Abstract

Teeth are one of the most common vertebrate fossils found, partly because they preserve far better than any other body part. If any evidence exists for NeoDarwinism, it would most likely be found in fossil teeth. The results of a literature research on the origin of teeth show no empirical support for their evolution. A review of the fossil record shows no evidence of transitional forms that bridge teeth to their theorized precursors, such as bone. Nor has any clear evidence been found to support the evolutionary origin of various types of teeth, such as molars or tusks. The complexity of teeth, and the complex inter-connections between teeth and bone, also conflict with a NeoDarwinian origin of teeth.

Introduction

Evidence for evolution of vertebrates "is derived largely from the fossil record, and much of it is provided by teeth" (Butler, 2002, p. 201). As Jernvall et al. (2000) noted, "the study of mammalian evolution often relies on detailed analysis of dental morphology" (p. 14444). The same is true for most other vertebrates. Many evolutionary conclusions, such as elephant evolution, are based largely on comparative dental morphology (Maglio and Ricca, 1977). The importance of teeth in human evolution is so great that "were it not for teeth, anthropology would be a different subject" (Jernvall and Jung, 2000, p. 172). Fossil teeth are ideal objects to study evolution because they preserve extremely well in the fossil record, much better than even bone (Teaford et al., 2000; Smith and Tchernov, 1992; Zhu, 1935; Wilson, 1943). As a result of their abundance, teeth play a major role in helping to distinguish between different extinct species (Johanson and Shreeve, 1989). In Gould's (1989) words:

> An old paleontological joke proclaims that mammalian evolution is a tale told by teeth mating to produce slightly altered descendant teeth. Since *enamel is far more durable than ordinary bone, teeth may prevail* when all else has succumbed to the whips and scorns of geological time. *The majority of fossil mammals are known only by their teeth* [emphasis added] (p. 60).

Deterioration of fossils is caused by water, weather, and temperature. Bone mineral crystals tend to be long and narrow and, as a result, the needle-shaped splinters that form from water trapped in the pore spaces that exist in all bone causes these pores to widen. As they widen, even more water is allowed to enter, forming yet larger crystals (Calcagno, 1989). Within a few weeks to a year in moist environments, the bone is rapidly damaged. The major causes of deterioration of animal body parts (including bone) are:

1. drying and wetting (very important in all semi-arid, arid, and temperate areas, or in humid areas with monsoonal climates),
2. formation of salt crystals during drying (and the analogous formation of ice crystals during freezing), and
3. freezing and thawing (an important process, especially at high altitudes or for short periods of time).

In contrast to bone, tooth enamel is far better preserved because enamel is extremely dense, with virtually no space between the crystals, and very few pores (Patterson, 1956; Teaford et al., 2000). Therefore, it requires about 10 to 100 times longer for the same deterioration effects to occur in

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tooth enamel as it does in bone. Even dentine takes longer to break down—usually 2 to 10 times longer on average—than bone. Conversely, cementum tends to be easily destroyed and, consequently, is rarely found preserved on teeth in the fossil record. Because the anchoring bone for teeth decays more rapidly than the teeth themselves, loose teeth are very common in the fossil record. Often, when a fossil is discovered, the teeth are among the best-preserved parts of the animal. Consequently, much of our understanding of animal history is a result of the study of teeth, and many animals are known *only* by their teeth (McCollum and Sharpe, 2001).

Over 50 basic types of teeth have been classified and teeth have so much variety that they often can be used to identify a mammal's taxonomic order (Miles, 1972; Forstén, 1973; Denison, 1974; Cocke, 2002; Matthew et al., 1924; Patterson, 1956; Raschkow and Hillam, 1973; Scott, 1892). Teeth are a major means by which to differentiate humans from other primates. Often an attempt is made to identify an animal solely on the basis of its teeth. This is sometimes very difficult, of course, as the classic case of the *Hesperopithecus* has shown—peccary teeth are very similar to human teeth and, as a result, are mistaken for human teeth (Bergman, 1993).

Mammals are heterodonts, which means that their teeth vary even within one animal. In fish and reptiles, however, the teeth are all close to identical, except for size (homodonts). Even closely related mammals can have very different tooth morphology, depending on their diet and food-chewing needs. Those who believe in the Darwinian origin of teeth assume that the evolutionary status of an animal's teeth is an excellent index of its body evolution. The stage of evolution of an animal's teeth, though, is not always directly related to the stage of the supposed evolution of its entire body (Frayer, 1977; Oxnard, 1987).

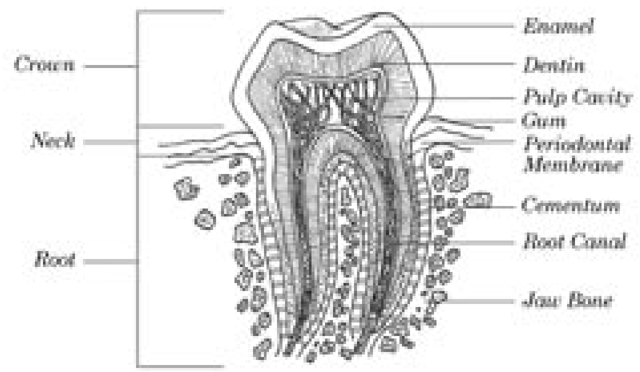

Figure 1. A modern incisor tooth showing its internal structure.

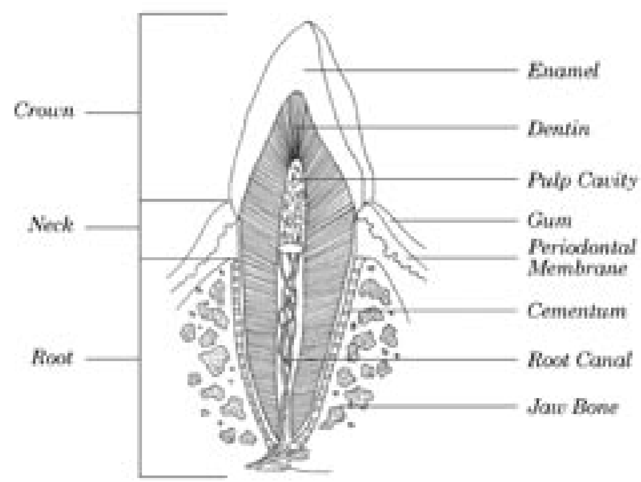

Figure 2. A modern molar tooth showing its internal structure.

The Structure of Teeth

Although seemingly simple organs, teeth are actually very complex, well-designed, living structures that require proper care to keep healthy, especially in humans. As Stokstad (2003) noted, "in whatever form they take, teeth are a marvelous invention, enabling us to rip into drumsticks or chew a caramel with abandon" (p. 1164). Although many animals can effectively chew a wide variety of materials, their teeth are often designed to fit the normal diet of the animal (Lucas, 1982).

The exposed part of the tooth is called the crown; the tooth part in the jaw is the root (see Figures 1 and 2). The outer part of the tooth, the enamel, is the hardest structure in the body. Enamel is composed of numerous microscopic crystalline structures that resemble soda straws set parallel to each other (Moeller, 2003, p. 119).

Below the enamel is the dentine, a substance that resembles bone, except that it is much harder (Shier et al., 2004). Dentine is living cellular tissue that requires adequate blood circulation, which is provided by the veins and arteries located in the root canal. The root is enclosed by a thin layer of material similar to bone called cementum, which helps to bond the tooth firmly in the bone socket. The tooth is firmly attached to the bone by thick bundles of collagenous fibers called periodontal ligaments. The ligaments contain nerves that keep the animal from applying excess pressure to the teeth.

Although mammalian teeth are more complicated and more efficient than those of other vertebrates, "all teeth are basically similar, formed in essentially the same way from enamel" (Butler, 2002, p. 208). Most vertebrates have teeth, but some totally lack them. In all toothed vertebrates except mammals (fish, reptiles, a few extinct birds such as *Archaeopteryx*, and amphibians) the teeth develop to fill the jaw space that was designed to hold them. In sharks, some amphibians, and even some other animals, no matter how many teeth are lost, new ones normally develop just like a cut always heals in a healthy animal. In these vertebrates the animal either has an endless supply of teeth or does not have any teeth.

The complex development of teeth is not well understood (Zhao et al., 2000). Teeth are merely the final product of a cascade that produces a complex structure which appears to have been designed to develop at a specific location in the body. Tooth evolution cannot be understood apart from the development of the entire dento-maxillary system. The periodontal ligament co-development, the root growth development, the condylar growth, the jaw basal bone, the enamel microcrystal structure, and the simultaneous development of the opposing arch are all part of this complex pattern of co-development (Moeller, 2003). Moeller (2003) concluded that ,"You cannot prove or disprove either evolution or Creation ... outside of the system approach. This is evolution's gross failure" (p. 1).

Mammals that have teeth are also unique because two sets of teeth form during their development—the first set, called primary teeth or milk teeth, erupt at regular intervals between about six months to two or three years of age. These teeth are then later replaced with a larger secondary or permanent teeth. Some mammals develop primary teeth but do not produce permanent dentition replacements. The monotreme *Ornithorhynchus*, duck-billed platypus, has "two pairs of upper teeth and three pairs of lower molariform teeth, but these are shed before maturation and are functionally replaced by a leathery beak" (Carroll, 1988, p. 420).

In humans, the primary teeth are both fewer in number (20) and smaller than the secondary teeth (32). The 32 secondary teeth are arranged as follows: *molars* (for grinding) are in the back; *premolars* on the side; *cuspids* (or canines) for tearing or stabbing are located on the side towards the front; and *incisors* (for cutting and biting off chunks of food) are located in the direct front of the mouth.

The complexity of teeth indicates that the number of genes involved in their formation is "undoubtedly large" (Butler, 2002, p. 208). All this variation is "genetically controlled to a high degree" and is little influenced by the environment (Butler, 1982, p. 44). If environmentally influenced, it would adapt to local conditions and genetic selection would be less important. Therefore, this trait is ideal for Darwinists to study and is another reason why the fossil record should show an abundant number of clear transitional forms.

The Evolution of Teeth

In the most widely held theory of tooth evolution, it is hypothesized that marginal oral skin produced small knobs (denticles) that then evolved into tooth-like condonts (McCollum and Sharpe, 2001). Figure 3 shows an artists rendition of one of the most commonly held concepts of tooth origin by evolution. Eventually the condonts evolved into primitive teeth and then, after many more eons, into modern teeth (Teaford et al., 2000; Miles, 1972). Many new discoveries have challenged this view. Even the theory that teeth evolved by co-option of external skin denticals at the margins of the jaws has recently come under attack by Smith and Johanson (2003) who examined the need for functional teeth to survive.

Because they preserve so well, teeth are an excellent means of evaluating neoDarwinism (Young et al., 1929; Smith and Tchernov, 1992; Kurtén, 1982; Osborn and Gregory, 1907; Butler and Joysey, 1978; Balkwill, 1893; Butler, 1982). The wide diversity of morphology (shape and size), enamel, and other microstructures of teeth among

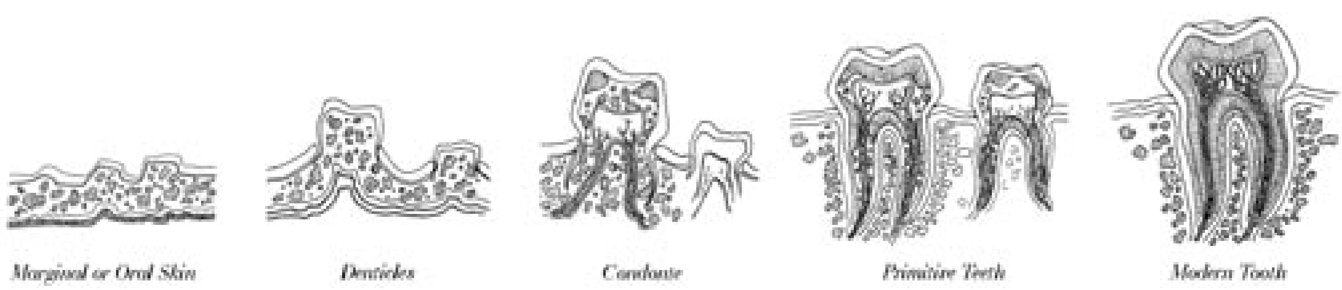

Figure 3. Artist's rendition of a common scheme of tooth evolution. Diagram by Artist Richard Geer.

the extant and fossil animals indicates that a large number of clear transitional forms should exist to confirm the path of their evolution (Moeller, 2003).

Although size changes can be observed, the fossil record reveals no evidence of tooth evolution, either from primitive teeth or from some theorized precursors. As Stokstad (2003) noted regarding teeth instead, "These complex structures are always organized—into sturdy rows of molars, for instance ..." (p. 1164). Even accessory structures such as dentine are found in the fossil record. In the case of dentine, the fossil record extends back to the late Cambrian (Smith and Sansom, 2000). As a result of the good fossil record in the "Cambro-Ordovician vertebrates, we know that there was great diversity" of dentine tissues even in the Cambrian (Smith and Sansom, 2000, p. 79). Furthermore, recent evidence challenges the classical view of teeth evolution (Smith and Coates, 1998). An example is the finding that living and fossil animals either have fully developed teeth, or none at all, and that "complex structures with dentine and enamel have been described in the earliest jawless vertebrates, condonts" (McCollum and Sharpe, 2001, p. 153).

All living amphibians have ridges on their jaws that can function as teeth, but they lack even very primitive teeth. Such ridges are interpreted as "transitional features," but they are, in fact, fully developed structures (Miles, 1972, p. 6). Some jawed vertebrates caught their prey with "bumpy gums or bony cutting blades and cuff-like structures made of so called semi dentine" (Stokstad, 2003, p. 1164) but these structures were not teeth, nor were they constructed out of dentine, enamel, or other modern tooth structures. They were merely bumpy gingiva, often covered by horny plates, and nothing more. Nonetheless, these horny plates were well developed systems, and not transitional forms; they functioned very effectively for grasping and slicing (Miles, 1972). Modern examples include turtles and tortoises.

Another major problem facing the theory that teeth evolved from bone is that there are at least two different types of proteins in teeth that are not found in bone. Furthermore, most all of the internal structures of teeth are considerably different from those of bones (Shier et al., 2004).

Did Teeth Evolve Once or Many Times?

The complexity of teeth and the small likelihood they would have evolved even once in history have caused many researchers to "assume that teeth evolved just once, in the common ancestor of jawed vertebrates" (Stokstad, 2003, p. 1164). A recent reevaluation of teeth, however, has now caused many researchers to question this assumption of monophylogeny. The extended jawed fish called placoderms, for example, have teeth that differ greatly from other fish teeth. The difficulty in fitting these teeth into a single, viable evolutionary scenario has posed such serious difficulties that the researchers involved argue that teeth must have evolved more than once (Smith and Johanson, 2003). This poses no small challenge to Darwinism, however, and has caused some researchers to question the position of "a significant portion" of animals on the current vertebrate family tree. In Stokstad's (2003) words, "scientists may need to shake up a significant portion of the vertebrate family tree" (p. 1164) as a result of these and other findings, by which he meant that the order and phyletic relationships of many groups on the tree may have to be changed.

Some researchers agree with tooth evolution expert Jukka Jernvall that "multiple origin of all the things that have something to do with teeth seem to be an emerging theme in evolutionary biology" (as quoted in Stokstad, 2003, p. 1164). This polyphyletic view renders tooth evolution less plausible because it was long considered to be so unlikely, forcing the conclusion that teeth must have evolved only once. To conclude now that they evolved *many* times indicates that something very unlikely must have happened often, forcing one to question the whole scenario. Such an unlikely trend toward the multiple origins of teeth in separate taxonomic group fits well with the concept of the creation of many distinct kinds (baramin).

This newfound parallelism of teeth does not "reveal how teeth came about" and, consequently, does not help to solve the evolutionary conundrum but only complicates it (Smith and Johanson as quoted in Stokstad, 2003, p. 1164). Generally, teeth of living and extinct animals are lined up according to criteria that appear to be based largely on size and complexity. The teeth are then assumed to have evolved largely along this pattern. A major problem with this approach, however, is the large amount of intraspecific variation in dental features found in some animals (Metz-Muller, 1995).

Another evolutionary theory for the origin of teeth is the belief that they did not arise as chewing structures, but for other purposes, such as a superior method to capture prey (Smith, 2003). This event is theorized to have occurred in a primitive animal that then gave rise to all of the other groups of jawed vertebrates, including sharks, osteichthyes (bony fishes), and certain extinct animals. Placoderms are considered the most basal group of jawed vertebrates, and for this reason their study is critical in researching the evolutionary origins of teeth (Smith and Johanson, 2003). Fortunately, well-preserved examples of early placoderms with teeth are available for study. These various placoderm teeth have now been studied carefully, and it was found that the animals with teeth all had true teeth, not primitive less-evolved teeth as had been expected. Once again, an evolutionary prediction was falsified.

Smith and Johanson in their study of well-preserved placoderm specimens concluded that the same tooth pattern in placoderms they studied is also found in modern lung fish. The placoderm teeth were not primitive bony projections but rather conical structures arranged in defined rows (Smith and Johanson, 2003). Smith sliced through a few teeth, showing that they were fully developed teeth made of "regular dentine, not semi dentine" (Stokstad, 2003, p. 1164). Some placoderms, though, totally lacked teeth. So far no evidence of transitional tooth forms between the no-tooth condition and completely developed teeth has been discovered.

A Computer Literature Search on the Evolution of Teeth

In my review of the literature, all articles having both the keywords "teeth" and "evolution" (some overlapping exists in these databases, and Biological Abstracts contains many journals devoted totally to evolution) were located and reviewed (see Table I). Most of the articles located fell into these categories: discussions of the growth and development of teeth in infants and children, theoretical/speculative discussions, studies of individual teeth, review articles, or discussions of new fossil finds. None provided clear evidence for the evolution of teeth but, at most, involved discussions of minor changes in the size and shape of fully developed teeth from different animals. But even here, much controversy existed (for example see Frayer, 1977). Many studies compared the teeth of animals in hypothetical evolutionary lineages, showing, at best, evidence for saltation (evolutionary jumps)—evidence that would fit equally well with the creation of separate kinds.

The Use of Living Animals to Study Evolution of Teeth

In contrast to many evolutionary hypotheses, one can create a mental picture of the development of teeth from bone into teeth (see Figure 3). This picture, in turn, gives us an idea of what to look for in the fossil record. Because teeth are the hardest structure in the body, teeth evolution evidence should therefore be very apparent in the fossil record. As indicated earlier, I have found few reports of plausible fossil evidence of tooth evolution (see Table I). Hypothetical scenarios are freely postulated, but all lack empirical evidence (Miles, 1972).

Many evolution studies are based on living animals such as primates, and operate under the assumption that some living primates are "primitive," and others are more "modern." (The terms "primitive" and "advanced" in this context, however, have meaning only if Darwinism is true.) The teeth of living animals are then compared, and trends in evolution are deduced from these comparisons (Butler, 2002). This, though, is not proof of evolution, but can merely provide plausible "just-so stories."

Of the hundreds of thousands of fossil teeth that have been evaluated so far, all are fully developed compared to their modern forms, and very few have even been claimed to be transitional. Although teeth vary considerably, no fossils have been proposed as clearly transitional from non-teeth to fully developed teeth. One problem, as described by Smith and Sansom (2000), is that:

> Historically, many descriptions have used terminology, either based solely on these interpretations, or on comparison with bone, based on the assumption that an evolutionary series exists as a fossil record of the transformation of bone into dentine. Terms such as mesodentine, semidentine and metadentine have been used unrealistically in phylogenies with this assumption (p. 79).

Table I. The Results of a Computer Literature Search*

Data Base	Records	Number of Hits**	Hits as Percent of Records
Biological and Agricultural Index	1,080,522	0	0.0
Biological Abstracts	6,469,420	20	0.00031
Medline 1966 to present	12,402,978	3	0.00002
Anthropological Literature	507,779	59	0.0116

* Date of search: Nov. 21, 2003.
** A "hit" was a record in which the search term set was identified.

As noted above, complex structures with both dentine and enamel have been found in "the earliest jawless vertebrates" (McCollum and Sharpe, 2001, p. 153). The major difficulties in the evolution of teeth, especially the fact that traits considered both "primitive" and "modern" are found in both ancient and modern teeth, are explained by some Darwinists as resulting from "convergent evolution." Jernvall and Jung (2000) conclude that the distolingual cusp in the upper molars (called the hypocone) has evolved "at least 20 times in mammals" and even "among primates, the hypocone has evolved multiple times" (p. 181). But, as noted earlier, such polyphyletic schemes in which teeth arise independently many times are extremely unlikely.

Morphogenesis: The Evolutionary Origin of Different Shapes and Types of Teeth

Teeth exist in a bewildering variety of shapes, seemingly every shape possible (Garcia and Miller, 1998). In fish and reptiles, all of the teeth in any one animal are very similar in shape (homodonts). In contrast, mammals are heterodonts (use many different kinds of specialized teeth). Moeller (2003) claimed that thousands of morphology variations and what can be called eruption sequence variations, together within other developmental cascades, exist. Thus, even though two teeth appear to have similar morphology, they could have major differences in development.

Some of the differences in morphology include teeth that are specially designed to scissor, stab, grind, dig, chisel (as in beavers), sieve (as in some aquatic animals), and lift (such as elephant tusks). Some "fangs" have a complex mechanism to deliver venom (Miles, 1977). The largest teeth in a living animal are elephant tusks, which are greatly enlarged incisors composed of dentine (Garcia and Miller, 1998). One documented elephant tusk was 16.5 feet (5m) long and weighed 465 lbs. (211 kg). Walrus tusks, which are teeth, can grow up to 1 meter long, and can weigh up to 12 pounds. (5.4 kg).

In addition, many other interesting teeth oddities exist, such as the Narwhale *Monodon monocerus* (order Odontoceti) that has two teeth in its upper jaw, but only one of these (normally the left one) grows out. This tooth grows long enough to serve as a tusk, while the other tooth remains small.

Other significant variables among the different kinds of animals include the dento-maxillary complex and the eruption sequence. The enamel microstructure differs widely and includes radial enamel, prismatic enamel, and synapsid columnar enamel (Moeller, 2003a). Even the periodontal attachment system varies enormously (Moeller, 2003). Moeller (2003) argued that the fossil record should not only contain mutational improvements, but also even more mutational failures that include such obvious changes as dental crowding, hypereruption, and hypoeruption. He concluded as follows:

> Considering the enormous amounts of fossil dental and jaw material available, it is statistically unrealistic to assume that no fossil evidence exists of any intermediate dental types. Just because it is possible to arrange different appearing dentitions in a phylogeny, this does not indicate support for the position that they evolved. The engine of evolution, that being genetic mutations, has great difficulty in accounting for the gradual modification of a highly complex integrated and coupled system in small increments. Genetic theory has an even greater difficulty in accounting for such changes .... (Moeller, 2003, p. 125).

Evidence for an evolutionary sequence among these many variations finds no support in the fossil record. Each of the many various types of teeth is believed to have evolved from the basic reptilian tooth type. This is sometimes called the "problem of tooth morphogenesis," concerning which Salazar-Ciudad and Jernvall (2002) noted that the:

> Generation of morphological diversity remains a challenge for evolutionary biologists because it is unclear how an ultimately finite number of genes involved in initial pattern formation integrates with morphogenesis (p. 8116).

"Transitional Stages" Lacking

Evolutionists would expect to find many fossil transitional teeth between the basic kinds of teeth, such as between elephant tusks and the common mammal teeth, for example. Models of morphogenesis exist, so we have some idea what to expect in the fossil record, but clear examples of linking steps have never been found in the millions of fossil teeth uncovered so far. This is a serious gap in the fossil record. Another problem is confirming the identity of a transitional tooth. Would it be a tooth that is smaller than a tooth in a modern animal? Would it be one with half the enamel, half the periodontal ligament, half the dentin, or half erupted compared to a non-transitional tooth? Or would transitional teeth be like malformed teeth as we see often in humans with genetic abnormalities?

Several groups of mammals lack teeth, including the ten species of whales in the order Mysticeti, the eight species of Pangolins family Manidae, and the three species of anteaters of the family Myrmecophagidae within the order Edentata. Modern toothless mammals and certain other animals such as birds are theorized to have lost their teeth in evolution, a conclusion that is also unsupported in the fossil record and hard to rationalize, considering how critical teeth are for defense, for grooming, for procuring food, and for using as tools. The only exception I have been able to locate is one reptile that has evidently lost its teeth in the distant past: the Triassic turtle *Proganochelys*. It had rows of small homodont palatial teeth whereas modern turtles have none (Romer, 1974).

Irreducible Complexity

One argument against Darwinism is "irreducible complexity," the observation that a complex organ must first exist in a fully formed condition to function, otherwise it will afford no selective advantage to its possessor. Some claim that this argument from irreducible complexity is less successful in the case of the evolution of teeth than for most other body parts because a less developed tooth may be better than no tooth at all, and small bone protuberances might be better than no bone protuberances for chewing food and self-defense. These evolutionists claim that *any* improvement would seem to be selected for, and most all transitional forms would seem to provide a survival advantage. If this were true, we would expect transitional forms to occur and they do not.

As noted earlier, teeth do not exist in a vacuum, but are part of a complex "functional system that necessarily has remained operational throughout evolutionary change" (Butler, 2002, p. 209). Irreducible complexity is therefore a valid concern because all of the basic parts of the dentomaxillary complex must exist for the system to be functional. University of California biologist Richard Goldschmidt (1982) even "challenged the adherents of the strictly Darwinian view ... to try to explain the evolution of ... teeth ... by accumulation and selection of small mutants" (p. 6–7). Importantly, no evidence exists of malocclusions in the first jawed fish, the placoderms: the first jaws articulated perfectly. To achieve perfect occlusion from day one is a large task for Darwinism (J. Cuozzo, 2004, personal communication).

In a paper published the same year as Goldschmidt's, Butler (1982) discussed the many problems of tooth evolution, concluding that their complexity severely limits the number of ways teeth can evolve. Moeller (2003) added that the dentomaxillary system is very resistant to the effects of random mutations. Of the about 100 known human and animal mutations that affect the dentomaxillary system, almost all are loss mutations. No known genetic mechanism can selectively modify single tooth morphology, but rather typically causes a variety of damaging changes to the gingiva, the jaw, and related structures.

This research has caused Moeller (2003) to conclude that the claimed "transitional" teeth involve various modifications that place them in hypothetical "phylogenies," that are then retrofitted into a scheme to "demonstrate" evolution. He added that no evidence of beneficial mutational changes in the developmental cascade exists. He concluded that the claimed "tooth only" fossil record demonstrates only trivial modifications of previously created tooth forms.

What the fossil record does demonstrate is "quantum leap dental-maxillary morphologic changes" which are apparent only by considering the dento-maxillary system as a single identity. An example Moeller (2003) gave is that the elephants (proboscidians) have an entirely different method of tooth eruption than ungulates. He concluded that evolutionists need to demonstrate fossil evidence for changes in tooth eruption patterns. The dento-maxillary system ought to provide untold examples of fossil intermediate malerupted teeth. The fact that there is no evidence of any such transitional modification of the dento-maxillary subsystems lends strong support for the Creation model.

Summary

Because teeth are comparatively well preserved in the fossil record, evidence for their evolution should be found if it exists. Osborn (1925) wrote that enamel is "the most enduring animal substance in the whole order of living Nature, defy[ing] all the vicissitudes of time and of subterranean burial and take first rank among Nature's hieroglyphics of the past" (p. 40–41). Yet, in spite of a century of intensive searching, evidence for evolution of teeth still cannot be found. The claimed support for macroevolution usually amounts to nothing more than very ambiguous evidence, such as bone fragments which, in living animals, generally make up much less than 10% of the mass of the entire animal body.

As a result, it is on the basis of bones rather than fossil teeth the claims for evolutionary change are usually made. In the case of teeth, it is difficult to argue that more fossil discoveries will fill in the enormous number of missing links required to prove their evolutionary origin. Millions of fossil teeth have been discovered and not one has provided clear evidence of teeth originating by macroevolution. Conversely, the fossil record for teeth, as well as the complex structure of teeth, provide clear evidence for intelligent creation according to separate kinds.

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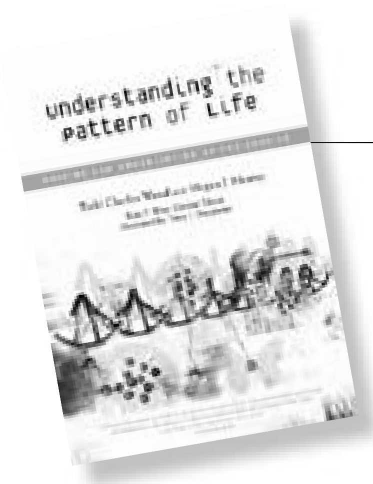

Book Review

Understanding the Pattern of Life
by Todd Charles Wood and Megan J. Murray
Broadman & Holman Publishers, Nashville, Tennessee, 2003, 490 pages. $25.00.

Todd Wood served as director of Bioinformatics for Clemson University Genomics Institute before becoming an assistant professor at the Center of Origins Research and Education at Bryan College. This paperback volume is composed of three general sections: Foundations, Methodology, and Application. Coauthor Megan Murray helped put the book into a popular, readable style. Each chapter ends with a summary, review questions, and suggestions for further discussion. Wood unabashedly starts with the Word of God and extensively uses scripture to illuminate his work. Indeed he demonstrates that the idea of a *baramin* (Hebrew for created kind) being fundamental to the pattern of life is derived from the biblical account.

Wood attempts to accomplish multiple things at once with this work. On the one hand the book is designed to be a textbook, acting as an introduction to creationist systematics. In this regard it is very successful. But he also attempts to seriously advance the work of baraminology, which he defines as a creationist biosystematic method, with some novel definitions and approaches. Some of these are insightful while others are confusing. The book is also a practical handbook which offers helpful tips for practicing baraminologists.

The book begins with an excellent cursory history of the issues involving systematics. For any who will wonder how this study is relevant to creationism or why it should be undertaken in the first place, these chapters will be enlightening. The next few chapters seek to establish a