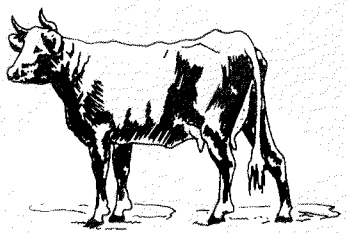
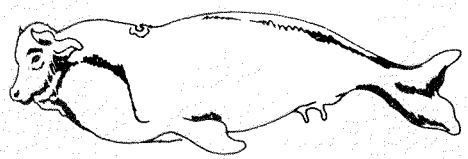
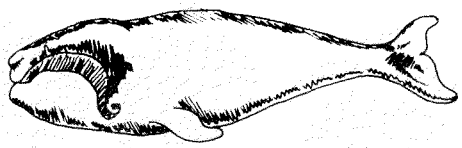
Creation / Evolution

Bossie to Blowhole







Is This How Whales Evolved?

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REPORTS and FEATURES

Teaching the "Right" Stuff: The Great Classroom Invasion

Various political, religious, and economic interests are out to control the content of public education. This is why the National Education Association's Twenty-First Annual Conference on Human and Civil Rights in Education will be devoting itself to these issues and to interest groups which are rocking the public schools today.

The conference will take place February 25–27, 1983, at the Capital Hilton Hotel in Washington, D.C. The first session will begin Friday morning at 9:00 AM and the closing session will end at 11:30 AM on Sunday.

The topics to be covered are:

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- The creation-evolution controversy
- The sex-education controversy
- The secular humanism hoax
- Censorship
- Public vs. private schools

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CREATION/EVOLUTION X (Volume 3, Number 4)

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Those Amazing Animals: The Whales and the Dolphins

Frederick Edwords

The animal world is full of amazingly complex and baffling life forms. It is the perfect hunting ground for any creationist out to impress an audience during debate or a reader of creationist publications. All the creationist needs to do is pick any one of millions of species, catalogue its unique characteristics and complexities, and then dare scientists to explain in detail how such an amazing specimen could have developed over time "by random and chance processes."

Often, the creationist will describe a hypothetical evolutionary scenario. Humor is an important element here; the creationist shows all the problems the animal's ancestors would have had trying to become the animal in question. Such scenarios are a parody of evolution but never fail to amuse audiences at lectures and debates.

Favorite Examples

Over the years, a particular selection of animals has become the stock-in-trade of those advancing the creationist cause. If one needed an encyclopedia of such "animal wonders," the best place to turn would be the Worldwide Church of God. This organization, directly or through its branches (Ambassador College, Ambassador Publications, Ambassador International), has published numerous colorful booklets and periodicals. Its most famous periodical, *The Plain Truth*, has frequently featured articles on these animals.

Back when Garner Ted Armstrong was with the organizaton, various booklets were published bearing cute titles such as *A Whale of a Tale or the Dilemma of Dolphins and Duckbills!*, *Some Fishy Stories About Evolution*, and *A Theory for the Birds*. The subject matter of each was self-evident. In these booklets, the reader was treated to beautiful color photographs and lavish descriptions by Armstrong of the duckbilled platypus, the dolphin, the angler fish, the lungfish, and the flicker woodpecker, among others. Humorous evolutionary scenarios

Fred Edwords, editor of Creation/Evolution, *has lectured and debated widely on the creation-evolution question. He is on the board of the New York Council for Evolution Education and is administrator of the American Humanist Association.*

were suggested to show how each animal could never have evolved.

Other creationists followed up on this lead, often cribbing arguments from Mr. Armstrong, at other times discovering "animal wonders" of their own. For example, Dr. Robert Kofahl of the Creation-Science Research Center seems to be responsible for adding examples such as the bombardier beetle and the gecko lizard to the growing menagerie, and Bolton Davidheiser has added the turtle.

What all these animals have in common is either beauty or intriguing complexity of structure and behavior. Conspicuous by their absence are animals that are dangerous or disgusting to humans. To remedy this oversight, a critic of creationism in Australia, John Bowden, wrote a booklet called *Creation or Evolution*. Among the arguments in this booklet, he included descriptions of animals with traits that humans consider less than desirable. These included the skunk, vampire bat, maggot, sewer rat, tapeworm, Chinese liver fluke, and bedbug. This latter animal, for example, could serve creationists well as evidence of "purposeful design." Bowden writes, "It has been observed that, if the legs of a bed are placed in receptacles containing insecticide, the bedbug will climb up the adjacent wall to the ceiling, crawl an inch or two thereon, and then drop onto the bed" (p. 31). However, it would be obvious whose side God is on!

Of course, such arguments don't disprove creation, they simply reveal a creationist preference for the most appealing examples. But the creationist arguments fail to disprove evolution. All they do is show that there are some things yet to be explained, some animal adaptations that are truly fascinating and incompletely understood. The theory of evolution does not require that its supporters come up with a step-by-step evolutionary history for every form of life on the face of the earth.

Nonetheless, it is often the case that the examples the creationists choose turn out to be animals about which science knows a lot. There frequently is a known evolutionary history that the creationists have simply ignored. Perhaps the most blatant example of this appeared in the August 1982 issue of *Youth 82*, published by the Worldwide Church of God. There the reader was treated to still another "animal wonder." However, this time it was the camel, an animal with a fossil record so complete and detailed that you can't find anyone with enough money to publish it in its entirety.

Whales and Dolphins

Creationists have recently renewed their interest in whales and dolphins and have referred to them often in debates as examples of animals that evolution cannot explain. Let us, therefore, take a look at the arguments creationists use and have used in this regard.

Garner Ted Armstrong, in his typical mocking style, declared in his 1970

booklet, *A Whale of a Tale*, that no matter how amazing the facts are about whales and dolphins, they are "nowhere *near* the 'whoppers' of the supposed story of their 'evolution.' " Armstrong's basic line of argument was to first establish the amazing characteristics of these animals. He noted, for example, that dolphins can dive more than one thousand feet, and whales much deeper, without the need to go through decompression to avoid getting the "bends." He then declared that the sonar of these animals is superior to humanmade sonar and that whales are capable of swimming in total darkness.

There is really nothing to dispute in this data. His conclusion, however, was that all of this is just too complex to have evolved.

Armstrong's next step was to quote authorities as proof that there is absolutely no fossil record for whales or dolphins. After five such quotations, he concluded, "Yet—in spite of *missing* evidence and *no* proof, evolutionists continue clinging to their faith."

Finally, he brought in "Dither, the doleful dolphin," who was the supposed ancestor of the modern dolphin. Dither lacked many of the characteristics modern dolphins require and so was unable to survive in the ocean. This destroyed the dolphin's line and hence the case for evolution.

Armstrong's pattern of argument is standard for creationists, whether the animal under discussion is the flicker woodpecker, the bombardier beetle, or any other fascinating example. Dr. Gish of the Institute for Creation Research uses the same basic pattern in his debate and lecture presentations. Here is what he said about whales in a March 20, 1982, debate held in Tampa, Florida (his opponent was Dr. Kenneth Miller):

> I had a great time yesterday watching the dolphins out in the bay going after a school of fish. Marvelous wonderful creatures, beautifully designed for life in the water! What do evolutionists say about whales and dolphins?
>
> Well, here is an article that appeared as a fold-out in the *National Geographic*, December 1976, entitled "Whales of the World." The author says that "whales' ascendancy to sovereign size apparently began sixty million years ago when hairy four-legged mammals in search of food or sanctuary ventured into the water. As eons passed, changes slowly occurred, hind legs disappeared, front legs changed into flippers, hair gave way to the thick smooth blanket of blubber, nostrils moved to the top of the head, the tail broadened into flukes, and, in the buoyant water world, the body became enormous."
>
> So according to this story, then, some hairy four-legged mammals evolved into a whale. Now here is an article that appeared in *Scientific American*, entitled "Dolphins," and this was in March 1979, by Dr. Burt Worsey. Dr. Worsey said that "dolphins evolved at least fifty million years ago from land mammals that may have resembled even-toed ungulates of today such as cattle, pigs, and buffalo." All right, that is what he said, "cattle, pigs, and buffalo." Something like that went into the water and evolved into a whale or dolphin or something like that.

Well, a friend of mine got together with an artist and tried to visualize what these transitional forms looked like. We see those in the next slide.

At this point, Dr. Gish presented a slide acquired from Luther Sunderland that depicted a cartoon of a smiling cow, much like pictures and cartoons used by some dairies in their advertising. This cow was shown evolving into a whale by becoming first a cow with whale flukes instead of hind legs, then a cow with front flippers instead of front legs (but still possessing an udder), and then, finally, a full whale.

We see that the cow got into the water, that's what they said, something that may have resembled a cow, pig, or buffalo got into the water, and listen, they said she stayed around the water for eons of time as her tail broadened into flukes, the hind legs disappeared, and the front legs changed into flippers. And I suppose if we had a failure in the thing that was just hanging underneath [pointing to udder], we'd call it an *udder* failure. Fortunately everything succeeded, and we finally ended up with a whale.

Now my challenge to Dr. Miller and to all evolutionists is the following: If you don't like these suggestions, what are yours? I would be delighted to see what your suggestions are. How did some hairy four-legged mammal get into the water, stick around for eons of time, and just gradually and slowly evolve into a whale which is wonderfully and marvelously designed for life in the water?

You see, when it comes right down to a specific case, the whole idea of evolution is an absurdity.

Well, Dr. Miller accepted Dr. Gish's challenge when his turn came. Dr. Miller responded:

And finally, evolution has even occurred where Dr. Gish makes his best jokes. Next slide. Now my wife is an artist, and I knew about Dr. Gish's slide. So I wanted to draw up the intermediate between a whale and a cow that Dr. Gish had before, and she made this nice slide for me before I came. If you would like to use this you can. I think it's a really good drawing and it's a lot of fun and it looks very silly. But when you retire from comedy and decide you want to do science, you say, "Okay, what do the real fossils look like?" Next slide.

What does the fossil whale look like? On the top is *Zeuglodon*. He is a fossil whale. You know what? *Zeuglodon* doesn't have his nose on the top of his head the way modern whales do. He has it in the front. Next slide.

There is, in fact, an evolutionary trend from terrestrial vertebrates on the left to *Pro-zeuglodon* to modern whales on the right which show slowly and gradually how the blowhole evolved in modern whales. And the next slide shows how these forms looked, what the record is. You don't need to make a joke. You can deal with the facts.

A Summary of the Evidence

The constraints of debate don't allow for a complete summary of the evidence for whale evolution, so it will be useful to cover the material more fully here. There are four basic bodies of evidence that support the proposition that whales evolved from land mammals. Let's take them one at a time.

1. Homology. First and most obvious is the fact that the cetaceans (whales and dolphins) are *mammals*. Sea life is not ordinarily mammalian, which shows that whales and dolphins are likely "intruders" into that domain. Because cetaceans are mammals, they are more similar to animals such as cattle than they are to fish. This is why cetaceans and land mammals have been grouped in the same class. Evidence from comparative anatomy and biochemistry completely justifies this.

2. Embryology. Creationists freely admit that mysticete whales, when in the embryonic stage, have tooth buds which are resorbed before birth and never erupt through the gums. Creationists are also aware of the coat of hair these embryos have and lose before birth. But they don't explain why the creator would have to put teeth and hair into a fetus in order to make a whale that has neither. Even if the teeth and hair could be shown to have some limited function in the development of the fetus, as creationists are inclined to claim, this would be a *new* function for old features and hence would not challenge the clear connection these features have with earlier evolutionary stages. Overall, whale and dolphin fetuses are more similar to fetuses of land mammals than they are to those of fish. This would not be the case if there was no relationship between cetaceans and land mammals.

3. Vestigial organs. In sperm whales, there are cases of posterior extremities attached to the pelvis that are structured like leg bones. As Yablokov concludes, these are "characteristic of the distant ancestral forms, which have apparently been discarded because of adaptive evolution" (p. 243). Thus, whales evolved from animals having hind legs.

These are true vestigial organs, since they neither help nor hinder the survival of the animal possessing them and since they appear only rarely. If sperm whales *needed* these limbs, they would all have them. If creationists respond that these are just "freak" features as are things like a fifth leg on a cow, they must remember that a cow has four other legs; whales have none. And if creationists claim that such limbs are signs of "degeneration" in the animal since creation, they will have to explain from what these legs are degenerating (Awbrey and Thwaites). The real source is clearly terrestrial mammalian hind legs.

4. The fossil record. Both the absence and presence of certain fossils demonstrate

that whales and dolphins evolved from land mammals. First, the *absence* of any fossil evidence showing that the cetaceans could have evolved from early sea life in a scheme of evolution paralleling that of the emergence of land mammals rules out that idea from consideration. Second, the *presence* of clear ancestral fossils of modern-day cetaceans that show greater similarities to land mammals than do modern cetaceans gives support to the position that whales evolved from the land.

Although everything is not known about the evolution of the cetaceans, there are a number of fossils that document the progression from land to sea. An illustration of five of these fossils appeared in the April 1979 *National Geographic*. It will be useful to summarize that data.

The first fossil was a Mesonychid, a member of a family of land mammals that lived fifty million years ago and had skulls similar to that of modern wolves or dogs. Its nostrils were at the tip of the snout, as would be expected for this type of mammal. The second fossil was a forty-five million year old *Protocetus*. This amphibious mammal had an elongated skull in which the snout was extended forward ahead of the nostrils. The third fossil was a *Durudon*, a forty-million-year-old, fully aquatic mammal with the snout even further out from the nostrils. The fourth example was from the family Squalodontidae, being a porpoiselike animal from twenty-five million years ago with its nostrils on its forehead between the eyes. The last example was a modern bottlenose dolphin. This animal first appeared fifteen million years ago and has nostrils above its eyes.

When this data is combined with the fossil examples Dr. Miller used, one can see that there is no lack of transitional forms in the fossil record.

A Better Scenario

The data from morphology, biochemistry, embryology, vestigial organs, and the fossil record all support cetacean evolution. They show us *that* whales evolved. However, people still wonder *how* they did. They picture this poor even-toed ungulate, such as a cow, jumping into the water and holding its breath, desperately trying to evolve before it drowns. They can't imagine how evolution would work.

No animal *tries* to evolve. Rather, due to variations caused by beneficial mutations, some animals *do* evolve. For example, if a cow was born with some of the abilities of a water buffalo, this cow could spend more time in the water. The mutation would *allow* this change in evironoment. Further evolutionary changes would allow later animals of this line to spend progressively more time away from dry land.

Modern hippopotamuses are even-toed ungulates that spend most of their lives in the water. Though they graze on vegetation as do cattle, they have large whalelike blubbery bodies and swim comfortably. This makes them an excellent

ecological type for demonstrating the workability of whale evolution. Hippos even have nostrils turned up to allow them to breathe while sleeping on the water's surface. Their calves are born and nursed under water and can swim before they can walk (Goodwin). One could imagine evolutionary changes that might create improved swimming abilities, such as seals and walruses have, bringing us even closer to the whale.

Of course, whales did not evolve from water buffalo, hippos, or walruses. But the above scenario does show us that intermediate stages make sense, thereby allowing us to dispense with the caricatures of evolution given by Armstrong and Gish.

Though the animal world is full of startling creatures that often seem to defy evolutionary explanation, this cannot help creationism if there are plenty of *other* animals that have well-known fossil histories. No creationist is prepared to say that perhaps some animals evolved and others didn't. Creationism is an all-or-nothing proposition. Therefore creationists should devote their time to explaining away the well-documented examples instead of focusing on those that they imagine are inexplicable. But if they insist on concentrating on the latter, demanding birth certificates for every transitional ancestor, they should first read the latest sources and study *all* the data. Otherwise they might find that the evolutionary answers to their bold challenges come all too quickly.

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True Vestigial Structures in Whales and Dolphins

Ernest C. Conrad

What Is a Vestigial Structure?

Webster's Third New International Dictionary defines a *vestige* as "a small and degenerate or imperfectly developed bodily part or organ that remains from one more fully developed in an earlier stage of the individual, in a past generation, or in closely related forms." It is those vestigial organs that show signs of coming from past generations that support the theory of evolution.

From the beginning, creationists have disputed either the existence or importance of vestigial organs. Robert Kofahl declares in his *Handy Dandy Evolution Refuter:*

> Advancing knowledge and physiology has shown that most of the supposed vestigial organs are useful and even essential. If there are any true vestigial organs, they show the loss of structure and design, not the production of something new. But to support the theory of evolution, evidence for the production of new organs is required.

On the other hand, leading scientists, such as the late zoologist and geneticist, Theodosius Dobzhansky, have continued to support vestigial organs as evidence for evolution. In his text, *Evolution, Genetics, and Man*, Dobzhansky wrote, "There is, indeed, no doubt that vestigial rudimentary organs silently proclaim the fact of evolution."

To speak to the statement by Kofahl, then, seems to be in order. Let us take his statement one sentence at a time.

When Kofahl says that advancing knowledge has discovered uses for most of what were thought to be vestigial organs, he is at least partly correct. Compared to what scientists thought in the last century, scientists today regard fewer organs as truly vestigial. Among the recent scientists who have been noting uses for formerly held vestiges is Russian zoologist Alexy Yablokov. His book, *Variability of Mammals*, discusses the important functions played by the pelvic bones and whiskers of whales—two features that were formerly regarded as vestiges.

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Does this signify that, given enough time, scientists will soon find uses for all so-called vestigial organs and that we would be well-advised today in giving up the vestigial-organ argument as a case that is doomed? This is what creationists would like us to suppose. But this attitude is based on a misunderstanding of *why* many structures regarded in the past as vestiges are today regarded as something else.

In a chapter entitled "Variability and the Problem of Vestigial Organs," Yablokov helps us clear up the misunderstanding. He sees much of the problem as having been caused by "vague definitions of the concept of vestigial organs," particularly "the vague or imprecise understanding of the concept of vestigial organ present in the works of Darwin . . ." (pp. 232-233). His purpose is to tighten up the definitions in order to provide scientists with a clearer idea of what criteria must be met before a structure can be called *vestigial.*

But even with tighter definitions, the organs no longer labeled as vestigial do not cease to have value in demonstrating evolution, as creationists might think. For example, when Yablokov denies that pelves and whiskers in whales are truly vestigial, he continues to affirm that they are clear throwbacks to an earlier evolutionary stage. As he states on page 240, "The structure of these organs was modified by a significant change in function at some time in their evolution." Because of his tighter definitions, he prefers to speak in such cases "about the vestigiality of functions rather than the vestigiality of organs" (p. 246). This means that creationists gain very little by the "advancing knowledge" that keeps discovering useful, but altered, functions for organs formerly defined as "vestigial." These organs still demonstrate descent with modification.

In Yablokov's view, the problem with most of the previously held examples of vestigial organs is that they were organs "present in all the individuals of a given species." But, "it is observed in all cases that such organs or structures, inherited by the whole population, have a functional significance and logically cannot be named as vestigial." To Yablokov, an organ should be taken as vestigial only if it is one which develops in some individuals but is not characteristic of the whole population (p. 241). And he adds, "It has been known for a long time that such organs exist in animals."

Armed with this clearer concept of vestigial organs, we can now look at the second sentence in Kofahl's statement. Here he says that any true vestigial organ would show the loss of structure and design instead of the development of something new. If we drop "design," Kofahl is perfectly correct. A true vestigial organ is indeed an organ that has lost its original structure. It has also lost its function. Individuals possessing a vestigial organ don't differ in fitness from those without it. The organ is simply a leftover. Therefore, Kofahl seems to be accepting the concept.

But when he speaks of "design," he implies a designer, a master architect who puts the organs in place; animals were perfectly made by the perfect maker who knew exactly what was to be done. Given such a position, it would seem

frivolous if this maker put some parts in that were of no use. But "design" is a concept that has no usefulness in science. As Richard Aulie points out:

> We do not observe design in nature. Rather our minds seem to be constructed so that we can perceive regularities to which, if we have religious presuppositions, we apply the concept of design. Furthermore, to make of design a biologic principle . . . is to reduce the need to interpret biologic processes as precursors of the adaptation that evokes wonder.

This brings us to Kofahl's last sentence. There he states that, since vestigial organs show a loss of structure, they don't help evolution, since evolution requires "evidence for the production of new organs. . . ." This sentence shows Kofahl's misunderstanding of why vestigial organs are used as evidence in support of evolution.

Vestigial remains hark back to an earlier evolutionary stage because these vestiges are organs or parts that have ceased to exercise their original function and have become unnecessary and atrophied. Yablokov considers them examples of atavism, "organs appearing in the development of present forms and indicating the condition of their ancestors (*atavus* = ancestor in Latin)" (p. 244). Production of new organs has nothing to do with the matter. This is an entirely separate evolutionary issue.

The Appearance of Limbs in Cetaceans

Now that we have a fuller understanding of what constitutes a true vestigial structure, we can proceed to look for a concrete example. The cetaceans (whales and dolphins) are commonly regarded as possessing many vestiges. Of course, it is precisely these mammals that have been used by Yablokov to demonstrate the errors scientists have made in regard to vestigial structures. So we must ask, does Yablokov find any evidence for true vestigial structures in the cetaceans? Yes, he does, and much of his data is based on personal investigation.

Among the vestigial structures in cetaceans that he accepts are vestigial hind limbs. He is aware of six cases in sperm whales alone. One in particular, which was later passed on to him for personal study, he discusses on page 242.

> In June 1962, V. I. Borisov observed a sperm whale with well-developed protuberances on the ventral region of the body, while working in the whale factory at Skalistii (Central Kuril Islands). One of these protuberances could even be X-rayed.

Yablokov himself observed a remnant of a femur in a male sperm whale in the factory at Podgornyi (North Kuril Islands).

Other investigators are also aware of this type of evidence. William King Gregory, writing in 1962 in the *Encyclopedia Britannica*, provided the following account.

> In July 1919, a female Humpback Whale (*Megaptera nodosa*) with two remarkable protrusions on the ventral side of the body, posteriorly, was captured by a ship operating from the whaling station at Kyuquot, on the west coast of Vancouver Island, British Columbia. One of the protrusions was cut off by the crew of the vessel but the other was photographed *in situ* by the superintendent of the station.

At the request of Roy Chapman Andrews, the skeletal remains, which consisted of two bones and two heavy cartilages, were sent from Canada to the American Museum of Natural History in New York City. The specimen as found had elementary legs protruding from the body about four feet, two inches, covered with blubber about one-half inch thick. Andrews identified the bones as tibia and metatarsal, the cartileges as femur and tarsus, and published his findings:

> After studying the material and discussing it with various scientists, I have come to the conclusion that the protrusions actually do represent vestigial hind limbs and show a remarkable reversion to the primitive quadrupedal condition.

Professor Andrews had sufficient anatomical reasons to reject the idea that the limbs were merely abnormal malformations with no reversionary significance. He concluded his reasearch on this remarkable specimen with the following observations:

> Since Kukenthal's and Guldberg's researches have shown that external hind limb rudiments are still present in some cases in embryonic life, it is by no means impossible that these vestigial organs should continue their growth and persist until the adult stage. I believe that that is exactly what has occurred in the specimen which I have described above, and that we are confronted with a clear case of partial reversion to a primitive quadupedal condition.
>
> The limbs, according to the statements of the whalers, were symmetrical; they are in the exact position in which the hind limb rudiments have been found in embryonic *Megaptera*; there are strong indications that the cartilaginious femur was attached to the pelvic elements.

The report, entitled "Remarkable Case of External Hind Limbs in a Humpback Whale," was published in June 1921.

In 1953, Teizo Ogawa, writing "On the Presence and Disappearance of the Hind Limb in the Cetacean Embryos" in *The Scientific Report on Whales Research*, concluded that:

> . . . in my opinion the disappearance of the paired hind limbs in the Cetacea seems to have an intimate causal nexus with the appearance of the paired caudal flukes of them. . . . In a 14 mm long embryo of the dolphin, *Prodelphinus caeruleoalbus*, and in a 20 mm long embryo of the Humpback, *Megaptera nodosa*, the paired elevations of the hind limb are pretty well developed. Photographs of them are shown. Further consideration was given to the simultaneousness of the disappearance of the hind limb elevation with the first appearance of the caudal flukes in the cetacean embryos. (p. 131)

In 1957, Tezio Ogawa and Toshiro Kamiya, writing in the same journal, reported on "A Case of the Cachalot with Protruded Rudimentary Hind Limbs."

> Needless to say, no protrusion of the hind limb is seen in all the Cetacea in their postnatal life. Only in the early embryonic stage they show a pair of protruded hind limbs, which but soon disappear. On the other hand, the existence of a pair of small pelvic bones is known as to nearly all of the Cetacea, lying far apart from the vertebral column on both sides of the genital opening. In the fin and blue whales and in the humpback, the femur too is present near the pelvis, and in the right whale even the tibia exists. Of course, these bones are deeply buried under the skin, causing no protuberance on the body surface. (p. 197)

After some discussion of the 1921 Andrews report, the authors continued:

> Recently another individual belonging, however, to the *Odontoceti* [sperm whale] and possessing likewise a pair of protruded hind limbs was encountered in Japan. . . . According to the report presented from the whaling station, it was a female measuring 10.6 m in length. The protuberances were present on both sides of the genital opening. . . . (p. 198)

The difference between the two cases is never essential but rather a problem of the quantity of materials for study.

In their summary, Ogawa and Kamiya stated:

> In a nearly adult female Cachalot captured in November of 1956, off Kinkwazan in Japan, a pair of budlike vestigial hind limbs were present. The height of the protuberance was 5.35 cm on the right side and 6.56 cm on the left side. Upon examining the interior of the left limb, three partially cartilaginous bones were found. They corresponded to pelvis, femur, and possibly to tibia, but no joints exist between them. Pretty strong muscles connect between pelvis and femur, while two weak muscles are extended between femur and tibia. . . .
>
> This case can be understood by assuming abnormal retention of the early embryonic state and shows very probably an atavism back to the quadrupedal condition of the whale's remote ancestors. It can never be a malformation of no phylogenetic significance. (p. 207)

These examples of rudimentary hind limbs meet Yablokov's criteria of being nonfunctional as well as uncharacteristic of the whole population. To demonstrate their noncharacteristic nature, a report by Seiji Ohsumi is instructive.

> On December 16 in 1963, a herd of about 450 blue white dolphins (*Stenella caeruleoalba*) was caught by fishermen at Kawana Beach in the eastern coast of Izu Peninsula, Japan. In the course of biological investigation on the herd, I found an individual with protruded rudimentary hind limbs . . . protruded on either side of just the mammary slit. (p. 135)

Out of 450, he found only one example.

Other vestigial reports on sea mammals could be cited, but enough has been presented to show that these rudimentary hind limbs do exist in cetaceans and are truly vestigial. Being vestigial, they point to an earlier stage of evolutionary development. Because of this and other evidence, William King Gregory concluded in his *Encyclopedia Britannica* article, "that the Cetacea have been derived from terrestrial, quadrupedal placentals."

The very word *vestigial* comes from the Latin *vestigium*, which means footstep or track. Vestigial organs are traces of organs previously functional. In a sense, vestigial remains are like footprints leading us back to an earlier time when they were fully developed, a time when the ancestral animal had a significantly different body structure and a totally different way of life from the example alive today. That is what we have discovered in the case of the cetaceans.

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Whales: Can Evolution Account for Them?

Matthew Landau

Paleontologist E. H. Colbert has commented on cetaceans (whales and their kin) as follows:

> Like the bats, the whales (using this term in a general and inclusive sense) appear suddenly in early Tertiary times, fully adapted by profound modifications of the basic mammalian structure for a highly specialized mode of life. Indeed, the whales are even more isolated with relation to other mammals than the bats; they stand quite alone.

Clearly the cetaceans can serve as ammunition for the creationists (Mayo). Just what makes us so sure that these beasts were not plunked down in the ocean as is?

Well, one of the nice things about science is that we can become more or less sure of our educated guesses as we test them. With regard to the evolution of extant groups of organisms, we can test our assumptions based on one set of characters, such as morphology, by looking at another set of characters. For example, if we decide that whales are more closely related to porpoises than to tuna, based on their comparative anatomy, and that we would like to convince our friends that we're right, the thing to do is search out comparative literature on each group's behavior, embryology, fossil record, biochemistry, and so on. If each time we use a different set of criteria the whale turns out to be more similar to the porpoise than to the tuna, we assume our initial theory is more likely to be correct than not. If two groups of organisms show many similarities, it is more likely that they shared a common ancestor with these characteristics than that the two groups evolved all the shared characteristics independently. We choose the theory which makes the fewer number of assumptions—that is, the most *parsimonious* choice.

We also choose the theory that explains or predicts the most facts. For example, creationism cannot explain the vestigial hind limbs found in whales, but evolution can. The evolutionary explanation is that whales evolved from land mammals that had four legs. Other structures not explained by creationism, such as the teeth of baleen whale embryos which are resorbed before birth (Peyer), are also explained by evolution: baleen whales evolved from mammals having teeth.

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It will be the purpose of this article to further reveal the parsimonious nature and explanatory ability of evolution as it applies to whales. The primary focus will be the evidence of whale evolution found in the fossil record and the relationship of whales with other mammals as seen through biochemistry. The conclusions drawn from both sets of data will hopefully suggest a parsimonious and explanatory solution to the question of why whales are the way they are.

The Fossils

Romer, Slijper, and Colbert have briefly reviewed our knowledge of extinct cetaceans. *Zeuglodon* (an elongate giant which reached seventy feet in length), *Dorudon, Protocetus*, and their relatives belonged to a primitive group of cetaceans, the archaeocetes. These mammals are best known from Eocene and Oligocene deposits (twenty-five to fifty million years ago) and give us some clues as to how the modern cetaceans evolved. A number of transitional features are shown in the archaeocetes whales which link the modern cetaceans with their ancestors on land. These features include: (1) independent neck vertebrae; (2) a forelimb which showed less fusion than extant whales; (3) a pelvic girdle which was somewhat reduced and unattached to the vertebral column but still more like their terrestrial relatives than today's whales (a ball and socket joint to articulate the femur and pelvis is especially telling); (4) facial bones of the skull that were not telescoped as in modern whales; and (5) nostrils placed in a forward position (not on the top of the skull to form the "blowhole" of extant species), typical of land mammals.

By the Miocene, or perhaps earlier, the two main groups of extant cetaceans, the toothed whales (odontocetes) and the whalebone whales (mysticetes) were already well established. Early toothed whales, such as *Prosqualodon*, showed dentition similar to the primitive Archaeocerta but had an advanced skull structure—another good "transitional fossil."

Van Valen reviewed the characters of extant and extinct whales. He concluded that extinct whales such as *Protocetus* may have given rise to both major suborders of recent whales. Speaking of the Protocetidae, he said, "It is beautifully intermediate between primitive mesonychids and recent whales, although in most respects more similar to the latter." The mesonychids were a group of very primitive ungulates (hoofed animals), some of which were rather large carnivores, that are known largely from the Paleocene and Eocene.

Recently Gingerich and Russell described a new archaeocete, *Pakicetus*, which was found in Pakistan. These and other fossil whales found in that area belong to the Protecetidae family. However, the specimen of *Pakicetus* found had a very well preserved skull and appears to have several cranial characteristics in common with other archaeocetes, but it "exhibits few of the other specializa-

tions of this group required for hearing under water." (Olson has pointed out that toothed whales have developed remarkable mechanisms for reception and transmission of sound. The mysticetes have a much lesser degree of modification, only moderately different from the archeocetes.) They go on to say, "The primitive nature of the dentition in *Ichthyolestes, Pakicetus,* and *Gandakasia*, the fact that all three genera are found in association with land mammals, and the primitive nature of the basicranium in *Pakicetus* combine to suggest that whales made the transition from land to sea as late as the early or early-middle Eocene." Gingerich had previously identified what seemed to be part of the mandible (jaw) of a juvenile artiodactyl (an even-toed, hoofed mammal in the same order as modern pigs, hippopotamuses, deer, cattle, and camels), but later Gingerich and Russell reinterpreted it as belonging to an archaeocete. Evidently the jaw's structure hints at an original version common to the two groups.

Biochemical Data

The explosion of "biochemical systematics" during the past three decades is a direct function of the power of science.

Boyden and Gemeroy used an immunological technique called the precipitin test to speculate about the relationship of Cetacea with other mammal groups. To perform this test, an antiserum is manufactured by rabbits after they are injected with an antigen, such as serum. The various antisera taken from the blood of the sensitized rabbits are reacted with different antigens. The relative turbidity, a measure of the interaction, is used as a measure of similarities between the groups. They found that the degree of similarity between Cetacea and other groups of animals was small except for Artiodactyla.

Constructing a phylogenetic tree (Figure 1) in the form of a *cladogram* (for an excellent discussion of the theory and use of cladograms, see Eldredge and Cracraft) on the basis of cytochrome sequences (matrix 1 in Dayhoff), we can independently confirm the work of Boyden and Gemeroy. Cytochromes are relatively stable proteins, compounds composed of long chains of smaller molecules called amino acids which are linked together in a very specific order. Using computers we can statistically estimate the similarity of several sequences to each other; the greater the similarity two sequences share, the more recently their common ancestors diverged.

However, the relationships are not always that clear cut. For example, myoglobin (modified from Dayhoff) gives us a slightly different cladogram (Figure 2) than do the cytochromes. While not identical to the cytochrome tree, we see that the horses, whales, and Artiodactyla make up a collective group whose common ancestor branched off after the common ancestors of the kangaroo or man.

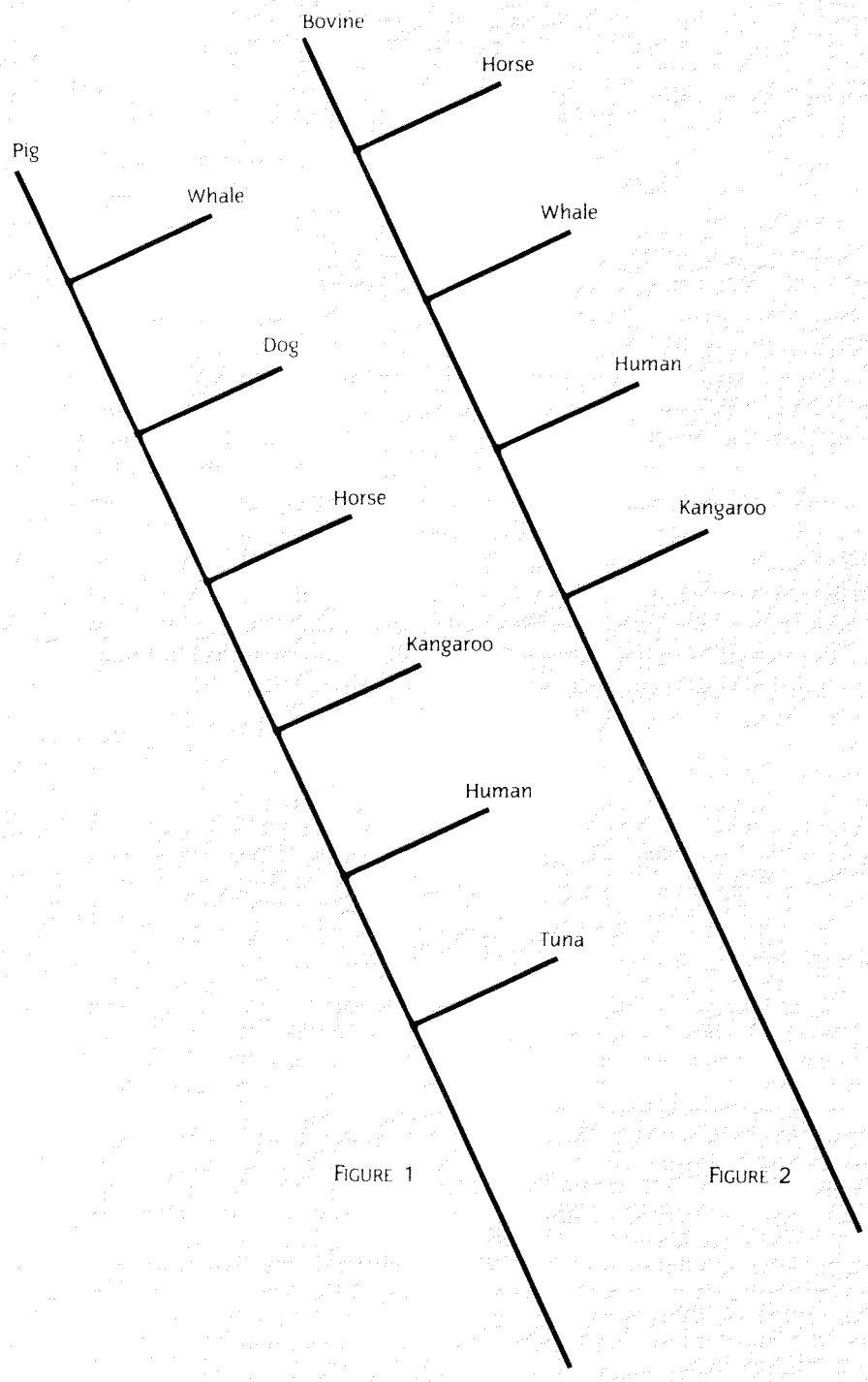

FIGURE 1

FIGURE 2

Conclusion

Fossil whales show a number of characteristics that are intermediate between extinct land mammals and living cetaceans. Many of these morphological features allude to hoofed organisms in particular. Concurrently, several biochemical assay techniques point to the same conclusion. The rule of parsimony therefore dictates that evolutionary biologists are well within the bounds of reason when they speculate about a common ancestor shared by the modern ungulates and living whales.

However, the whale does present those not familiar with natural history with a problem, since, based on external anatomy, the cetacean certainly doesn't resemble other mammals, especially those with hoofs. This is just the sort of thing creationists delight to use in debate since it is much more economical to show a humorous slide which depicts a cow or pig trying to become a whale than it does to discuss protein sequences and cranial specializations. Nothing can really be done about this except to point out that, regardless of first impressions, a diamond is much more similar to a lump of coal than to a quartz crystal; sometimes we have to go beyond a first impression and study a subject in an orderly and objective manner. In the long run, a scientist must have a lot more than cute slides or he'll find himself laughed into a less-demanding field.

Acknowledgement

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The Turtle: Evolutionary Dilemma or Creationist Shell Game?

Andrew J. Petto
with illustrations by Sarah Petto

For the Wyandot Indians of the central plains of North America, the world grew from a few grains of earth from the bottom of the sea spit onto the back of Big Turtle by Old Toad. The world of the Onandaga was formed by Muskrat who placed earth on Snapping Turtle's back. In several Hindu myths, the god Vishnu, in his second incarnation as a turtle, retrieves earth from the bottom of the sea. On his back stands the elephant whose shoulders support the earth (Reeve, 1975).

In these cultures, the world rests on the shell of a turtle. In our culture, the turtle bears the weight of an anti-evolutionary argument on its back as well. How, ask "scientific creationists," could the turtle *evolve* ribs on the outside of its shoulders from ancestors who are built the other way around? And why do no other descendants of those reptilian ancestors share this arrangement?

Bolton Davidheiser (1971) wonders:

> If the turtle evolved from animals of a more "orthodox" structure, it is a mystery how they managed to get their shoulder bones inside their rib cages. If they were outside the ribs, as in other animals, they would also be outside the shell. (p. 246)

In other words, Davidheiser believes that the turtle's shoulder and rib arrangement is too different from that of other animals and too complex to have arisen through evolutionary processes.

Klotz (1979) voices a second objection to the evolution of the turtle. He claims that there is no evidence, in the form of intermediate or transitional forms, of shared ancestry between turtles and other reptiles:

> All reptiles are supposed to have developed from the stem reptiles, the cotylosaurs. A modified cotylosaur, *Eunotosaurus*, is sometimes postulated as the ancestor of all the turtles in that it comes from the proper time and it appears to be on the verge of developing a shell. But it has one serious drawback as a turtle ancestor. The carapace of modern turtles does not develop just from

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> wide ribs but from independent plates of dermal bone which expand markedly and fuse with one another and with the underlying ribs and any shell or plastron. This unique armor and the contortions which the skeleton had to undergo to fit into it, combined with the toothless beak, have suggested to some that turtles are entirely different from any living reptile. (p. 457)

Creationists argue that the first turtle found in the fossil record is clearly a complete turtle, not some intermediate or transitional form on the way to becoming a turtle from a more conventional reptile.

Davidheiser's denial of a plausible evolutionary pathway to account for the transition attempts to deal a fatal blow to the evolution of the turtle.

> It was hoped that a study of the embryonic development of the turtles would clarify this. The problem is discussed by Archie Carr, professor of biological sciences at the University of Florida. He says, "It might accordingly have been hoped that the evolution of the relationship between the shell, ribs, and the girdles during embryology would shed some light on the original history of these events, but such is not the case. (p. 246)

This passage suggests that Carr finds no evidence of a reasonable link between the development of the turtle embryo and evolutionary changes in the turtle lineage.

The creationist challenge appears formidable since it attacks the roots of evolutionary biology. The main arguments dispute similarity of form, shared ancestry, and a plausible evolutionary pathway from the stem reptiles to turtles. Yet as formidable as this claim appears, there is little substance in the creationist objections. A careful examination of these arguments against turtle evolution will show why.

The key question is: Do turtles start with the same basic structures as other reptiles and change during their growth and development or are they truly different from the moment they begin to take shape? The answer will determine the strength of the other creationist objections.

Turtle Embryology

Studies of a developing embryo are useful in evolutionary biology. Stephen Jay Gould shows how small changes in the rate and timing of developmental processes can result in major changes in the form of the adult animal (1977:257–260). An unusual feature in an adult animal might be the result of such a developmental change *or* might be a new feature unique to a particular group of animals.

Does Carr really fail to find any reasonable link between the turtles and other reptiles, as Davidheiser claims, or is Carr a victim of the creationist tactic of selective citation? Davidheiser's citation was taken from the introduction to Carr's *Handbook of the Turtles*, which reads in part:

> In many cases, some inkling of the historical origin of an anatomical feature may be gained by studying its development in a growing embryo. The occurrence of lateral folds in turtle embryos, for instance, probably means that the ancestral form had these structures, which today are found only in lizards. It might accordingly have been hoped that the evolution of the relationship between the shell, ribs, and the girdles during embryology would shed some light on the original history of these events, but such is not the case. (p. 3)

Carr goes on to discuss research which has shown that the turtle conforms to expectations for an animal maintaining a *conservative* reptilian embryology with an anatomical specialization for external armor. In this context, Carr's comments argue *for* the reptilian ancestry of the turtle, not against it as Davidheiser would have us believe.

Carr says that the embryology of the turtle confirms that it is a "good" reptile. No new or unusual—nonreptilian—structures appear in its embryology. His disappointment that his study failed to reveal much about the historical origin of the turtle's specializations was based on his observation that turtle development follows rather ordinary pathways. If the process of turtle growth and development is so ordinary, then what explains the unusual result?

Growth and Development of the Shoulder Girdle and Shell

Walker (1947) follows the development of the turtle shoulder girdles from the stage at which limb tissues are first recognizable (when the embryo is 9.5 mm in length) to the stage at which the formation of elements is complete, except for the growth to hatchling size (32 mm). Two significant events occur in the turtle development (ontogeny) which account for the relationship between ribs and the shoulder girdle.

First, the ribs become associated with the shell covering the back (carapace). They do not extend belly-ward to enclose the body. Since the ribs do not surround the body to attach to the middle of the chest, there is no breastbone.

Second, the shoulder girdle becomes associated with the bottom shell (plastron). Parts of the shoulder girdle which are formed from dermal bone actually become incorporated into the plastron. Both these developments confirm the importance of the specialization for external armor in the development of the rib-shoulder relationship.

When the carapace is formed, its embryonic model (anlage) begins as a narrow band of tissue running down the middle of the animal's back. The rib models are short and very strongly associated with the carapace even at this early stage (embryo length: 9.6 mm). Over the next few stages, the shell development dominates body growth, and the whole embryo becomes wide and shallow. The narrow band expands, and the developing carapace carries the ribs with it.

At this stage the "collarbones," also a part of the shoulder girdle, are strongly associated with the developing plastron. Soon (when the embryo reaches 11 mm in length) the collar bones are completely contained within the plastron, and the bony shields of both shells begin to harden. In short, the shoulder girdle does not change its position. The ribs become fused to the shell and are carried outward during the course of development.

The ribs and the limb bones are formed as models in cartilage before being replaced by calcified tissue which later becomes bone. This type of bone is called *replacement bone*, since cartilage models are replaced by bony tissue.

The bony shields of the turtle shell form directly in the skin without being formed first in cartilage. It belongs in the category of *dermal* or *membrane bone*, and it is prominent in fishes and early land animals. The collar bones are dermal bone and are incorporated into the plastron during development. This close association between developing plastral bone and conservative reptile dermal elements in the abdomen and chest skeleton is common among reptiles (Zangrel, 1969). In turtles with reduced shells, the plastra are not platelike. They are rodlike and are distributed in a pattern similar to the pattern of dermal bone in the abdomen and chest of ancient reptiles.

The development of the turtle shell accounts for most of the unique features of these animals. The basis of the turtle adaptive shift is the development of the body armor. The primacy of the shell in development confirms its importance as a basic feature of turtle adaptation. Yet, except for the incorporation of certain bones into the shell, other aspects of turtle development follow the general reptilian pattern, as Carr states.

The embryonic development of the turtle tells us many things. First, the "unusual" features arise from a very ordinary reptilian embryo. Shared ancestry with other reptiles is confirmed. The structural similarities between turtles and other reptiles are great indeed.

Second, the developmental changes involved are simple. The timing and intensity of the outward growth of the embryonic structures are altered. This occurs at a time before muscle attachments have formed, avoiding problems for limb function at a later stage. The rib cage alters *its* position, but the shoulder girdle develops as usual for a reptile. Similarity of form is maintained. A plausible evolutionary pathway exists: enclose a reptile in a shell of dermal bone and horny scales.

The Form of the Shoulder Girdle

In land animals that walk on all fours, the shoulder girdle consists of a combination of bone and muscle which provides the strength for movement and support. In the earliest land animals, the bones of the shoulder girdle formed a robust

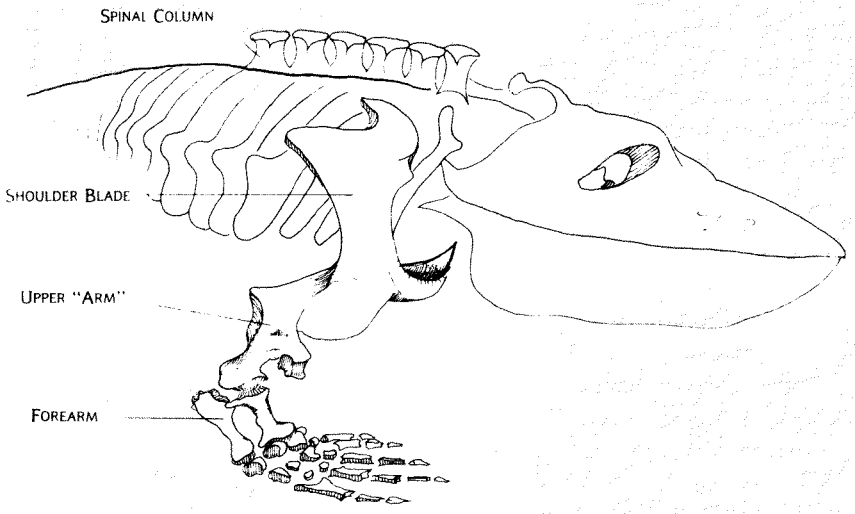

FIGURE 1. *Eryops megacephalus*, an early land animal that has typically short ribs which do not enclose the body. The shoulder girdle is a basin of heavy bone set very close to the animal's head. Without a great deal of competition on the land, the biggest problem for *Eryops* to solve is that of a stable support for its large body and heavy head.

basin on which the body rested (see Figure 1). In modern mammals, much of the support is provided by a muscular sling from which the body is suspended (see Figure 2).

The differences between these two ways of supporting the body are similar to the differences between a hammock and an army cot. A hammock resembles the muscular sling used by land mammals. The supporting columns are spaced off to the sides, and the weight they support is suspended on a flexible material stretched between them. This makes the whole structure light and easy to move.

The army cot approach is more common among reptiles—especially the earliest land animals. The support columns are connected to a sturdy frame which is directly underneath the weight they support. The same sort of flexible material is used, but it is stretched taut over the frame. The main task of support falls to the frame itself. This makes the whole structure very strong and stable but heavy and more difficult to move.

These differences may be seen in Figures 2 and 3, which are drawn from models of cat and turtle shoulder girdles, respectively. In the cat, mobility is favored over stability in the shoulder girdle. The animal is able to move, change directions, and adjust quickly to changes in terrain. In the turtle, stability and strength are emphasized. The protection offered by a strong armor is the key to its success. The bones of its shoulder girdle can be compared with those of the ancient land animal in Figure 1.

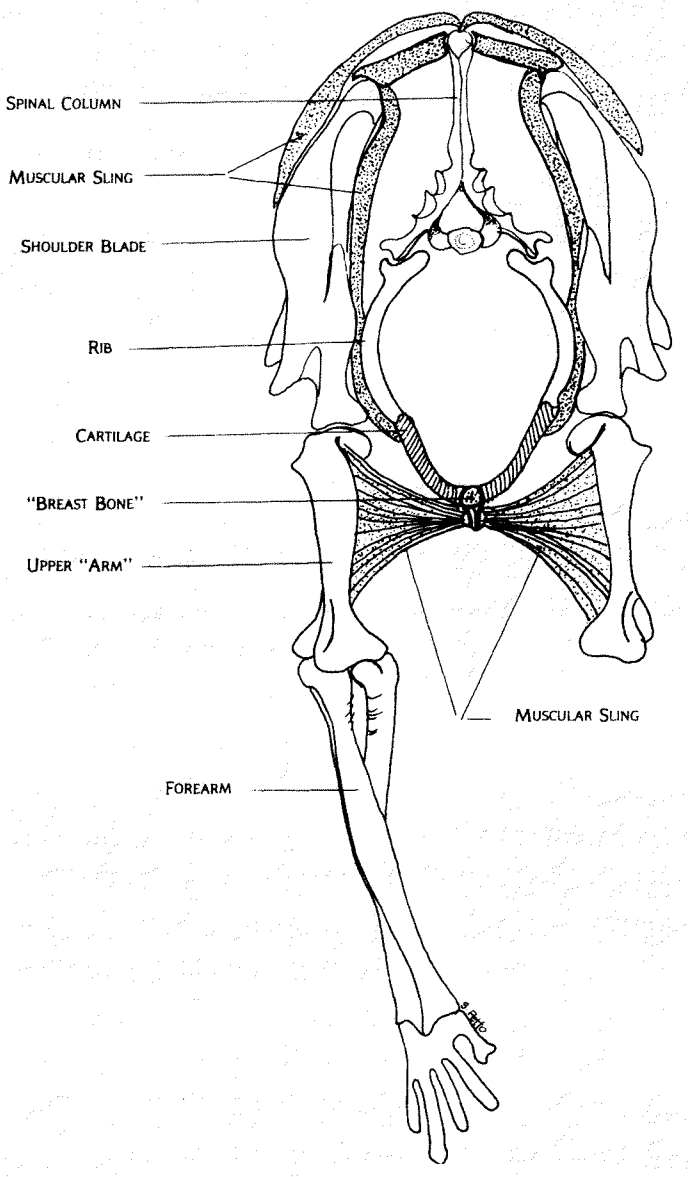

FIGURE 2. Front view of *Felis domestica*, the house cat, shows the general relationship between the shoulder girdle and forelimb for running mammals. The ribs extend most of the way to the belly and are connected by cartilage to the breast bone. The shoulder blades are connected to this bone on each side by a combination of relatively reduced collar bones and a sling of muscles and connective tissue. This arrangement makes the whole complex light and manueverable. This is important for an animal which hunts active prey and performs a lot of different locomotive activities such as running, jumping, and climbing.

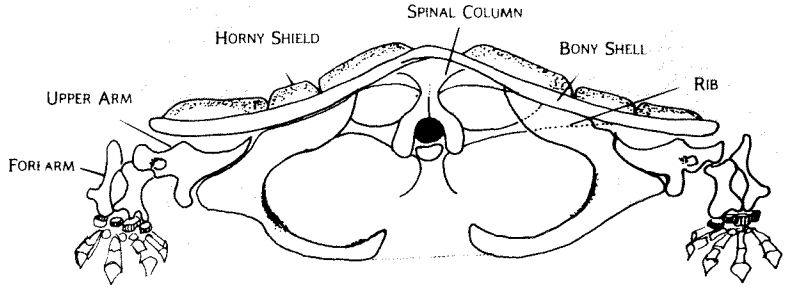

FIGURE 3. Front view based upon the skeleton of *Chelydra*, the snapping turtle. Shows the basinlike shoulder girdle typical among primitive land animals. The space between the two girdles in the bottom shell is where the two join with the bones of the lower shell. Since the shell provides protection and hunting strategy differs from that of the running animals, the main problem is again that of strong support of the heavy body and stability.

The shoulder girdles in Figures 1 and 3 are very similar—robust, bony basins. There is still one question left unanswered, however. Davidheiser still wants to know "how they managed to get their shoulder bones inside their rib cages" (p. 246). To answer this question, it is important to ask what the ribs have to do with the shoulder girdle. Let us start by asking what it is the ribs do.

The functional relationship between the ribs and the shoulder girdle varies. In land animals, ribs give support and maintain the form of the trunk and "afford attachments for axial skeletal muscles," that is, muscles of the trunk (Romer, 1956, p. 56). Some muscles of the shoulder girdle do attach to the ribs. Their function is to hold the "shoulder blade" in place while other muscles move other bones in the forelimb. These forelimb movements are performed mainly by muscles which connect the bones of the forelimb to other bones in the shoulder girdle or to the spinal column.

The ribs are not necessary for the functioning of the shoulder girdle, except that they give the body its form. They are convenient to the shoulder girdle in many modern land animals, but in the fishes and the earliest land animals the shoulder girdle was associated with the dermal bone of the skull.

The shoulder girdle and the ribs form two separate sets of bone and muscle systems. The shoulder girdle is for support and locomotion. The ribs are for form, support, and attachment of trunk musculature. The normal course of reptilian development confirms this separation. The trunk skeleton forms on the "back" section of the embryo, and the shoulder girdle develops on the belly side. Turtles follow this reptilian pattern, too.

Despite the noticeable change in form, the way that the ribs and shoulder girdle function and their operational relationship to each other are essentially unchanged in the turtle. Their relative locations are changed, but this is not significant from a functional standpoint. We are led to the conclusion that the second

creationist objection, concerning shared ancestry, is not supported by the course of development of the turtle embryo *or* by the mechanics of the trunk muscle-ribs and shoulder girdle functional complexes.

Turtle Phylogeny

The study of turtle embryology demonstrated the process by which a seemingly unusual adult form is produced. Carr's question about the set of conditions which would favor the development of an external shield remains with us, however. What evidence is there for the potential among reptiles to shield their bodies with hard tissues in the skin?

Turtles are covered with a shell of bone. It is the most prominent part of their anatomy to even casual observers. A more careful examination reveals a covering of horn or keratin covering the bony shell. Keratin is a hard substance that forms our finger nails and hair and the claws, horns, and spikes of many other animals. One of the most important of reptile adaptations was the development of this horny layer around the outside of the body. Keratin prevented extreme water loss, and it allowed reptiles to live in more places on the land—much farther from water than the amphibians could travel.

L. B. Halstead reports not only that keratin is a typical covering for reptiles but that some develop small plates of bone deeper in the skin. He goes on to say that the so-called hard keratin of nails, claws, and horn is readily calcified. Adding calcium to keratin makes the tissue harder and stronger but does *not* produce bone. A body covering of even hard keratin is not likely to be preserved in the fossil record, because its chemical composition and properties are very different from the more frequently preserved hard tissues of bone and teeth.

Whether or not it was calcified to some degree, a hard, external armor made up of horny plates could easily have been the basis of an adaptive shift. Such shields are common among reptiles. The later development of bony armor which *could* be preserved in the fossil record is also not unusual for reptiles. Halstead leads us to the conclusion that it is chiefly the *extent* of the development of dermal bone in the skin which distinguishes the turtle from its reptilian relatives. The fact that this dermal bone forms in the skin without a cartilage model makes it precisely the sort of bony shield evolutionary biologists would predict for a reptile committed to enclosing itself in armor. The fact that it forms dirctly in the skin accounts for its location outside the limb bones.

The reduction of the rib skeleton is also to be expected under these conditions. The shell, once it became complete, would provide form and support for the body. The ribs would not be necessary for this function, and the muscles which move the trunk could attach themselves to the bony shield. In fact, the turtle's ribs do not disappear but become incorporated into the shell. Since the

shell is outside the body, the ribs are too.

The studies of embryology show the importance of the shell in the turtle's development and confirms its central role in the turtle's adaptation to its environment (Romer, 1924, 1956; Walker, 1947, 1969). Despite this drastic change of emphasis, Walker (1947) and Zangerl (1969) reiterate that the turtle is a "good" reptile—that is, development and basic structure remain conservative for this class of animals.

A plausible way to develop a turtle from a basic reptilian ancestor has been proposed. It is plausible because it relies on structures and developmental processes which we can observe in living animals and because it is based upon the natural laws which we have observed operating in so many other cases. No new or special mechanism is necessary to explain the result.

Summary and Conclusion

Turtles that are related to other reptiles by a common ancestor should have the following features in common with other reptiles: (1) the form and function of the structures should be developed on the same basic plan; (2) structural modifications should be derived from known anatomical features in the ancestral form; (3) the derivation should be accomplished by means of processes known to exist among the relatives.

Examining these three points for the turtle, we see that all three conditions are satisfied. The function and form of the shoulder girdle of the turtle follow the basic reptilian plan. The dermal bone in the girdle becomes a part of the dermal bone of the lower shell. No new or unique elements appear in the turtle shoulder girdle that distinguishes turtles from primitive reptiles found earlier than the Triassic (195–225 million years ago), according to Romer and Carroll.

The form and function of the turtle ribs are modified by their attachment to the carapace. Some trunk muscles still attach to the ribs, but the function of giving support and shape to the body is yielded to the shell. The ribs fuse with the shell on the back in the same way that the elements of the shoulder girdle fuse with the lower shell.

The processes which might explain the shift toward external armor are present in varying degrees among close relatives. The outermost layer of horn is one of the features that distinguishes *all* reptiles from their ancestors, the amphibians, and fishes. External armor from horn, calcified keratin, and dermal bone are common among the reptilian relatives proposed for the turtle. The turtle needs no new processes or structures. It uses its existing potential for bodily shields.

Studies of development (ontogeny), evolutionary history and relationships (phylogeny), and functional analysis combine to support a common ancestry of turtles with other reptiles, functional similarity of turtles with other reptiles, and a

plausible evolutionary pathway from generalized reptile to a specialized turtle. Rather than posing a dilemma for the evolutionary biologist, the turtle is a prime example of how a commitment to a new adaptive strategy can have a far-reaching impact upon a whole lineage of animals.

No special creation is needed to explain this accomplishment, however. Only a shift in developmental processes to accommodate a commitment to external armor is needed. There is no fundamental reorganization of form or function which is not associated with the development of the turtle's shell.

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Censorship of Evolution in Texas

Steven Schafersman

Recent textbook adoptions by the Texas State Textbook Committee continue the state's suppression of the topic of evolution in science textbooks. On September 8, 1982, the Textbook Committee refused to adopt the top-rated world geography textbook, *Land and People* (Scott, Foresman, and Co.), because it contained the following sentence: "Biologists believe that human beings, as members of the animal kingdom, have adjusted to their environment through biological adaptation." The book also contained many passages stating that the earth and its features were millions of years old and that the universe began as stated by the Big Bang theory. These items were heavily criticized by a religious fundamentalist and creationist husband-and-wife team, Mel and Norma Gabler of Longview, Texas, whose sole business is reviewing textbooks. The Gablers are known in education circles throughout the nation as the most effective textbook censors in the country. This couple has been promoting their narrow fundamentalist views for over twenty years by criticizing and influencing the removal of textbooks that contain material opposed to their views. Some of the Gablers' objections to the Scott, Foresman world geography textbook were that "most people do not consider themselves animals," that "many people, including scientists, do not believe the earth is millions of years old," and that "the text is biased in favor of evolution. By not including other theories, the text implies that evolution is the only credible one. . . . Many people, including scientists, believe that the mammals were created, not 'developed.' . . . The text contains evolutionary speculations presented as fact [and] violates [Section] 1.3 of the [Texas Textbook] Proclamation."

During the Textbook Committee's discussion, two members spoke against the book, claiming it overemphasized the Big Bang theory and the theory of evolution and violated the proclamation dealing with evolution. Mr. Noon, from Longview, obviously motivated by the criticisms of the Gablers, said that the book was the most "controversial" book on the entire list and that "we will be in trouble all around Texas if we put it on the [adoption] list." Because of the attack by religious fundamentalists, the book failed to be adopted, despite its high quality.

Other world geography textbooks, all adopted, were mostly inferior to the Scott, Foresman book, but they did not make the "mistake" of saying something

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about evolution and the Big Bang theory. Michael Hudson, Texas coordinator of People for the American Way, was present at the Textbook Committee meeting and made the following observation: "It seemed apparent to all in the room—especially the publishers—that the treatment of evolution had condemned an otherwise excellent book to be the sole casualty of the seven books that were bid."

The Texas Textbook Proclamation contains the rules that textbooks must follow if they are to be adopted by the state of Texas. Texas is the second largest purchaser of textbooks in the country. Its centralized book-buying policy controls 8 percent of the total school textbook market in America, and it spends $60 million a year to buy textbooks for Texas's 1,150 school districts. Since only a few titles of each subject are selected at six-year intervals, publishers vie ferociously to get their textbooks on the adoption list, and, since the Texas adoption choices can make or break a publisher, the publishers bend over backwards to comply with the Proclamation. Furthermore, the textbook designed for the lucrative Texas market is used throughout the country, so the enormous economic influence of Texas shapes the contents of America's textbooks. Concerning evolution, the only scientific topic that Texas feels compelled to regulate at present, the Proclamation states the following:

> 1.3 Textbooks that treat the theory of evolution should identify it as only one of several explanations of the origins of humankind and avoid limiting young people in their search for meanings of their human existence.
>
> (1) Textbooks presented for adoption which treat the subject of evolution substantively in explaining the historical origins of humankind shall be edited, if necessary, to clarify that the treatment is theoretical rather than factually verifiable. Furthermore, each textbook must carry a statement on an introductory page that any material on evolution included in the book is clearly presented as theory rather than fact.
>
> (2) Textbooks presented for adoption which do not treat evolution substantively as an instructional topic but make reference to evolution, indirectly or by implication, must be modified, if necessary, to ensure that the reference is clearly to a theory and not a verified fact. These books will not need to carry a statement on the introductory page.
>
> (3) The presentation of the theory of evolution should be done in a manner which is not detrimental to other theories of origin.

My discussions with some of the state Board of Education members who were responsible for writing and passing Section 1.3 have convinced me that it was promulgated primarily for religious reasons and is hence a violation of the principle of church-state separation. For example, former board member Johnnie

Marie Grimes believes that evolution is "a powerful force against the spiritual dimension of man" and that, if we teach it as a demonstrated scientific fact, then our public schools will be a "barrier" to the Christian and Jewish religions. Board member William Kemp calls scientists "narrow-minded and bigoted" for preferring to believe in evolution rather than creationism. He made these remarks to me when I suggested that Section 1.3 was a misrepresentation of science. He then told me, "You will only get something worse if you try to change the current regulation." Board chairperson Joe Kelly Butler says that scientific knowledge consists of just the "opinions" of scientists and that such opinions are "irrelevant" to how the state board should treat the topic of evolution. He maintains that the present policy is "about as good as we can do." Butler was not interested in a statement signed by scientists that protested Section 1.3; he said that the "opinion" of scientists would not change his mind. It is possible, however, that a statement signed by the regents of the University of Texas and Rice University against the Proclamation might cause him to alter his view. Presumably, the other board members share these fundamentalist anti-scientific sentiments.

The history of the adoption of Section 1.3 provides the most important evidence for the religious intent behind the Proclamation. Section 1.3 was adopted largely in its present form at the urging of Mel and Norma Gabler. In their letter to the Commissioner of Education, dated August 10, 1973, the Gablers protested the teaching of evolution in the state's schools. They complained that the biology textbooks taught evolution as a fact, not a theory, and omitted any reference to creation. They asserted that:

> Textbooks completely censor the fact that there is *more* scientific evidence *against* than *for* evolution. *This denies students their academic freedom to learn.* . . . Strictly speaking, evolution is not a science because it cannot be proven—it must be accepted on *faith* as a philosophy or as a religion. . . . Textbooks include evolutionary *dogma* with none of the important evidence for special creation. *Why?* . . . At present all evidence and assumptions are directed toward evolution being the only explanation for life. But the theory of special creation is just as scientific and requires equal treatment. . . . *Either* include equal space for scientific evidence *for* special creation *or* delete all evolutionary dogma!

The Gabler letter ironically justified their demand for equal time by asking for "fairness and objectivity" and for teaching "all the facts" about evolution, including "all the bad" facts. This justification directly conflicts with all the well-known Gabler demands to remove the "bad" from textbooks dealing with other topics and present only the viewpoint favorable to the desires of the Gablers. Perhaps the most ironic example of this in their letter is their analogy of the treatment of evolution and the history of the United States. It states:

> We're often told that students must be given the bad about our country, so let's do the same about evolution and discontinue the present *double standard*. . . . Supposedly, students who reach college without having been told "all the bad" about our country are so disillusioned to find the "truth" that their confidence is shaken. Let's begin telling them "all the bad" about evolution if we want to be fair.

During the August 1982 textbook adoption hearing, the Gablers objected to a Scott, Foresman civics text because it presented the United States "in a bad light, criticizing the American system and slighting American achievement." If the Gablers opinion about fair play and equal time for topics in American history has changed during the past nine years, why hasn't it changed for topics in biology as well?

Also, in their letter, the Gablers say, "Let's practice what had been told us for years: Students have the right to know the truth even if we don't agree with what they are taught." If the Gablers truly believe this, they would have retired from their textbook protesting business in 1973.

The Gablers' letter was convincing enough to the state Board of Education that they adopted on May 11, 1974, what is now Section 1.3 of the Proclamation. Although the Gablers had asked that either equal space for scientific creation be included in textbooks or evolutionary dogma be deleted, the state board found that, because of prior court decisions, they couldn't do this. Therefore, the current wording was chosen by the Priorities Committee to come as close as possible to the demands of the Gablers without violating, in their estimation, case law. The official state Board of Education minutes for May 1974 reported that, because of the changes in the 1974 Textbook Proclamation, Mrs. Mel Gabler "had withdrawn the complaint" and the new policy "was satisfactory to the Gablers." Paragraph (3) of Section 1.3 was added to the Proclamation in 1977 by William Kemp. Why this was thought necessary is not known, but Kemp's well-known anti-evolution prejudices suggest that he thought a further inhibiting factor was necessary to ensure that public school students were protected from the pernicious dogma of evolution.

The impact on textbooks of the Gablers' complaint and the Texas Board of Education's action was dramatic. The post-Sputnik increase in the quality of the biology textbooks was halted and reversed in 1974. Since then, many biology textbooks have been revised to reduce the amount of space devoted to evolution and to present the subject in more tentative terms. Almost all pre-college science textbooks preface any sentence mentioning evolution with the words "scientists believe" (this is the least objectionable way to make a statement theoretical rather than factual). The word *evolution* is rarely used today; euphemisms are employed, such as *adaptation, development*, or simply *change*. The 1977 edition of Otto and Towle's Modern Biology reduced word coverage of evolution by a third over the 1973 edition. Several texts mention creation, such as textbooks by

Smallwood and Green, Houghton Mifflin, Prentice-Hall, and Burgess Publishing Company, without characterizing it as a supernatural explanation that is outside the domain of science. An executive with Doubleday's Laidlaw Brothers asserted, "You're not going to find the word *evolution* in our new biology textbook. The reason for self-censorship is to avoid the publicity that would be involved in a controversy over a textbook. We'd like to sell thousands of copies." Many editors admit that they try to satisfy both the scientific and creationist camps, a seemingly impossible task. Editors today may rewrite biology and geology textbooks to suppress the evolution content, sometimes over the authors' objections. An example of this is Houghton Mifflin's *Investigating the Earth*, a team-written textbook sponsored by the American Geological Institute. Some biology textbook writers have received letters from their publishers asking them to leave the topic of evolution out of their books.

All of these science textbooks are being used throughout the country, and all are written to conform to the Texas Textbook Proclamation. Since publishers have written their pre-college science textbooks to comply with the Texas Proclamation, the educational results have been uniformly regrettable. Textbooks include equivocations and misrepresentations about evolution, have reduced coverage of this established theory to a couple of pages or nothing, omit any connection between evolution and other biological phenomena, and even include pro-creationist statements. The result has been that high school graduates have received a censored, second-rate biology education in most schools in the country and will continue to do so until this Proclamation is repealed.

News Briefs

New Trouble in Arkansas

When the Arkansas legislative session opens in January, there may be a new creation bill for legislators to consider. Arkansas Citizens for Balanced Education in Origins is behind a proposed new law to be entitled "The Thorough Explanation of Origins and Development in Textbooks Act." The stated intent of the measure is to "require complete, but reasonable, disclosure" of which assumptions are testable and which are not when textbooks present scientific data about origins. This is allegedly necessary because students need to know what assumptions underlie the data presented and the state needs to ensure "that education is maximized and indoctrination is minimized."

The bill's spokespersons—Ed Gran, a physics instructor at the University of Arkansas at Little Rock, and Malcolm Windsor, an engineer at the Pine Bluff Arsenal, offered a sample of how they felt the law would affect textbook material. This sample quoted a textbook's account of Stanley Miller's 1953 experiment that produced amino acids from elements that may have been present on the primitive earth. The law would require that the textbook explain that the experiment assumed a reducing atmosphere, assumed the formation of DNA in the experiment, and assumed negligible effects from such factors as low amino acid concentration, low temperature formation, high destruction rates, and so on.

The tenor of this sample shows three things. First, it shows that creationists hope to drown any textbook evolutionary explanation in a flood of qualifications; they want to list every *caveat* they can think of. Second, it shows that creationists want to get equal time for their favorite anti-evolution arguments, most likely those arguments that say radiometric dating is based on unproven premises, that rocks date fossils and fossils date rocks and hence the geologic column is based on circular reasoning, and that all studies of origins are untestable and therefore unscientific. Third, it shows that, if creationists in Arkansas cannot get publishers to produce textbooks that meet their rigid specifications, the state simply won't buy any textbooks that mention the subject.

This latter point is crucial. The bill would, if passed, effectively ban all existing public school science textbooks that treat evolution. None meet these extreme requirements. Without textbooks, evolution would likely not be covered to any extent. Thus, by binding up the textbook selection process in red tape greater than that in Texas, evolution would be effectively banned from Arkansas public schools. Section three of the bill makes this clear when it states that textbooks are not required to present any information about origins and the development of the universe and life.

The Louisiana Case

The U.S. District judge in New Orleans struck down the Louisiana creation law on November 22, 1982, in response to a motion for summary judgment entered by the state board of elementary and secondary education. The board argued that the creation law violated the *state* constitution by allowing the legislature to set curriculum independent of the board. The creationists plan to appeal the ruling.

Liberty Baptist Students Gain Certification

On April 8, 1982, a Virginia State Board of Education teachers' visiting committee approved biology graduates of Jerry Falwell's Liberty Baptist College for certification as Virginia public school teachers. However, this caused a furor when Falwell announced that his graduates would be teaching creationism. So on May 21, the Board of Education teachers' advisory committee voted unanimously to deny teacher certification to the graduates. This brought the matter to the full board in July. At the July meeting, it was decided that Liberty Baptist College officials should answer a list of thirty questions regarding church-state issues raised by the school's practice of teaching and advocating creationism. The questions were answered, and the results were then brought before the board on September 24.

There Judy Goldberg, lobbyist for the ACLU, argued against the certification, and Jerry Falwell argued for it. Falwell charged the ACLU with being a defender of Nazis in Illinois and an enemy of religious freedom in Virginia. He referred to himself as a victim of a "Scopes trial in reverse." Ms. Goldberg said that the new evidence presented by the college in answer to the thirty questions shows that the college changes its story whenever objections are raised. After this confrontation, the board split four to four on certification, resulting in no decision being made.

But on December 10 the board took up the matter again, this time with all members present. The vote was seven to two in favor of certification. This means that Liberty Baptist College graduates are now authorized to teach in Virginia and in thirty-five other states that recognize Virginia certification. The board will review its decision in one year.

New York City Reverses Trend

In an unprecedented action, the New York City Board of Education recently declared three science textbooks unacceptable because of inadequate coverage of evolution, presentation of creationism as science, or both. The books were *Life*

Science from Prentice-Hall, *Experience in Biology* from Laidlaw, and *Natural Science: Bridging the Gap* from Burgess.

Carol Brownell, a spokesperson for the board, said, "The professionals came down on the side that you cannot exclude the discussion of Darwin's theory. They feel the theory of evolution is firmly established in science and has to be acknowledged." This decision could encourage similar decisions elsewhere.

Iowa Embroiled Again

Iowa continues to be a target for creationist efforts. This summer an intense, well-bankrolled, statewide creationist effort got underway. The campaign involves three thrusts: (1) threatening with lawsuits school districts or individual teachers who teach evolution, (2) petitioning school boards to hold referenda on adding a list of fifteen creationist books to every school library, and (3) persuading school districts to purchase a creationist videotape entitled *The Timeless Issue of Life: Creation or Evolution*. So far, due to the grass-roots efforts of the Iowa Committee of Correspondence and allied groups, every creationist effort has been blocked.

Irwin Sinks His Teeth into Ararat

In August, former astronaut James Irwin led an expedition up Mt. Ararat in search of Noah's ark. This expedition, financed by his own evangelical foundation based in Colorado, found "solid evidence" of the ship's presence on the mountain. The climbers, however, have been secretive about the facts but plan to announce "important findings on the interstructural formation of the mountain in the near future," as if that was what the world was waiting to know. The expedition would have lasted longer than it did had Irwin not fallen from an ice ridge and lost all but three of his teeth. However, after the expedition was discontinued, Irwin and Lt. Orhan Baser of the Turkish army stayed behind to take a final aerial look at the northwest side of the mountain where "pure and solid proof" of the ark's existence was supposedly found. No more reports were made after that until Irwin conducted a second expedition up the north*east* side of the mountain, following up on a recent "sighting" by Dennis Burchett. Apparently nothing was found, because, after Irwin returned home, he indicated to *Maclean's* magazine that he was still in pursuit of "a dark, promising object" on the northeast side of the mountain. "We know the ark is there," he declared, but he offered no solid evidence.

Another "Ark" Expedition

A self-styled explorer, Tom Crotser, of the Institute for Restoring Ancient History, says that he and others have found the Ark of the Covenant, allegedly buried by Moses, and has been asking financial support for an expedition to retrieve it. The Institute claims a considerable track record in finding biblical remains. In recent years, they allegedly uncovered Noah's ark and discovered the site of the Tower of Babel. London banker David Rothschild was approached for possible backing of the Ark of the Covenant venture but declared Crotser's effort to be a "pure joke." Nevertheless, Crotser declares that his team discovered it on October 31, 1981. After examining the Bible, they concentrated on a peak near Mount Nebo in northwest Jordan. There Crotser's team found the Ark but did not move or open it, lest they incur the wrath of God. The Ark supposedly contains Aaron's budding rod, the tablets of the Ten Commandments, and other important things these "raiders of the lost Ark" are eager to acquire.

Startling Gallup Poll

According to a recent Gallup survey, 44 percent of the respondents agreed with the statement, "God created man pretty much in his present form at one time within the last ten thousand years." Thirty-eight percent agreed that "man has developed over millions of years from less-advanced forms of life, but God guided this process, including man's creation." Only 9 percent held that "man has developed over millions of years from less-advanced forms of life. God had no part in this process." Another 9 percent said they didn't know or gave other responses.

This is the first time an accurate survey has been made of creation belief in America. Usually the questions are phrased wrong and leave out the true nature of the issue at hand. This one did not. However, it is important to understand that creation belief does not imply a desire for creationism in the public schools. Not all creationists want "equal time" or feel that the public schools offer an appropriate setting. Some creationists believe that reducing their theism to a "mere scientific theory" does it an injustice. This is why the survey results, on the question concerning which account of origins should be taught in the public schools, came out a little different. Thirty-eight percent felt that creationism should be taught, 33 percent felt that evolution with God should be taught, and 9 percent thought that evolution without God should be taught. None were asked if all three should be taught, so it is hard to decide what these results mean. We don't know how many of the 38 percent favoring creationism wanted "equal time" and how many wanted creationism exclusively. The4 percent who said that they favored all three views being taught *volunteered* that opinion.

Book Reviews

H. James Birx

Darwin edited by Professor Philip Appleman (New York: W. W. Norton, 1979)

In the flood of recent books on the theory of evolution, the revised and updated second edition of *Darwin*, edited by Professor Philip Appleman, remains an outstanding introduction to the breadth and depth of thought on this timely subject. This now classic work surveys the relevant evolutionary literature from the scientific opinions of the nineteenth century (for example, Lyell, Hooker, and Huxley) and includes crucial selections from Darwin's *On the Origin of Species* and *The Descent of Man* to the more recent views and reactions concerning evolution in sociology, modern philosophy, process theology, and the literature of this century.

As such, Appleman's *Darwin* is a must for all enlightened readers who wish to obtain a comprehensive understanding of the historical development and impact of the evolutionary framework on the modern worldview. It is a rich, unique, and indispensable source of facts and ideas surrounding the issues of evolutionary thought. In my opinion, no other single book accomplishes this needed task.

For this new edition, Appleman has wisely included sections representative of the latest advances in evolutionary theory and the special sciences: Wilson on sociobiology, Lorenz on ethology and aggression, Leakey on human evolution, Wade on recombinant DNA research, Mead on the process of cultural development, and Gould on the issue of potentiality and determinism in modern biology. Even a selection from the writings of Carl Sagan is included to encompass the emerging science of exobiology.

The writings of Dewey, Randal, and Teilhard de Chardin represent the philosophical and religious views on the subject of evolution. Of particular importance is the attention given to the ongoing creation-evolution controversy.

This volume clearly demonstrates Darwin's influence on seven areas of modern research: evolutionary mechanisms, fossil humans, genetics, society, primate behavior, and the emergence of human intelligence.

In his brilliant epilogue and postscript (pp. 521–571), Appleman has

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authored two essays which defend the modern synthesis—or neo-Darwinism. He emphasizes the need for more science and free inquiry within a naturalist and humanist perspective. Special attention is paid to Darwin among the moralists.

Darwin remains significant to a proper conception of humankind's place within natural history. This important book is of great value to the student, teacher, scholar, and general reader. Extensive footnotes, selective readings, and an index are provided.

Darwin for Beginners by Jonathan Miller (New York: Pantheon Books, 1982)

In the paperback, *Darwin for Beginners*, the talented author, Jonathan Miller, has written a very informative and unusually delightful introduction to the life and thought of Charles Darwin without distorting the facts and controversies surrounding him. With remarkable clarity and attention to detail, Miller shows the awakening of the idea of evolution in the mind of the young naturalist. He points out that the theories of Lyell in historical geology and Malthus in population studies played key roles in Darwin's recognition of the truth of evolution and his subsequent discovery of the principle of natural selection. Miller also shows how the unique experiences and evidence amassed during the global voyage of the H.M.S. *Beagle* (particularly, its five-week visit to the Galapagos Islands in 1835) were likewise crucial to shifting Darwin's interest from geology to biology and his worldview from the acceptance of special creation to "descent through modification."

Miller does not neglect to present the conservative, religious, and sociopolitical environment of the time, especially the emergence of the creation-evolution controversy, best represented in the 1860 debate at Oxford University between paleontologist Thomas Huxley ("Darwin's Bulldog") and Bishop Samuel Wilberforce ("Soapy Sam"); the former defended evolution in terms of science and reason, while the latter unfortunately misrepresented the facts and misinterpreted the theory. To the reader, it is not surprising that Charles Darwin had hesitated to publish his major work, *On the Origin of Species* (1859), for a period of twenty years and then even delayed the appearance of *The Descent of Man* (1871) for over a decade, understanding the great furor his ideas would cause.

This excellent book places Charles Darwin within the nineteenth century, with the final pages devoted to the synthetic theory of evolution in our century and the most recent advances in population genetics. It is profusely illustrated by Borin van Loon, whose excellent drawings are both informative and clever but never distasteful. As an introduction to Darwin and evolution, this little book is of much value.

Life Itself: Its Origin and Nature by Francis Crick (New York: W. W. Norton, 1981)

Life Itself: Its Origin and Nature is a recent and challenging book about evolution written by Francis Crick, codiscoverer with James D. Watson of the double helix structure of the DNA molecule. Nobel laureate and biologist Crick has written an informative and provocative work that boldly presents an unorthodox speculation to account for the first appearance of organic objects on this planet several billion years ago. This book proposes the hypothesis of directed panspermia, an intriguing idea first developed by Crick and Leslie E. Orgel in a joint paper published in the space journal, *Icarus* (1973).

From Aristarchus of antiquity to S. A. Arrhenius in the nineteenth century and J. B. S. Haldane in 1954, some thinkers have maintained the existence of cosmic seeds or spores which have originated elsewhere in outer space but then drifted to earth and started life as we know it on our own planet. Crick explores nature from the submicroscopic world of atoms and molecules to the vast panorama of this galaxy and the universe (that is, from the primeval big bang to human consciousness of today). He seriously offers a variant of the panspermia hypothesis: the evolution of life on this planet began only after an unmanned alien rocket carrying microorganisms (bacteria) from another world in this Milky Way Galaxy was deliberately sent by intelligent beings into deep space billions of years ago and landed in or near the life-sustaining waters of our earth. Crick's directed panspermia hypothesis assumes that there have been intelligent beings in our galaxy and that the astonishing biochemical unity of all complex life on earth, from amoebas and cilicates to plants and animals, is due to a common source such as simple bacteria of celestial origin.

Crick emphasizes the awesome age (perhaps twenty billion years), unimaginable size, and essential emptiness of the material universe. Likewise, he presents those steady physical conditions necessary for primitive living things as we now know them to survive and thrive on a planet: free energy from sunlight, liquid water on the planet's surface, a gaseous atmosphere (made up of simple compounds of hydrogen, nitrogen, oxygen, phosphorus, sulphur, and especially carbon), and a suitable gravity and temperature.

Crick's plausible notion does not actually account for (but merely assumes) the prebiotic origin of life from nonlife somewhere in our galaxy. Nevertheless, it is very unlikely that such an aimless life-carrying spaceship would ever land on earth about four billion years ago at just the right time and in a suitable location to favor the survival of its organic visitors. This viewpoint does, however, raise important questions. Did life first appear here on earth or elsewhere in the cosmos? Is the origin of life an extremely rare event or an almost certain occurrence? Did the nucleic acid emerge first as the DNA molecule, the RNA molecule, or as a simple protein? Or did they all evolve together?

Finally, more or less reversing his own hypothesis, Crick envisions humans

seeding the universe with life (bacteria, of course) and warns that the process should proceed slowly and wisely: we should not take lightly the contamination of our galaxy. One quickly enters the area of cosmic ethics.

Life Itself does give an alternative explanation for the origin of living things from nonlife and, as such, offers some answers to those questions raised by the fundamentalist creationists. First, from a scientific perspective, Crick's book shows that an evolutionary origin of life (even if as improbable as creationists say) only needed to occur once in the universe to eventually spread throughout the cosmos. Second, the book shows that, if there are problems with demonstrating how life on earth could arise by chance within a naturalistic framework (perhaps because our planet is not old enough), the directed panspermia hypothesis offers a possible solution. Third, if we must posit a humanlike "creator" to account for life on earth, there is no reason such a creator could not have been an alien civilization rather than a supernatural being. In short, this book will make enjoyable reading for speculative scientists and any budding panspermists.

Letters to the Editor

As Stephen Brush noted in *Creation/Evolution* VIII, creationists cite the philosophical and religious views of famous scientists such as Kepler, Newton, Bacon, and Kelvin to somehow justify their supernaturalistic approach. Their implication seems to be that the scientific credibility and fame of men such as these are linked to their supernaturalistic views, as varied as these views may have been. I am amazed that creationists would use such a weak and groundless justification for supernaturalism and, therefore, creationism. I would like to add my own comments.

Where is the supernaturalism in Kepler's three laws of planetary motion, in Newton's three laws of motion, in Bacon's inductive method of experimentation, or in Kelvin's thermodynamics? Independent of whether scientists have taken a naturalistic approach or a supernaturalistic approach (or any other approach for that matter, as I think creationists are being far too reductionist to restrict the number to two—what about theistic evolution, for example?), their contributions to science are weighed only by the contributions' correlations with nature, with the real world. Their contributions stand on their own scientific merit—not on revelation, religious belief, clerical or secular authority, or personal world-

views. If Kepler's theistic views on origins can be justified by his laws, then logically so could his Pythagorean mysticism and his pagan feelings about heliocentricity; if Newton's views on a supernaturalistic origin of the world can be justified by his mechanics, then logically so could his Arian views on Christianity; or if Kelvin's skepticism about the long age of the sun could be justified by his work in thermal physics, then logically so could his calculation that man-made machines could not fly. Scientific theories in all fields exist independent of religious contexts, and, if we mix science with religious views to seek what is objectively true, we are not being scientific. To quote from a recent letter to *Science* (April 16, 1982) from James C. Hickman, Botany Department, University of California, Berkeley:

> . . . Scientists (when they are behaving scientifically—that is, not all the time) do not 'believe in' anything except their ability to gather reasonably objective information about the universe. Rather, they tentatively accept propositions they are unable to reject using available information. Despite our increasing uncertainty about events at progressively greater removes in time, the origins of life and the origins of the universe can be and are being explored scientifically.

Like all human beings, scientists embrace a myriad of nonscientific behaviors, including religion (from atheism to fundamentalism) and politics *(from far-left to far-right), but none* of these various behaviors have any direct bearing upon the validity of the science they may have accompanied. As I have written to Dr. Morris, if the theism of some scientists can be correlated to their contributions, then the atheism of other scientists can be correlated to their contributions, resulting in theism and atheism both being equally justified! Such absurdity is to me additional evidence that creationism cannot be scientifically justified; creationists are using an impotent argument to indulge in self-gratification of their religious views, which are identical with their creationist views.

Ronnie J. Hastings, Ph.D.
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Steven Brush provided documentation showing that Henry Morris was wrong to claim that Lord Kelvin was a creationist (*Creation/Evolution* VIII). Morris was also wrong in claiming that Sir Isaac Newton was a creationist. The following quote is from a letter Newton wrote to Thomas Burnet during the winter of 1980–1981 (the full text can be found on pp. 329–334 of *The Correspondence of Isaac Newton, Vol. II, 1676–1687,* edited by H. W. Turnbull, Cambridge University Press, 1960):

> As to Moses I do not think his description of ye creation either phil-

> osophical or feigned, but that he described realities in a language artificially adapted to ye sense of ye vulgar . . . his business being not to correct the vulgar notions in matters philosophical but to adapt a description of ye creation as handsomely as he could to ye sense and capacity of ye vulgar. So when he tells us of two great lights and the stars made ye fourth day, I do not think their creation from beginning to end was done ye fourth day nor in any one day of ye creation. . . .
>
> . . . But in ye third day for Moses to describe ye creation of seas when there was no such thing done neither in reality nor in appearance. . . .

Clearly, Newton was not a special creationist. The letter goes on to indicate that Newton believed in a day-age theory, with the first two "days" being of indeterminate length and that the diurnal motion of the earth was built up by the application of a constant force. There is no evidence of any similarity in the sequence or timing of events between Newton's day-ages and the days of the Genesis story.

Brent A. Becker
Charlottesville, VA

Although I have found *Creation/Evolution* VII and VIII to be most enlightening, informative, and entertaining, I do have one criticism.

One of the more infuriating tactics used by writers of the creationist *camp is a tendency to employ secondary, rather than original, sources (frequently out of context) to bolster their arguments. Although your writers are more accurate in their citations, they too are often found to be using textbooks and other secondary sources in their bibliographies. I fully appreciate the difficulties which are associated with trying to prepare articles when at a distance from a good reference library, but I feel that it is essential to provide complete and up-to-date sources if the arguments are to be compelling. Perhaps your editorial board could suggest that authors spend a bit more time in researching the literature.*

Overall, however, I applaud your efforts to combat the resurgence of creationism and its underlying fundamentalism.

Donald G. Albertson
Griggsville, IL

Robert E. Kofahl, science coordinator for the Creation-Science Research Center, states in his letter to Creation/Evolution IX that I owe his chief, Kelly Segraves, "an apology and a retraction." The matter at hand deserves neither.

First, Robert M. Price, in an article that inspired Kofahl's request, was referring as he now has made clear, to my article, "A Survey of Creationist Field Research" (Issue VI) in which I suggested that efforts of some creationists to confirm Genesis through scientific research had

been a disaster.

That article dealt with projects of the Institute for Creation Research, evidently the competitors of the CSRC in seeking acclaim for announcing the co-existence of dinosaurs and humans on the basis of tracks in the rocks along the Paluxy River in Texas. I did not know then that the CSRC had also entered the contest and hence had not referred at all to that organization or to Segraves.

But Kofahl's letter confuses the main issue. Local artisans long ago embellished dinosaur tracks found near Glen Rose, but that is less important than what the ICR and the CSRC have turned up since in the way of undoctored material. As of now, *no* "man footprints" have been validated. In fact, those reported have been questioned by no less than other creation-oriented people, such as those from Baylor University (Baptist) and Columbia Union College (Seventh-Day Adventist).

Creationists have been deterred from removing natural objects from much of the area, a lot of it now state park land, and thus frequently have had to rely on making plaster casts, "rubbings," or photographs of tracks. But these are not amenable to scientific study as I pointed out in 1975 (*Liberty* magazine, September/October), and Segraves photos are hardly substitutes for the real thing.

Professor John D. Morris, of the University of Oklahoma, who has worked on ICR projects, reported in his book, *Those Incredible Dinosaurs . . . and the People Who Knew Them*, about a discovery of "the most perfect [man track] ever found" and then commented that within a year "it had completely eroded away" (page 49). This is regrettable. The Texas Memorial Museum of the University of Texas in nearby Austin could have legally found a way to preserve such invaluable evidence, and it is unfortunate that creationist explorers did not seek the aid of specialists.

Any paleontologist would be delighted to share in a discovery of such importance. The remarkable discovery of new hominids in East Africa made Donald Johanson of "Lucy" fame a television celebrity. The rewards are substantial.

Unless Segraves and Kofahl are willing to follow the accepted methods of science—as in description, publication, and deposition of materialsfor others to examine—the Paluxy claims will continue to rank as a hoax comparable to P. T. Barnum's "Cardiff Giant."

In "Fundamentals" by Peter Steinhart (*Audobon*, September, 1981), Kofahl stated, "I just don't think our science is all that competent. Besides, in my personal view, it's bad theology to argue with scientists. . . . Since the fall of Adam, man's intellect, his emotions, and his will have been shaken up. Therefore to expect that we can use arguments to the intellect to persuade these evolutionists . . . is bad theology."

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