

**North Carolina Scientists
Speak Out on Evolution**



Prepared by

THE NORTH CAROLINA ACADEMY OF SCIENCE

1997

PREFACE

This booklet, prepared by the North Carolina Academy of Science (NCAS), is a compilation of statements concerning evolution by scientists from across the state of North Carolina. The impetus for preparation of the booklet was Rep. Russell Capps' (R-Wake) submission to the North Carolina General Assembly (March, 1997) of House Bill 511, entitled "An Act to Amend the Public School Laws to Ensure that Evolution is Not Taught as Fact in North Carolina Public Schools." The accompanying anti-evolution document, "An Evaluation of NC Approved Biology Textbooks," distributed by the office of Rep. Capps, contained material many scientists consider misleading and inaccurate. This booklet attempts to give a more accurate perspective.

The North Carolina Academy of Science sees the theory of evolution as the cornerstone of modern biology. We think that passage of a bill restricting the teaching of evolution would, at best, stifle free exchange of scientific information, establishing an atmosphere that is the antithesis of that required to teach and learn science.

Although the playing field is North Carolina, this bill is part of a creationist effort across the country that has been successful in some states and has been turned back by a narrow margin in others. According to a recent article in Science (Schmidt, K., 1996. Creationists evolve new strategy. Science 237: 420), "In the past 6 months, creationists have mounted a surge of assaults on science education around the United States. In Alabama, when school opens this fall, every biology textbook will carry a paste-in warning stating that evolution is a controversial theory that shouldn't be considered fact. In Ohio, Tennessee, and Georgia, creationist bills reached state legislatures for the first time."

House Bill 511 was not brought to the floor of the Senate in this past legislative session. Michael G. Kinnaird, who seems to be coordinating support for the bill for Rep. Capps, has stated, however, that the bill will probably be re-introduced in another form in the next session. Thus it appears that we may be in for a long and arduous task if we are to prevent the passage of a bill restricting the teaching of evolution.

A firm understanding of the theory of evolution and knowledge of scientific evidence that supports the theory are strong tools for combating religious/political efforts to legislate the teaching of science. This booklet attempts to give its readers some of that information in a readily referenced form. The intended readership is all citizens of North Carolina who consider the term "creation science" an oxymoron, but who are not familiar enough with the arguments of creationists or the specific scientific evidence to evaluate the materials creationists provide.

We have attempted to compile a uniquely "North Carolina" compendium of material designed to enable teachers and citizens in North Carolina to "speak out on evolution"

more effectively. At the heart of the booklet are several refutations of specific arguments found in the anti-evolution document, "An Evaluation of NC Approved Biology Textbooks." The refutations were prepared by North Carolina scientists doing research or teaching in areas that deal with the scientific evidence that has been called into question. We have certainly not attempted to refute all known creationist arguments; rather, we have selected some that can be used to illustrate most clearly the most common fallacies of the arguments against evolution.

The North Carolina Academy of Science thanks those scientists who have contributed their time and expertise to address specific creationists' arguments. Special thanks go to Nancy Edwards, Robert P. Higgins, Charles Keeling, and Margaret Ray for invaluable information and editorial suggestions, and to Susan M. Thomas and Amanda Branscombe for making suggestions as non-scientific readers.

To obtain printed copies of this booklet, please write the Executive Secretary of the NCAS, Dr. Susan Stephenson, North Carolina Academy of Science, P.O. Box 2418, Durham, NC 27715-2418, or contact her by email at sstephen2@aol.com. The booklet is also available on the NCAS website (<http://ncacadsci.org/>). This material is not copyrighted and the NCAS does not object to its duplication and distribution for whatever purposes seem appropriate.

October, 1997

Mary Beth Thomas, Editor
Board of Directors, NCAS
Department of Biology
The University of North Carolina at Charlotte

For more information on the North Carolina Academy of Science, visit our web site at www.ncacadsci.org

TABLE OF CONTENTS

PART I. OVERVIEW	1
A. Evolution is not Anti-religious.....	1
B. What is Science?	2
C. Why Do Scientists Debate Evolution among Themselves?.....	2
D. What are the Basic Tenets of Creationism?.....	4
E. Why is Creation Science Unscientific?.....	6
F. Creationists’ “Tricks of the Trade”.....	7
1. Misquotations or quotations taken out of context.....	8
2. Outdated information.....	10
3. Reliance on authority.....	12
4. Misunderstanding of /failure to acknowledge valid scientific studies	13
5. Red herrings.....	16
6. Refusal to withdraw arguments that have been refuted.....	16
G. Legal Decisions Concerning the Teaching of Evolution.....	18
H. What’s Wrong with Legislating the Teaching of Evolution?.....	19
PART II. NC SCIENTISTS ADDRESS SOME CREATIONIST ARGUMENTS..	21
A. The Origin of Life.....	21
B. Mutations.....	22
C. Gill Slits.....	25
D. Transitional Fossils.....	26
1. Reptiles, Birds, and Mammals.....	26
2. Whales and Terrestrial Mammals.....	27
3. The Hominid Fossil Record.....	30
E. Evolution of Horses.....	33
F. Evolution of Plants.....	35
PART III. POSITION STATEMENTS	37
A. North Carolina Science Teachers Association (NCSTA).....	37
B. University of North Carolina Mathematics & Science Education Network (UNCMSSEN).....	38
C. North Carolina Academy of Science (NCAS).....	39
PART IV. SOURCES OF ADDITIONAL INFORMATION	41
APPENDIX	42
A. House Bill 511.....	42
1. Original Version Submitted to Education Committee of House.....	42
2. Amended Version Approved by the House.....	43
B. “An Evaluation of NC Approved Biology Textbooks” (ENCABT).....	43

PART I. OVERVIEW

A. EVOLUTION IS NOT ANTI-RELIGIOUS

Scientific discoveries, including discoveries indicating that evolution occurs, need not threaten our religious beliefs. Eugenie C. Scott, Executive Director of the National Center for Science Education, in an article entitled “Creation and evolution: what administrators should know,” has pointed this out quite clearly with the observation that “whereas creationism is antievolutionism, evolution is not anti-religious.”¹ Arthur Greenberg, Professor and Chair of the Department of Chemistry at the University of North Carolina at Charlotte, writes in an article entitled “Faith can survive good science”: “Why do some people feel that good science will tarnish religion? Over 500 years ago, Copernicus demonstrated the extremely heretical fact that the Earth is not the center of the universe, but merely a miniscule outpost in one corner of it. Our religious faith survived this departure from rigorous scripture unharmed, as it has the reality of evolution and as it will survive countless other tests.”²

Scientific discoveries can be incorporated into our religious beliefs. Most religious groups and many scientists have incorporated the theory of evolution into what Eugenie Scott calls “theistic evolution,” basically the view that God creates, but through the process of evolution. According to the article “Science, faith not such bitter enemies,”³ Leo Sandon, Professor of Religion at Florida State University, states that “most mainline theologians and churches have come to accept the theory of evolution ‘as God’s way of doing things.’ ” This was certainly obvious for the Roman Catholic Church when on October 22, 1996, Pope John Paul II issued to the Pontifical Academy of Sciences a document, “Truth Cannot Contradict Truth,” in which he defended both the evidence for evolution and its consistency with Catholic doctrine.

Science and religion deal with different kinds of perceptions of life on this planet. Science is limited to observation and manipulation of the natural world. While the scope of science is enormous, many questions that concern humankind lie outside its realm. Such questions as why we exist, what is truth or beauty, how do we distinguish good from evil, simply cannot be addressed by science. Concepts such as faith, love, and forgiveness cannot be explored by the methods of science. Certainly questions about the supernatural (by definition) fall squarely outside the parameters of science. Thus religion and science can’t duplicate each other. They can, however, complement each other. William Carroll, Cornell College, recently emphasized this need for complementariness when he stated: “The natural sciences explain the world of physical reality. Religion gives us insights into the ultimate source and meaning of that physical reality. Human beings need both of them to have a comprehensive view of the world.”⁴

B. WHAT IS SCIENCE?

¹ California Curriculum News Report, 1994, 20:12.

² The Charlotte Observer, June 23, 1997.

³ Tim Funk, The Charlotte Observer, July 19, 1997.

⁴ Tim Funk, The Charlotte Observer, July 19, 1997.

To borrow the theme of John Moore's series of essays published by the American Society of Zoologists (now the Society for Integrative and Comparative Biology), science is a "way of knowing." It is a method or tool for gaining certain limited kinds of information or knowledge. Fundamentally, the scientific method requires an hypothesis that can be tested by observations of the natural world.

The scientific hypothesis has an important requirement - it must be stated in such a way that it can be disproved or falsified. Why must it have that seemingly strange requirement? The reason is that one can never completely prove a scientific hypothesis. As a very simple (and simple-minded to be sure) example, suppose you hypothesize that "all apples are red," and then begin to score apples. With every red apple scored, you gain support for your hypothesis, but you never know if the next apple you see will be a different color. Thus even after scoring 5000 apples, you have not proved your hypothesis. This is the reason, then, that a scientific hypothesis cannot be proved. An hypothesis can, however, be disproved or falsified. One green Granny Smith apple disproves/falsifies the original hypothesis, so it must be rejected.

The power of the scientific method stems from this requirement for falsification. Once an hypothesis has been rejected, scientists use the information from that study to modify the original hypothesis ("all apples are either red or green") and test that new hypothesis, so the process continues in an orderly fashion.

Since an hypothesis cannot be proved, but only supported, what do we call an hypothesis that has been supported by a large body of evidence and never been falsified? It is called a "theory." And so we elevate hypotheses that have withstood rigorous testing to the level of a theory: e.g., the "Atomic Theory of Matter," the "Theory of Relativity," the "Theory of Evolution."

Much of the debate over the Theory of Evolution stems from different meanings of the word "theory." The meaning in science is actually the antithesis of its general usage, where it can mean a "hunch" or a "guess." A scientific theory is an hypothesis that has, on the strength of accumulated evidence, an extremely high probability of being correct.

Notice that no requirement for an "eyewitness account" is included in the description of the scientific process. Creationists often argue that if we can't see a process with our own eyes, then we can have no scientific knowledge about it or cannot with validity formulate testable scientific hypotheses about it. Nothing could be farther from legitimate scientific methodology. We do not "see" atoms, or gravity, or energy, yet we have the Atomic Theory of Matter, the Law of Gravity, and the Theory of Relativity because we see their effects. In this way, the Theory of Evolution is no different from other unifying scientific theories and laws.

C. WHY DO SCIENTISTS DEBATE EVOLUTION AMONG THEMSELVES?

A question often raised by creationists is "why, if the evidence for evolution is so sound, do scientists continue to debate it among themselves"? The answer is that scientists do not debate whether or not evolution occurs, because the strength of this evidence is overwhelming. Debate generally centers, instead, on topics such as those listed below.

- mechanisms that have driven evolution
 - the time course of various evolutionary events
 - specific ancestor for an organism or group of organisms

a. Mechanisms that have driven evolution

As one example of the kind of debate on evolution that occurs among scientists, examine briefly possible mechanisms that may operate to drive evolution. Darwin proposed that the driving mechanism for evolutionary change was natural selection. Basically, Darwin observed that variations occur within a species and that more offspring are produced than survive to reproduce. He proposed that individuals bearing variations that prove to be beneficial (adaptive) to a particular environment are the most likely to survive to produce offspring, thereby passing along those traits to the next generation. As the process continues over time, the population gradually changes as heritable environmentally selected adaptations are passed on to successive generations.

Since the time of Darwin, however, evidence has emerged to suggest that natural selection may not be the only mechanism leading to change. For example, chance plays a role (the Sewell-Wright phenomenon of “genetic drift”).

b. The time course of various evolutionary events

It has been proposed that change may not always be gradual as proposed by Darwin; instead, evolution may occur in “fits and starts” (Eldredge and Gould’s hypothesis of “punctuated equilibrium”).

c. Specific ancestor for an organism or group of organisms

An example of a more recent and widely publicized debate centers on the origin of birds. Ann C. Burke and Alan Feduccia, faculty members in the Department of Biology at UNC-Chapel Hill, recently provided evidence that the widely held hypothesis that birds arose from dinosaurs may be false.⁵ Both dinosaurs and birds have only 3 digits (fingers) in the ‘hand,’ and dinosaurs possess digits I, II, and III. Burke and Feduccia found, from examination of embryos of birds, that birds possess digits II, III, and IV, suggesting that birds cannot have arisen from the dinosaurs.

Debate among scientists is useful, even critical, but has created problems of credibility outside the scientific community. For example, coverage in The Charlotte Observer of the discovery by Burke and Feduccia bore the headline, “Thumbs down on dinosaur-bird link? UNC embryo study suggests evolution theory is ‘definitely in trouble.’”⁶ Feduccia confirmed, of course, that it is not the theory of evolution that is in trouble, but

⁵ Burke, A.C., and A. Feduccia, 1997. Developmental patterns and identification of homologies in the avian hand. Science 278:666-668.

⁶ The Charlotte Observer, Oct. 24, 1997.

only the origin of birds from dinosaurs. Feduccia stated that “birds are derived from archosaurian reptiles.”⁷

How big a role does chance play in directing evolution? How common is discontinuous evolution? Are birds derived from dinosaurs or from other reptiles? These are the kinds of questions that scientists debate scientifically, not whether or not evolution occurred.

The implication of the problem scientific debate causes outside the scientific community is well stated by Stephen J. Gould.

Most of all I am saddened by a trend I am just beginning to discern among my colleagues. I sense that some now wish to mute the healthy debate about theory that has brought new life to evolutionary biology. It provides grist for creationist mills, they say, even if only by distortion. Perhaps we should lay low and rally around the flag of strict Darwinism, at least for the moment -- a kind of old-time religion on our part. But we should borrow another metaphor and recognize that we too have to tread a straight and narrow path, surrounded by roads to perdition. For if we ever begin to suppress our search to understand nature, to quench our own intellectual excitement in a misguided effort to present a united front where it does not and should not exist, then we are truly lost.⁸

D. WHAT ARE THE BASIC TENETS OF CREATIONISM?

The basic schools of thought that exist among creationists are listed below.

- Young-earth Flood Creationism
- Day-Age Creationism
- Gap Theory Creationism

1. Young-earth Flood Creationism

Young-earth Flood Creationism holds that the earth was created less than 10,000 years ago, that life forms were created during creation week as described in Genesis, that the flood eliminated life forms that were not taken aboard Noah’s ark, and that all terrestrial life forms today are progeny of passengers on the ark.

2. Day-age Creationism and Gap Theory Creationism

Day-age Creationism and Gap Theory Creationism, both of which can be viewed as “Old-earth Creationism,” attempt to reconcile the Biblical account of creation with scientific evidence for the great age of the universe and the earth. Day-Age Creationism holds that the six days of creation as described in Genesis were considerably longer than 24 hours. Gap Theory Creationism, which interestingly had its origins before publication of Darwin’s Origin of Species, introduces both a gap and a creation between Genesis 1:1 and Genesis 1:2. According to this theory,

⁷ Personal communication, Oct. 24, 1997.

⁸ Discover, May, 1981.

God created the heaven and the earth with life forms, had to destroy it because it was evil (thus the earth became without form and void), and then recreated it according to the account in the rest of Genesis 1 and 2.⁹ Thus Day-age and Gap Theory Creationism can be seen as occupying a different rung from Young-earth Flood Creationism on the Creation-to-Evolution continuum illustrated in Fig. 1.

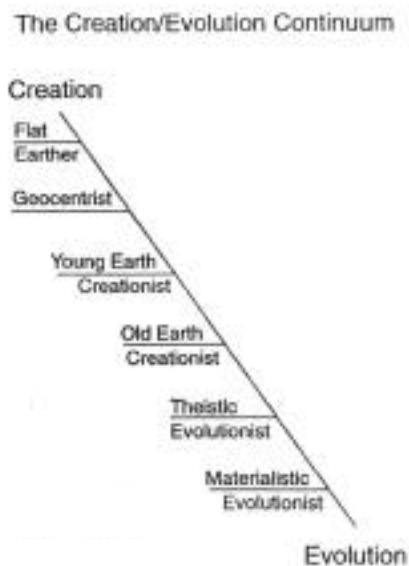


Fig. 1. Representation of a continuum of perceptions of the earth and the origin of its life forms.¹⁰

Strict creationists today subscribe to Young-earth Flood creationism, and it is their tenets that will be examined here. Their beliefs can be characterized most accurately by using their own works and statements. For example, membership in the Creation Research Society requires acceptance of the statement, “All basic types of living things, including man, were made by direct creative acts of God during creation week as described in Genesis.”¹¹ Duane Gish of the Institute for Creation Research has stated: “By creation we mean the bringing into being of the basic kinds of plants and animals by the process of sudden, or fiat, creation described in the first two chapters of Genesis.”¹²

For Young-earth Flood creationists, the time frame for this event is generally agreed to have occurred no more than 10,000 years ago.¹³ E.W. Faulstich, founder of the Chronology History Research Institute which studies biblical chronology, has calculated that the planets were created on Wednesday, March 22, 4001 BCE.¹⁴

⁹ McIver, T., 1988. Form and void: gap theory creationism. *Creation/Evolution* 24:1-24.

¹⁰ Kindly provided by the National Center for Science Education.

¹¹ Miller, K., 1982. Answers to the standard creationist arguments. *Creation/Evolution* 7:1-13.

¹² Gish, D., 1979. *Evolution, the Fossils Say No!* (Creation-Life Publishers, San Diego).

¹³ Morris, H.M., 1984. *The Biblical Basis for Modern Science* (Baker, Grand Rapids, MI).

¹⁴ Jeffrey, W.H., 1987. “Sun, stand thou still”: an astronomical critique of a creationist Biblical chronology. *Creation/Evolution* 21:18-30.

Noah's ark and the flood figure prominently in Young-earth Flood Creationism.¹⁵ The Noachian Deluge is held to have been the basis for most, if not all, extinctions that appear in the fossil record. The ark and the flood have also been factors in the origin of the creationist notion of "basic created kinds." Because the dimensions of the ark are given and its size would have been too small to have accommodated male and female of all species (even all terrestrial species), it is concluded that prototypes of the 'basic kinds' of animals (e.g. cat, dog), with tremendous capacity for genetic variation, were taken on board the ark and that these have given rise to subtypes of these 'basic kinds' today.¹⁶

To summarize, the fundamental tenets for most Young-earth Flood creationists arise directly out of their religious interpretation of Biblical scriptures. These tenets are summarized below.

- All basic types of living organisms were created by God during Creation Week that occurred no more than 10,000 years ago.
- Extinctions documented in the fossil record were produced by the Noachian Deluge.
- Some microevolutionary changes have occurred from the genetic variations contained in the "basic created kinds" (a tenet of at least the more progressive creationists of this school).

E. WHY IS CREATION SCIENCE UNSCIENTIFIC?

The fundamental tenet of creationism, that all forms of life were created by God essentially instantaneously as described in Genesis, cannot be tested by the scientific method (in which an hypothesis that can be falsified through observations of the natural world is tested). Scientific hypotheses about such things as God and Divine Creation cannot, by definition, be tested by the scientific method because they lie outside the realm of the natural world.

An implication of that fundamental tenet, however, does lend itself to scientific inquiry. That implication, stated in the form of a testable hypothesis, is that the diversity of life on earth arose recently and instantaneously, and has changed little over time. That hypothesis, however, has been falsified by an overwhelming body of evidence -- evidence that life forms have existed for much longer than 10,000 years, have appeared gradually, and have changed dramatically and continue to change over time.

This is the body of evidence that creationists must refute. Still their approach is not to formulate and test hypotheses. Loren A. Raymond, Chair and Professor of Geology at Appalachian State University, has commented on this lack of experimentation. He writes:

¹⁵Whitcomb, J.C., and H. M. Morris, 1961. The Genesis Flood: The Biblical Record and its Scientific Implications (Presbyterian and Reformed Pub. Co., Nutley, NJ).

¹⁶Jones, J.A., 1973. How many animals on the ark? Creation Research Society Quarterly 10:102-107.

Evolution is a major organizing principle of science that is supported by an immense amount of data and experimentation.

In contrast, almost no scientific evidence has been published in support of instantaneous creation. To my knowledge, two hypotheses have been presented in scientific forums in support of instant creation. One was published as an abstract implying that fossil trees may form quickly because they are buried quickly by eruptions like the Mt. St. Helens eruption, but the hypothesis was not supported with data that showed rapid rates of fossilization. The other, published by C.V. Gentry in an article in Science magazine, has to do with radioactive halos of polonium forming quickly, and it was rebutted in subsequent articles.

“Scientific Creationists” spend their time trying to debunk evolution rather than doing science that will provide evidence in support of instant creation. In fact, some leading creationists, such as Henry Morris, have argued that scientific evidence for instant creation cannot be discovered through the scientific method: Rather, a “philosophy of origins...can only be achieved by faith.” In short, there is no scientific evidence for instant creation, and, hence, it is not a scientific theory.¹⁷

Viewed another way, creationists formulate hypotheses, but do not test these hypotheses. Further, many of their hypotheses have already been falsified by the scientific method.

F. CREATIONISTS’ TRICKS OF THE TRADE

Faced with a lack of evidence to support the hypothesis that organisms arose recently through instant creation and have remain unchanged over time, the creationists’ approach is to try to poke verbal holes in the evidence that runs counter to their beliefs. Their approach takes the form of such scientific-sounding statements as “evolution defies the second law of thermodynamics,” “there are no transitional fossils,” “mutations are all bad,” etc. Numerous examples of this creationist approach can be found in “An Evaluation of NC Approved Biology Textbooks,” hereafter abbreviated as ENCABT. ENCABT is reprinted in full in APPENDIX, B. Quotations from ENCABT are unedited and are italicized throughout this booklet.

Creationists support their arguments in a strange way, one that is antithetical to the accepted practice of good science; namely, their arguments are usually characterized by one or more of the following:

- misquotations or quotations taken out of context
- outdated information
- reliance on authority
- misunderstanding of/failure to acknowledge valid scientific studies
- red herrings
- refusal to withdraw arguments that have been refuted

¹⁷The Charlotte Observer, July 7, 1997.

These tactics are examined below, drawing examples from the arguments found in ENCABT. More detailed rebuttals by North Carolina scientists of some of the arguments in ENCABT are presented in PART II.

1. Misquotations or quotations taken out of context

Examples of misquotations or quotations taken out of context abound and are particularly frustrating and distressing, since confirming the accuracy or inaccuracy of such quotations requires meticulous research. Three examples of blatant misuse of quotations in ENCABT are addressed below.

a. Quotations concerning mutations

“I was able to find both of the publications cited, yet I could not find the quoted passages in either.”

--Todd Steck, Associate Professor of Biology, UNC-Charlotte

The authors of ENCABT take issue with the statement on page 127 of G.B. Johnson’s text, Biology: Visualizing Life (Holt, Rinehart and Winston, NY): “Mutations act as a source of the variation that is needed for a species to adapt to changing conditions or a new environment, and, thus, evolve over time.” The ENCABT response to this statement is reprinted in italics below:

Response: “Most mutations are bad. In fact, good ones are so rare that we can consider them all as bad.” H.J. Muller, “How Radiation Changes the Genetic Constitution”, Bulletin of the Atomic Scientist, vol. 11 No. 9 (November 1955, p. 331). Dr. Muller is recipient of the Nobel Prize for his work with mutation.

“Mutation never produces anything new. They [mutant fruit flies] had malformed wings, legs and bodies and other distortions, but they always remained fruit flies” (Theodosius Dobzhansky [world renowned naturalist and an evolutionist], in Heredity and the Nature of Man. New York: Harcourt, Brace and World, 1964. p. 126).

Todd Steck, Associate Professor of Biology at UNC-Charlotte, obtained and examined the two publications cited and responds, “...I was able to find both of the publications cited, yet I could not find the quoted passage in either. Neither quotation is accurate as cited, and neither publication contains even the sentiments of the given quotes. Misquoting articles shows a blatant disregard for the truth. Interestingly, the often quoted statement by Dobzhanski, ‘Nothing makes sense in biology except in the light of evolution,’ does appear on p. 115 of his article cited by ENCABT.” (see PART II, B)

b. Quotation on fossils transitional between reptiles and birds

“The quotation may be accurate, but that is difficult to confirm, since no date for the book is presented and the book is not found in Books in Print.”

Mary Beth Thomas, Department of Biology, UNC-Charlotte

The statement from N.A. Campbell’s 1993 textbook Biology, “Birds (class Aves) evolved from a reptilian ancestor during the great reptilian radiation of the Mesozoic era,” is rebutted in ENCABT as follows: “*This statement represents faith in the theory of evolution, yet there is no proof. W.E. Swinton of the British Museum of Natural History wrote in Biology and Comparative Physiology of Birds: ‘...there was no fossil of the stages through which the remarkable change from reptile to bird was achieved.’*”

The quotation may be accurate, but that is difficult to confirm, since no date for the book is presented and the book is not found in Books in Print. Certainly the book was written many years ago, since Swinton died in the 1970s. In any event, it is a skewed view, since strong evidence exists to indicate that birds arose from reptilian ancestors. Susan E. Peters, Associate Professor of Biology, UNC-Charlotte, writes (see PART II, D, 1):

Responses in Capps’ letter claim that we lack transitional fossils for the origin of birds from reptiles, or of mammals from reptiles. These statements are simply untrue. Archaeopteryx is considered by virtually all vertebrate paleontologists to be an excellent transitional fossil between reptiles and birds. Anti-evolutionists claim that because Archaeopteryx had feathers, it’s a fully developed bird. Granted that the feathers of Archaeopteryx are well developed, but the skeleton shows many transitional features. For instance, Archaeopteryx has a typically reptilian skull and teeth (also possessed by much later fossil birds); like reptiles, it has a long, bony, lizard-like tail instead of the fused tail bones of modern birds; the breast bone is broadened as in birds, but lacks the distinctive keel that modern birds have; though the fingers have been reduced to only 3 (which are fused in modern birds), they retain the free phalanges (fingers) and claws of a reptilian hand. So Archaeopteryx is clearly not a bird in the modern sense, and it retains many reptilian characteristics.

c. Quotation on fossils transitional between reptiles and mammals

“By citing quotations from eminent evolutionary biologists like Roger Lewin out of context, the responses in this ‘evaluation’ are disingenuous, at best.”

--Susan E. Peters, Associate Professor of Biology, UNC-Charlotte

ENCABT also questions the following statement from N.A. Campbell's textbook Biology: "Mammals evolved from reptilian stock even earlier than birds." ENCABT states that "*The [evolutionary] transition to the first mammal, which probably happened in just one of, at most, two lineages, is still an enigma' (Roger Lewin, 'Bones of Mammals' Ancestors Fleshed Out', Science, vol. 212, 26 June, 1981, p. 1492.).*"

Susan E. Peters, Associate Professor of Biology at UNC-Charlotte, points out, however, (see PART II, D, 1) that "the enigma Lewin refers to is not about whether mammals evolved from mammal-like reptiles, the synapsids. The enigma is exactly which synaptid mammals evolved from, and whether monotremes, marsupials and placental mammals all came from a common ancestor or from different synapsid lineages. She adds, "By citing quotations from eminent evolutionary biologists like Roger Lewin out of context, the responses in this "evaluation" are disingenuous, at best."

2. Outdated information

Outdated information characterizes the entire ENCABT document. The most recent articles cited in ENCAPBT are dated 1987 (one citation) and 1984 (one citation).

Scientific information becomes available at a rapid rate. For example, just since House Bill 511 was introduced in the spring of 1997, two important and widely publicized discoveries in evolutionary biology have been published. In July, 1997, an article reported results of a study of DNA isolated from a bone of a Neandertal.¹⁸ In October, 1997, evidence was presented that suggests that the widely held view that dinosaurs gave rise to birds may be in error.¹⁹ Because of the rapid rate at which new information appears, most books and articles more than 5-10 years old are out of date. In some subdisciplines of biology, information must be updated almost daily.

Although principles elucidated in the past often remain as a foundation for current scientific exploration, outdated original research articles, review articles, and textbooks are useful mainly for historical perspective. Thus it is not difficult to imagine the dismay of a scientist when confronted with arguments based on articles written as long as 40 years ago. Two examples of these geriatric arguments are discussed below.

a. "Mutations are all bad"

"Of the thousands of articles written about mutations, it is unusual that such old publications would be excerpted, especially since so much knowledge has been gained about mutations since that time."

--Todd Steck, Associate Professor of Biology, UNC-Charlotte

¹⁸ Kahn, P.A., and A. Gibbons, 1997. DNA from an extinct human. *Science* 277:176.

¹⁹ Burke, A.C., and A. Feduccia, 1997. Developmental patterns and identification of homologies in the avian hand. *Science* 278:666-668.

G.B Johnson's textbook, Visualizing Life states that "Mutations act as a source of the variation that is needed for a species to adapt to changing conditions or a new environment." ENCABT counters with the following two quotations:

'Most mutations are bad. In fact, good ones are so rare that we can consider them as all bad.' H. J. Muller, 'How Radiation Changes the Genetic Constitution', *Bulletin of the Atomic Scientist*, vol. 11 No 9 (November 1955, p. 331f)."

"Mutations never produce anything new. They [mutant fruit flies] had malformed wings, legs, bodies and other distortions, but they always remained fruit flies" (Theodosius Dobzhansky [world renowned naturalist and an evolutionist], in *Heredity and the Nature of Man*. New York: Harcourt, Brace and World, 1964. P. 126.).

The first article cited was written in 1955 - 42 years ago! Watson and Crick had only published the structure of DNA, the discovery that marked the beginning of molecular genetics in 1953, so the citation is woefully out of date. The other citation used to 'support' the notion that all mutations are bad is dated 1964, 33 years ago in what is probably the single most rapidly advancing subdiscipline of modern science.

Today we know of many mutations that are beneficial to a species. For example, Deborah Langsam, Associate Professor of Biology, UNC-Charlotte, writes in response to the ENCABT statement, *"It is a stretch to claim that the unique human brain...developed through mutations, which are 'usually harmful, and never produce anything new,..."*:

The textbook "evaluation" cited by Rep. Capps relies on information that is, at best, a misinterpretation of currently accepted evolutionary theory and of the vast body of data accumulated to support this theory. At worst, the information provided is just untrue. A very quick and simple example illustrates this. According to the author, mutations are "always" detrimental and "never" lead to the development of new, usable characteristics in organisms. This is hard to justify in light of antibiotic-resistant bacteria (e.g., the bacterium that causes tuberculosis) that are currently threatening public health. Such resistance, which is clearly "good" for the bacterium, develops as the direct result of mutations in bacteria that previously had shown susceptibility to such antibiotics. The conferral of such types of mutation-produced resistance is, in fact, so simple that it is often demonstrated (although not using disease-causing bacteria) in high school and college classrooms!

b. “No evidence that whales evolved from terrestrial mammals”

“Widely publicized...discoveries within the past five years have shown clear transitional stages between land mammals and whales.

--James Mickle, Associate Professor, Biological Sciences
Interdepartmental Program, North Carolina State University

James Mickle, Associate Professor, Biological Sciences Interdepartmental Program, North Carolina State University, states that “while age does not necessarily dilute the truth of statements, the scholarship cited is seriously out-of-date. For example, the work cited to supposedly discredit whale evolution is dated 1955. Widely publicized (e.g., articles in the Raleigh News and Observer and in Discover magazine) discoveries within the past five years have shown clear transitional stages between land mammals and whales.”

In the response concerning evolution of whales by H.J. Daniels and C.A. Singhas, East Carolina University, (see PART II, D, 2) notice that the ENCABT quotation was from Colbert’s 1955 edition of The Evolution of Vertebrates rather than the 1991 edition. Why, in 1997, would one use a 1955 edition when the 1991 edition was available? Further, notice that the ENCABT documents makes no mention of the scholarly articles published recently (1994) indicating that Pakicetus was indeed an ancestral form of modern whales.^{20,21}

The point that failure to consult the current literature results in misconceptions about our understanding of evolution is vividly illustrated in the discussion of the evolution of whales by Ann Pabst, Assistant Professor of Biology, UNC-Wilmington (see PART II, D, 2). Pabst includes citations of molecular studies published between 1993 and 1997 that support a close relationship between artiodactyls (ungulates, which include ruminants, pigs, and camels) and whales. The molecular data include: 1) position and sequence of retroposons (Shimamura et al., 1997); 2) 12S and 16S rRNA, cytochrome b, and myoglobin sequences (Milinkovitch et al., 1993; Hasagawa et al., 1997); 3) protein and mitochondrial DNA (Graur and Higgins, 1994); 4) milk casein genes (Gatsey et al., 1996; 5) IRBP genes (Smith et al., 1996; and 6) cytochrome b sequences (Arnason and Gullberg, 1996). She points out that some of these molecular studies are indicating that whales may be even more closely related to some artiodactyls than these terrestrial species are to each other!

3. Reliance on authority

“I don’t think prizes stop criticism. Data does.”

--Stanley Prusiner, 1997 recipient of the Nobel Prize in Medicine

²⁰Gingerich et al., 1994. Nature 368:844-847.

²¹Thewissen et al., 1994. Science, 263:210-212.

The ENCABT document, like most creationist attempts to debunk evidence for the theory of evolution, tends to rely on the credentials of the ‘authorities’ they quote rather than on scientific evidence (e.g., “*Theodosius Dobzhansky [world renowned naturalist and an evolutionist]...*”). This is similar to what we have done above with the quotation from Dr. Stanley Prusiner, the 1997 recipient of the Nobel Prize in Medicine. The difference, however, is that, although we agree with Dr. Prusiner’s statement, we recognize that just because a Nobel laureate said it does not make the statement scientifically valid.

Science relies not on the credentials of the experimenter or the decree of an “authority,” but on peer-reviewed research articles. More specifically, scientific discovery is based on evidence presented in articles that have been critically reviewed by other experts in that field before they are published. After an article is published, it is further scrutinized by the scientific community at large and either validated or challenged by other scientists -- again based on data, not opinion.

The scientist’s reliance on evidence rather than credentials was illustrated a number of years ago when Linus Pauling, recipient of the 1954 Nobel Prize in Chemistry for his discovery of the structure of proteins, became interested in the benefits of vitamin C. When data did not support some of his hypotheses, they were rejected, even though they were the hypotheses of a Nobel Laureate. This is the point Dr. Prusiner was making in the statement quoted above. He was awarded the Nobel Prize for discoveries about particles called prions, which he has implicated in such infectious brain diseases as mad cow disease. Some scientists have questioned whether or not prions alone are responsible. When asked if receiving the Nobel Prize would stop criticism of his ideas, he responded, “I don’t think prizes stop criticism. Data does.”²²

In scientific publications, the names of researchers are of course given to credit them, and their affiliations are included so that the institution supporting the research is acknowledged and the author can be contacted. The author’s credentials are not included, however, because scientific studies are judged on the basis of the work itself, not the previous accomplishments of the scientist.

4. Misunderstanding of /failure to acknowledge valid scientific studies

Some creationists’ arguments are in error because they either lack an understanding of or they fail to acknowledge the validity of scientific studies that do not support their beliefs. Some examples are discussed below:

a. Experiments related to the origin of life

“The critical condition of the experiments referred to...is exactly the opposite of that stated in the ENCABT document.”

Mary Beth Thomas, Professor of Biology, UNC-Charlotte

²² The Charlotte Observer, October 7, 1997.

ENCABT states that “*all of the textbooks claim that some of the amino acids of life are formed when an electric current is passed through the atmosphere of oxygen*” In fact, the critical condition of the experiments referred to, first carried out by Miller and Urey in 1953, is exactly the opposite of that stated in the ENCABT document (see PART II, A). The experiment requires that there be no free oxygen (because oxygen is not thought to have been present in the atmosphere of the young earth -- the atmosphere the experiments attempted to simulate).

b. Evolution defies the Second Law of Thermodynamics

“Mr. Romano implies that evolution violates the second law of thermodynamics and then quickly departs this heavy scene.”
 --Arthur Greenberg, Chair and Professor of Chemistry, UNC-Charlotte

Creationists often argue that evolution defies the Second Law of Thermodynamics. Exactly how it is purported to do so is not made clear, as observed by Arthur Greenberg, Department of Chemistry, UNC-Charlotte, in his response in The Charlotte Observer to a guest columnist’s article attempting to debunk evolution. Greenberg notes: “Mr. Romano implies that evolution violates the second law of thermodynamics and then quickly departs this heavy scene. But let’s spend a moment here. The second law introduces entropy, a measure of disorder. The second law says that every natural occurrence increases the entropy (disorder) of the universe.”²³

To elaborate on this point, the second law requires that the entropy of an isolated or closed system can never decrease. This does not mean that entropy cannot decrease in an open system, in which energy in the system under study can be exchanged with energy outside the system. In fact, entropy of a system can decrease spontaneously if energy is supplied from outside the system.

To illustrate the concept of the second law in biological systems (which are open systems), consider that life itself is orderly (maintains low entropy), but only because of a constant input of energy from outside the living system. That energy source is ultimately the sun (which is becoming disorganized as it radiates light). The sun’s energy is used by plants, through the process of photosynthesis, to drive the synthesis of complex molecules (carbohydrates such as glucose) from less complex molecules (carbon dioxide and water). The complex molecules synthesized provide chemical energy that is then used for maintenance of order not only of plants, but also of animals that eat plants. So living systems maintain order at the expense of order around them (disorder increases in the universe).

Because living organisms obtain energy from their environment to maintain order, order and entropy become essentially non-issues for evolutionary considerations.

²³The Charlotte Observer, June 23, 1997.

Requisite energy for the organism can be acquired from its environment. Moreover, evolutionary changes involve changes in genetic information that are often very minor (consider that DNA sequences between chimpanzees and human beings differ by only about 1%, and that these differences evolved over countless generations). Further, these genetic differences lead primarily to changes in form and pattern. Such parameters are not directly linked to energy requirements. For example, does it take more energy for a forelimb to develop as a hand rather than as a walking leg, a wing, or a flipper? Given the potential for organisms to acquire energy, any differences in energy requirements for such evolutionary changes would seem inconsequential.

c. Hominid evolution

“This statement shows a misunderstanding of the science of taxonomy.
--Karen R. Burns, Visiting Professor of Anthropology, UNC-Charlotte

In ENCABT the authors object to the following statement in the textbook Biology, Visualizing Life: “The first hominid to migrate out of Africa into Asia and Europe was Homo erectus ('upright man').” Their objection is that use of the word hominid “*suggests that man evolved from the apes.*” Karen Burns, Visiting Assistant Professor of Anthropology, UNC-Charlotte, explains that “This statement shows a misunderstanding of the science of taxonomy. Hominids are members of the primate family Hominidae. They are more closely related to each other than they are to other primates such as the apes (family Pongidae) or the monkeys (families Cebidae and Cercopithecidae).” (see PART II, D, 3)

“Their statement simply is not true.”

--Karen R. Burns, Visiting Professor of Anthropology, UNC-Charlotte

Karen Burns responds to the ENCABT statement, “*All candidates for the "ancestor" of Homo Sapiens have either proved to be fakes (Piltdown Man) or misrepresentations or apes, or fully human. Neanderthal Man was fully human, specimens of Homo erectus (Java Man and Peking Man) have been declared probable orangutans...*,” with the comment, “Their statement is simply not true. First, any fakes have been proven to be fakes by the perceptive work of scientists themselves, operating under the ethical standards of the scientific community. Second, Neanderthal Man was not a modern Homo sapiens. Recent information about DNA discovered from Neanderthal bone has provided evidence that the Neanderthals may have been a side branch of the human family tree, not our direct

ancestors and that it is unlikely that they contributed to our gene pool.”²⁴ (see PART II, D, 3)

5. Red herrings

“The quotation from Eldredge has essentially nothing to do with the treatment of the evolution of horses in the textbook under consideration.”

--Wayne Van Devender, Professor of Biology, Appalachian State University

To rebut a statement in the textbook, Biology: A Journey into Life (1994) about O. C. Marsh’s classic study of evolution of horses, the authors of ENCABT use a quotation from Niles Eldredge, Curator of Invertebrate Paleontology at the American Museum of Natural History. In the ENCABT statement, Eldredge is quoted as lamenting that an exhibit on horse evolution at the American Museum of Natural History prepared many years ago has been presented as truth in textbooks. As unfortunate as that may be, Wayne Van Devender, Professor of Biology at Appalachian State University, points out that (see PART II, E)

The quotation from Eldredge has essentially nothing to do with the treatment of the evolution of horses in the textbook under consideration. Contrary to the inference one might draw from the response in ENCABT, the textbook is not presenting Marsh’s 1897 view of the evolution of horses and the accompanying diagram of horse genealogy in the textbook is not the figure produced by Marsh in 1897 (nor the one hanging on the walls of the American Museum of Natural History, for that matter). The figure is, instead, an artistic rendition of how some facts (fossils) fit together in time and space. If one tried to trace the “genealogy” of Equus (modern horses, asses, and zebras) from the diagram in the textbook, the best conclusion would be to say that perhaps Hyracotherium was really ancestral to the whole group, a conclusion shared by most experts in the field.”

6. Refusal to withdraw arguments that have been refuted

“It is infuriating to be quoted again and again by creationists - whether through design or stupidity I do not know - as admitting that the fossil record includes no transitional forms.”

--Stephen J. Gould, Distinguished Professor of Zoology and Professor of Geology, Harvard University

²⁴Kahn, P.A., and A. Gibbons, 1997. DNA from an extinct human. *Science* 277:176.

Frustrating for the scientist is the fact that that when fallacies or mistakes in creationist arguments are pointed out, those arguments don't go away; rather, they reappear over and over. Scientists whose statements have been misquoted or misinterpreted have tried to correct the misuse of their work. In an article published in 1981, "Misquoted Scientists Respond,"²⁵ seven scientists whose writings had been subjected to this creationist tactic tried to set the record straight.

Setting the record straight appears to be a hopeless cause, as illustrated by creationists' treatment of Stephen Jay Gould's essay in "The Episodic Nature of Evolutionary Change," (The Panda's Thumb, 1980). A series of statements, strung together, have been used to quote Gould as saying that the fossil record contains no transitional forms.

The Panda's Thumb was published in 1980. In 1981, in "Evolution as Fact and Theory" Gould writes, "It is infuriating to be quoted again and again by creationists - whether through design or stupidity I do not know - as admitting that the fossil record includes no transitional forms."²⁶

One might think that that would be the end of that, but examine the ENCABT document, distributed to North Carolina legislators 16 years later, and read: "*Stephen J. Gould of Harvard has written in 'Is a New and General Theory of Evolution Emerging?': 'The extreme rarity of transitional forms in the fossil record persists as the trade secret of paleontology Darwin's argument still persists as the favored escape of most paleontologists from the embarrassment of a record that seems to show so little of evolution directly it [gradual evolution] was never seen in the rock.'*"

According to an article in the Raleigh News and Observer, "Monkeying around with quotes,"²⁷ Rep. Capps' allusion to that quotation during debate in the NC legislature prompted Rep. Bob Hensley (D-Wake) to contact Gould. Portions of the article are quoted below:

Gould says he was misquoted by Capps, calling it "just one more lamentable example of the dishonest debating tactics used by creationists."

To the contrary, Gould said, "Evolution is as well documented as anything ever discovered by science (including the Earth's shape and its revolution around the sun) - and if that doesn't count as a "fact" in the usual sense of the word, then I don't know what the word means."

Gould said that the words in quotation cited by Capps were correct, but that the meaning is "totally distorted" by linking two entirely separate statements across the insertion of three dots. "My essay actually says the opposite of the false quotation cited," Gould said.

²⁵ Cole, J.R., 1981. Misquoted scientists respond. Creation/Evolution 6:34-44.

²⁶ Discover, May, 1981.

²⁷ Raleigh News and Observer, April 12, 1997.

The article closes with the following quotation by Gould: “This is so typical of the intellectual level of most creationist literature. Do we really want our students to be taught by this form of dishonest argument”?

G. LEGAL DECISIONS CONCERNING THE TEACHING OF EVOLUTION

Source: Voices for Evolution, 1995. M. Matsumura, ed. The National Center for Science Education, Inc. Berkeley, CA., pp. 1-13. Contributions by Dr. Tinsley Yarbrough, Professor of Political Science, East Carolina University, are also acknowledged.

The courts have consistently ruled, on the basis of the establishment clause of the First Amendment to the U.S Constitution that

- states cannot ban the teaching of evolution,
- teaching of creation science along with evolution in the science classroom cannot be legislated,
- disclaimers of evolution are in violation,
- school districts can prohibit the teaching of creation science,
- the requirement to teach evolution is not in violation of the teacher’s First Amendment rights.

Pertinent cases are summarized below:

During the 1920s, several states had laws prohibiting the teaching of evolution. Despite the publicity surrounding the Scopes trial in Tennessee in 1925, such legislation remained on the books in some states, including Tennessee and Arkansas, until the late 1960s. In 1968, in *Epperson v. Arkansas*, the United States Supreme Court ruled that the Arkansas statute prohibiting the teaching of evolution was unconstitutional on the grounds that it violated the establishment clause of the First Amendment.

In 1971, in the case of *Lemon v. Kurtzman*, the United States Supreme Court drew on earlier decisions and announced the three criteria (the Lemon Test) to be used in determining whether or not laws affecting religion violate the establishment clause of the First Amendment. The Lemon Test requires that state statutes meet the following criteria:

- the legislature must have adopted the law with a secular purpose
- the statute’s principal or primary effect must be one that neither advances nor inhibits religion
- the statute must not result in an excessive entanglement of government with religion.

The clause applies not only to statutes, but also to all actions by public employees and officials that would result in a prohibited promotion of religion.

When it became clear that statutes prohibiting the teaching of evolution were unconstitutional, attempts were made by some states to enact “balanced treatment” legislation, requiring the teaching of creation science along with the teaching of evolution. In 1982, in *McLean v. Arkansas Board of Education*, a federal court ruled that an Arkansas statute requiring public schools to give balanced treatment was in violation of the establishment clause. Further, the decision included a definition of “science” and declared that “creation science” is not a science.

In 1987, ruling on a Louisiana statute, the “Creationism Act,” which required balanced treatment of creation science and evolution in the public schools, reached the United States Supreme Court. In *Edwards v. Aguillard*, the Court ruled that balanced treatment violated the establishment clause of the First Amendment and agreed that creation science is a religious concept.

In 1997, in *Freiler, Smith and Jones v. Tangipahoa Parish Board of Education* (Louisiana), the Federal District Court ruled that use of a disclaimer about evolution is also in violation of the establishment clause. Judge Livaudais ruled that the disclaimer failed to meet the Lemon Test and acknowledged the singling out of evolution by the Board of Education when he wrote, “...there is no other scientific theory in the science curriculum of which the School Board disclaims endorsement. On no other topic in the science curriculum, or indeed in any other subject, does the School Board announce its intention not to influence or dissuade whatever opinion the student may already hold.” The religious motivation behind the issue also factored heavily in the decision when the court found that the disclaimer was passed for religious reasons, stating: “... it is patent that ... School Board members believed that teaching the theory of evolution is antithetical to ... religious belief ..., [and] that the proposal was introduced to satisfy similar religious concerns of [a] majority of the constituency.” Judge Livaudais also found that academic freedom was “not furthered by either the outlawing of the teaching of evolution or mandating of the teaching of creation science.”

Two other cases are relevant here. In 1990, in *Webster v. New Lenox School District*, the Seventh Circuit Court of appeals ruled that to ensure that the establishment clause of the First Amendment is not violated, a school district may prohibit a teacher from teaching creation science. Further, in 1994, in *Pelozo v. Capistrano School District*, the Ninth Circuit Court of appeals ruled that a teacher’s rights under the First Amendment are not violated by a requirement to teach evolution in a biology class.

H. WHAT’S WRONG WITH LEGISLATING THE TEACHING OF EVOLUTION?

House Bill 511, An Act to Amend the Public School Laws to Ensure that Evolution is not Taught as Fact (passed by the North Carolina House Committee on Education by a 25-10 vote and passed by the House by a vote of 71-46) reads: “The State Board of Education shall revise the Standard Course of Study in the science curriculum to reflect that evolution is taught as a scientific theory, not as a proven fact.”

Since scientists themselves have applied the label “theory” to the concept of evolution, why then is the scientific community so strongly opposed to passage of the bill? This question is addressed by the following statement, endorsed not only by the Board of Directors of the North Carolina Academy of Science,²⁸ but also signed and sent to the Senate by a large number of individual scientists from North Carolina.

As scientists and educators concerned with preparing scientifically literate citizens, we strongly oppose passage of House Bill 511, “Evolution not Taught as Fact.” The bill requires that evolution be “taught as a scientific theory, not as a proven fact.”

How can scientists argue against such a statement when the Theory of Evolution is a theory? The reason is that the term ‘theory’ has a very different meaning in science than in everyday life. In science, a theory is not an opinion or a belief; to the contrary, the term connotes a high level of probability that a hypothesis is correct. Thus only concepts that have withstood rigorous testing over long periods of time are elevated to the status of a theory.

The Theory of Evolution is supported by thousands upon thousands of pieces of data (facts) gleaned over the past 150 years from scientific fields as diverse as molecular biology and biochemistry, comparative embryology and anatomy, and geology.

As with any comprehensive scientific theory (such as the Atomic Theory of Matter or the Theory of Relativity), aspects remain that require further inquiry. Nevertheless, the evidence supporting the basic concept of evolutionary change is so strong that it forms the very cornerstone of modern biology, not as a belief or as a simple fact, but as a critical scientific theory.

In the eyes of those who do not understand or are unwilling to acknowledge that a scientific theory is far more than an opinion or belief, teachers who accurately teach their students the Theory of Evolution risk being perceived as in violation of the proposed law even if they never use the word ‘fact.’ In a climate in which legislators who drafted the original bill state that “whereas, the theory of evolution is a belief and not true science...” [emphasis added] the bill can only limit the free exchange of ideas and information, establishing an atmosphere that is the antithesis of that required to teach science.

Because an atmosphere of free inquiry is essential to educating the students of North Carolina, we strongly oppose this attempt to legislate the teaching of science.

The position of the full membership of the North Carolina Academy of Science (NCAS), of the North Carolina Science Teachers Association (NCSTA), and of the University of North Carolina Mathematics and Science Education Network (NCMSEN) are expressed in PART III, POSITION STATEMENTS.

²⁸“Bad for teaching science,” Raleigh News and Observer, June 1, 1997.

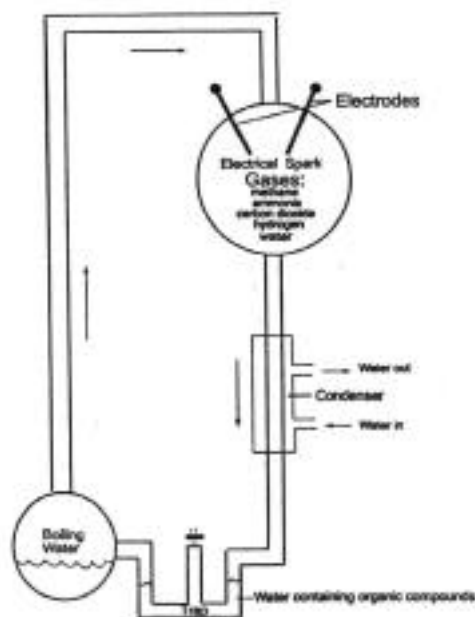
PART II. NC SCIENTISTS ADDRESS SOME CREATIONIST ARGUMENTS

North Carolina scientists prepared the following statements in response to the document “An Evaluation of NC Approved Biology Textbooks” (ENCABT) circulated by Representative Russell Capps to members of the North Carolina General Assembly in the Spring of 1997. Some of the statements were sent individually to members of the Senate in an effort to provide Senators with information to allow them to evaluate Rep. Capps’ document. Minor editorial changes, approved by the authors themselves, have been made to adapt them to the format of this booklet.

A. THE ORIGIN OF LIFE

The following statement was prepared by Mary Beth Thomas, Professor of Biology, UNC-Charlotte.

The document ENCABT states that, “*In discussing the possibility of life arising from non-living chemicals, all of the textbooks claim that some of the amino acids of life are formed when an electric current is passed through the atmosphere of oxygen....*” Surely no text says that, since the critical condition of these experiments is that there be no free oxygen. The experiments, first carried out by Miller and Urey in 1953, were designed



based on evidence that the young earth did not contain free oxygen (evidence suggests that free oxygen came later, primarily as a by-product of photosynthesis). Thus in this type of experiment, water is heated in a closed apparatus (see Fig. 2) that contains a mixture of such substances as carbon dioxide, methane, ammonia, and hydrogen, but never oxygen. The gases are exposed to an additional energy source such as an electrical discharge. The results are that within a matter of days or weeks not only amino acids, but also numerous other organic compounds including sugars and purines and pyrimidines, components of the genetic materials DNA and RNA, are produced. In the context of the actual experiments, then, the ENCABT admonition “2) *the amino acids*

Fig. 2. Diagram of apparatus used by Miller and Urey. Modified from Wolfe, 1993. Molecular and Cellular Biology, Wadsworth Pub. Co. (Belmont, CA).

formed must be separated immediately from the watery mixture or they decompose rapidly” is meaningless, because this would apply only if free oxygen had been present.

In fact, in the actual experiments, the organic molecules do not have to be removed immediately from the watery mixture.

When asked to explain the rationale behind the assertion that the amino acids must be removed from the watery mixture, Michael Kinnard from the office of Rep. Capps replied in an email communication to me on June 5, 1997:

I have gone back to some documentation sources and verified that regarding the Miller-Urey experiments on the origin of life:

-the assertion that the products were rapidly removed from the reaction zone [note lack of mention of "watery mixture"] was correct,

-the assertion that this procedure artificially "stacked the deck" towards production and not destruction of the chemicals so produced was also correct.

Kinnard presumably refers to the inclusion in the apparatus of a cooling condenser that condenses water vapor containing the reaction products (see Fig. 2). The condenser in no way removes the amino acids from the "watery mixture," because water vapor condenses to form the liquid water in which the amino acids are found. Further, the inclusion of the condenser was not to protect the newly formed amino acids; rather, it was critical to the experimental design. The condenser simulated the cooling that would have occurred in the upper atmosphere, resulting in rain (containing the newly formed amino acids).

The material discussed above is reviewed in cell and molecular biology texts, including Wolfe, S.L. (1993) Molecular and Cellular Biology (Wadsworth, Inc.), pp. 1121-1145; and Alberts et al. (1994) The Molecular Biology of the Cell (Garland Pub. Co.), pp. 3-11.

B. MUTATIONS

The following statement was prepared by Todd Steck, Associate Professor of Biology, UNC-Charlotte:

As an Associate Professor of Biology at UNC-Charlotte and as a scientist who has conducted molecular genetics research for over 15 years, I am qualified to correct the section of the ENCABT document dealing with genetic mutations. Before I point out the mistakes in the document, allow me first to put a discussion of mutations in perspective.

New species can arise only if changes in DNA occur in an existing species. Although the environment can influence an organism's phenotype (i.e., their observable characteristics), DNA is the material that carries the genetic code that is passed from generation to generation. Genetics deals with understanding the mechanisms that underlie how changes to DNA occur.

When sexual reproduction occurs, no offspring is identical to either parent. This is because each offspring gets half of its DNA from each parent. Producing offspring does not necessarily create new DNA, however. Some new DNA can arise if the DNA present

in our chromosomes is rearranged (often by a process called recombination), but recombination usually results only in additional mixing of DNA that is already found in the population of that species. The process that does create new DNA is mutation.

Our knowledge of genetics and mutations has had a profound impact on the theory of evolution. Darwin's original theories proposed that an organism's phenotype can change over time, by the process of natural selection, to such an extent as to give rise to new species. Darwin was unaware of genetics, and as a result was not able to explain the mechanism by which changes were passed from generation to generation (the father of genetics, Gregor Mendel, was conducting his research at about the same time Darwin was performing his). Further, he was not aware of DNA and mutations, and could not explain the mechanism by which heritable changes arose. We now define evolution as "a change in the genetic composition of a population." We now know that mutations are a source of new DNA and that mutations are constantly arising in every species, although not always at the same rate. In fact, one can think of the mutation rate as being the maximum rate of change in DNA and hence the maximum rate of evolution. Natural selection, then, is not the process that creates mutations, but the process that selects, from among all the mutants, those that will be maintained in the population.

In ENCABT, two passages (one from a peer-reviewed article and one from a book) are given to indicate that scientists disagree on the role of mutations. According to the authors of ENCABT, these excerpts indicate that most mutations are harmful and therefore can't lead to a "better organism." In response to this part of the document, two clarifications need to be made. First, the most recent quotation is from a book published over 30 years ago and the other is from an article published over 40 years ago. Of the thousands of articles written about mutations, it is unusual that such old publications would be excerpted, especially since so much knowledge has been gained about mutations since that time. Second, I was able to find both of the publications cited, yet I could not find the quoted passage in either. Neither quotation is accurate as cited, and neither publication contains even the sentiments of the given quotes. Misquoting articles shows a blatant disregard for the truth. Interestingly, the often quoted statement by Dobzhanski, "Nothing makes sense in biology except in the light of evolution" does appear on p. 115 of the article cited by ENCABT.

Even though the quotations as cited don't exist, I would like to respond to the content of the misquotations because I've heard similar ideas expressed by creationists. Evolution is argued to be incorrect because "most mutations are bad," or "mutations never produced anything new." It is correct to say that only a very small fraction of mutations are beneficial. Most mutations are either neutral or harmful. But what opponents of evolution fail to recognize is that because of natural selection, those organisms that carry harmful mutations will not be maintained in the population, whereas beneficial mutations will have a chance to be maintained to contribute to evolution. This is what is meant by the scientist Richard Dawkins in his 1986 book The Blind Watchmaker²⁹ when he states:

²⁹ Dawkins, R., 1986. The Blind Watchmaker (W.W. Norton & Co., NY), p. 125.

...natural selection exerts a braking effect on evolution....All that natural selection can do is accept certain new variations, and reject others. The mutation rate is bound to place an upper limit on the rate at which evolution can proceed. As a matter of fact, most of natural selection is concerned with preventing evolutionary change rather than with driving it.

One of the reasons that evolution of complex organisms takes such a long time is that mutation rates are low and only a small fraction of those mutations are beneficial. It is incorrect to say, however, that “*good ones [mutations] are so rare that we can consider them all as bad.*” Given enough time, creation of good mutations, however rare, can cause a species to evolve.

That beneficial mutations can occur and can be incorporated into a population is difficult to comprehend based on our day-to-day experiences. For example, our time frame for observation is limited; if beneficial mutations occur at a rate of say one in a billion mutations (a very rough estimate), then it is doubtful that you will be around when one is created. Further, deleterious mutations are more easily recognized than beneficial mutations. Organisms are amazingly complex, requiring thousands of chemical reactions to occur in the correct order, at the right time, and at the right place. Since genes encode the enzymes that control these reactions, it is easy to see that if a defective enzyme is made, the result can lead to a very noticeable change in appearance and fitness. A single change to DNA that results in the loss of one particular enzyme causes the disease Tay-Sachs; babies with this genetic disease rarely live past four years of age. Beneficial mutations, by contrast, do not always lead to changes that are readily apparent. In fact, because natural selection keeps organisms genetically fit for the environment in which they exist, many mutations are beneficial only in a unique environment or when the environment changes.

Consider, for example, sickle cell anemia. This disease, caused by a single change in the DNA, reduces the ability of the red blood cells to carry oxygen. It occurs when an individual carries a mutant form of both copies of the gene for hemoglobin. This would appear to be a “bad” mutation. When individuals carry only one copy of the mutant gene and one copy of the normal gene, however, they are more resistant to the blood cell parasite that causes malaria. So in regions of the world in which malaria is common, this “bad” mutation can be a “good” mutation. If malaria were to be eliminated, we would expect that, all else being equal, the frequency of this gene would decrease over time. Conversely, if the incidence of malaria were to increase over time, we might expect the frequency of the gene to increase. It all depends upon what benefit/harm a particular mutant confers on members of a species living in a specific environment. In this regard,

evolution of new species often can be correlated with changes in the environment.

C. GILL SLITS

The following statement was prepared by Susan E. Peters, Associate Professor of Biology, UNC-Charlotte:

A criticism is made that by teaching the fact that all vertebrate embryos form gill slits early in development, we perpetuate a fraud that was unmasked over 120 years ago. It is further claimed that teaching the gill slit story is “ignorant ... or deceitful,” and that all references to this story should be stricken from textbooks. This response is simply hogwash. Ernst Haeckl was a great German embryologist who was instantly excited about the theory of evolution when Darwin's book was first published. The reason he was so excited is that evolution explained what Haeckl had been observing for years - that because of common descent, there are great similarities between the embryos of all vertebrates, and that many structures, like the gill slits, which have known functions in ancestral forms (fish), are also found in descendants (land vertebrates). Why on earth should land vertebrates like mammals have gill slits during development? Haeckl recognized that these are retained from the ancestor. Unfortunately, in his zeal to show the many ways in which ontogeny (development) recapitulates phylogeny (evolutionary history), Haeckl went too far. He misinterpreted the evidence and thought that adult ancestral structure was passed on to embryos of descendants - that, in fact, functional gills developed while a mammal embryo was in utero, and that later in development the gills were modified into mammalian structures.

Wilhelm His, another scientist, pointed out Haeckl's errors and fudging of his drawings. And today we evolutionary anatomists know that adult ancestral structures do not form in the embryos of descendants. What is found in modern embryos, however, are many examples of the embryonic structures of ancestors. Yes, “gill slits” do, in fact, form transiently in mammalian embryos, but they are not the fully developed gill slits with functioning gills inside that Haeckl imagined. In mammals (as in all vertebrate embryos) the first part of the gut, the pharynx, develops a series of paired pouches in the “neck” region of the embryo. In the embryo, these pouches grow outward, contact the skin, and openings - slits - form through the skin. In fishes, the lining of the pouches goes on to develop the gill filaments that become their breathing apparatus. In land vertebrates, the gill filaments never develop. Anterior pouches develop into ear structures, parathyroid glands and a few other derivatives, but never functioning gills.

This is an example of modifying an ancestral structure for other functions in a descendant - the primary way by which new things form in evolution. We think that embryonic modification of ancestral structures to form new ones is so common because it is the easiest way to get something new without interfering with functions that must continue in the embryo. As an analogy, if you live in a 2-bedroom house and your family grows so that you need a 4-bedroom house, the easiest way to get it is to add-on, rather than tearing down and rebuilding. This, in fact, is how you would have to do it if you needed to continue living in the house while changing it. Thus, using the gill slit story to explain how and why

embryonic development is so important is not “deceitful” or “ignorant”; rather, it is basic to communicating with students our understanding of evolutionary change.

D. TRANSITIONAL FOSSILS

1. Reptiles, Birds, and Mammals

The following statement was prepared by Susan E. Peters, Associate Professor of Biology, UNC-Charlotte:

Responses in Capp's letter claim that we lack transitional fossils for the origin of birds from reptiles, or of mammals from reptiles. These statements are simply untrue. Archaeopteryx is considered by virtually all vertebrate paleontologists to be an excellent transitional fossil between reptiles and birds, although there is debate today over the specific group of archosaurian reptiles from which the birds arose. Anti-evolutionists claim that because Archaeopteryx had feathers, it's a fully developed bird. Granted, the feathers of Archaeopteryx are well developed, but the skeleton shows many transitional features. For instance, Archaeopteryx has a typically reptilian skull and teeth (also possessed by much later fossil birds); like reptiles, it has a long, bony, lizard-like tail instead of the fused tail bones of modern birds; the breast bone is broadened as in birds, but lacks the distinctive keel that modern birds have; though the fingers have been reduced to only 3 (which are fused in modern birds), they retain the free phalanges (fingers) and claws of a reptilian hand. So Archaeopteryx is clearly not a bird in the modern sense, and it retains many reptilian characteristics.

The fossil record of transition from reptiles to mammals is much better than for birds, and is probably the best known transition in vertebrate paleontology. We have an excellent record of fossils coming from an ancient group of reptiles, the Synapsida or mammal-like reptiles, which we think were ancestral to mammals. The earliest of these synapsids have the typical features of reptiles, but over a period of about 100 million years, from the Triassic into the Jurassic, many species are found that are developing mammalian characteristics. One of the most striking to illustrate transitional forms is Diarthrognathus ("two-jointed jaws"). The posterior half of the jaw joint is the same as that found in reptiles, between two bones that are missing in mammals' jaws (the articular and quadrate). But these bones are greatly reduced at the back of the jaw, and the anterior half of the jaw joint is formed by the dentary (=mandible) and squamosal (=temporal), as in all modern mammals. Thus, Diarthrognathus is the epitome of a transitional form, retaining both ancestor and descendant characteristics within one species. Many other species of these synapsids show a series of transitions in other bony characteristics; for instance, the lumbar and cervical ribs (that are typical of reptiles) are gradually reduced until in the most advanced synapsids, the ribs occur only on the thoracic vertebrae, as in mammals. A number of these features are thought to be indicative of warm-bloodedness, and a few fossils show imprints indicating that the advanced synapsids may also have evolved hair. Thus, an entire group of reptiles was evolving mammalian features just as the dinosaurs began their dramatic rise. We think that most of them were forced into extinction by the dinosaurs, but that a few stragglers survived and one, or possibly two, of these reptilian species gave rise to all of the modern mammals.

By citing quotations from eminent evolutionary biologists like Roger Lewin out of context, the responses in this "evaluation" are disingenuous, at best. According to ENCABT, *"the [evolutionary] transition to the first mammal, which probably happened in just one, at most, two lineages, is still an enigma" (Roger Lewin, "Bones of Mammals' Ancestors Fleshed Out", Science, vol. 212, 26 June, 1981, p. 1492.)*. The enigma Lewin refers to is not about whether mammals evolved from synapsids, but exactly which we evolved from, and whether monotremes, marsupials and placental mammals all came from a common ancestor, or from different synapsid lineages.

2. Whales and Terrestrial Mammals

The following statement was prepared by Hal J. Daniel, Professor of Biology and Anthropology, and Charles A. Singhas, Assistant Professor of Biology, East Carolina University:

After reading the ENCABT document provided by Representative Russell Capps' office in support of House Bill 511, we offer the following comments for your consideration:

The evaluation instrument responds with statements that in many cases are misleading and/or scientifically incorrect. In several instances references are made to scientific literature which is outdated or has been replaced with newer editions containing recent discoveries supporting evolutionary principles. As an example we would call your attention to the response in ENCABT to the textbook quotation: "Whales have bony flippers because they evolved from land mammals with bony forelimbs." To this the respondent stated: *"There is no proven evidence that whales evolved from land mammals"* and continues by quoting from Colbert's outdated 1955 edition as follows: *"Like the bats, the whales...appear suddenly...fully adapted...for a highly specialized mode of life... they stand alone."*

If the individual writing the response had consulted the most recent edition (1991) of Colbert's The Evolution of Vertebrates, he or she would have read: "These mammals (whales) probably arose in early Cenozoic times from primitive carnivore-like mammals known as mesonychids. 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." (p. 306)

The full quotation from Colbert's 1991 edition renders the response incorrect and scientifically unsound. Whales definitely had a terrestrial ancestor. Its name was Pakicetus. One of us (HJD) had the opportunity to examine and study the ear bone structure of Pakicetus at Duke University and concurs with the scholarly publications that Pakicetus was indeed an ancestral form of modern whales.^{30,31} A current quote from Colbert (p. 308) speaks of Pakicetus as an intermediary between land animals and modern whales:

It is perhaps significant that the otic region of Pakicetus lacks the

³⁰ Thewissen et al. 1994. Fossil evidence for the origin of aquatic locomotion in archaeocete. Nature. 388:666-670.

³¹ Gingerich et al. (1994). Nature 368:844-847.

specializations characteristic of whales that have established the highly efficient underwater directional hearing in these mammals. Yet there is good reason for classifying Pakicetus as a true cetacean. Pakicetus is found in river sediments along with various land living mammals - an indication that the earliest and most primitive cetacean had not as yet returned into the open ocean, although it probably did frequent marine embayments into which the rivers flowed.

Michael Novacek of the American Museum of Natural History summarizes this return to the sea in a one page article entitled "Whales Leave the Beach." Novacek writes: "In the case of the Order Cetacea, the whales and dolphins, this return to the sea was so decisive that adaptations to swimming, diving and feeding match or surpass those in fishes and sharks. It was a big evolutionary plunge, one that has eluded documentation for many decades."³²

The following statement was written by Ann Pabst, Assistant Professor of Biology, University of North Carolina at Wilmington:

Ambulocetus nutans

The oldest (52 million years ago) known cetacean, Pakicetus, has been described only from cranial (skull) characters. The skull of Pakicetus clearly shows that this species was a cetacean, but the post-cranial skeleton (i.e. vertebral column and limbs) has not been discovered. Thus, we know little about how Pakicetus moved on land or in the water. The discovery of Ambulocetus, a species slightly younger than Pakicetus, offered the first look at the post-cranial skeleton of an early cetacean.³³ This species, which was found in shallow marine deposits, has well preserved fore- and hind-limbs. The limbs indicate that Ambulocetus could both move on land as well as swim. The feet were large, suggesting that the animal flapped its feet dorsally and ventrally (i.e. up and down) while swimming, much like a modern otter. Thus, Ambulocetus shows us an important transitional form in the evolution from terrestrial mesonychids to the completely aquatic modern cetaceans.

Molecular Evidence of Relationship between cetaceans and artiodactyls

The Order Artiodactyla are the even toed ungulates, which include ruminants, pigs and camels. These terrestrial mammals have been hypothesized to be the closest living relatives to modern cetaceans based on anatomical features (e.g. reticulate kidney, three bronchi, penile erection based upon smooth muscle).³⁴ Molecular studies are now commonly used to either support or refute hypotheses of evolutionary relationships based upon anatomical data. Recent molecular studies strongly support the very close

³² Novacek, M., 1994. Whales leave the beach. Nature 268:809.

³³ Thewissen et al. 1994. Fossil evidence for the origin of aquatic locomotion in archaeocete. Nature. 388:666-670.

³⁴ Reviewed in: Milinkovitch, M.C. and J.G.M. Thewissen, 1997. Even-toed fingerprints on whale ancestry. Nature 388:622-624; Thewissen, 1994. Phylogenetic aspects of cetacean origins: a morphological perspective. Journal of Mammalian Evolution 2:157-184; Slijper, E.J., 1979. Whales. (Cornell University Press, Ithaca, NY).

evolutionary relationship between cetaceans and artiodactyls. A growing number of molecular studies suggest that cetaceans may even be more closely related to some artiodactyls, than these terrestrial species are to each other! An incomplete list of the types of molecular data that support the close relationships of artiodactyls and cetaceans include:

- 1) position and sequence of retroposons,³⁵
- 2) 12S and 16S rRNA, cytochrome b and myoglobin,^{36,37}
- 3) protein and mitochondrial DNA,³⁸
- 4) milk casein genes,³⁹
- 5) IRBP genes,⁴⁰ and
- 6) cytochrome b sequences.⁴¹

Thus, many lines of molecular evidence support existing anatomical studies and point to the relatedness of cetaceans with terrestrial, even-toed ungulates.

3. The Hominid Fossil Record

The following statement was prepared by James E. Mickle, Associate Professor, Biological Sciences Interdepartmental Program, North Carolina State University:

Many misrepresentations are found in the ENCABT document. For example, it is implied that Java Man and Peking Man are the only examples known of Homo erectus. In fact, Homo erectus is known from a large number of specimens from Africa, Asia, and Europe. Java Man is indeed an example of Homo erectus despite statements to the contrary made by its discoverer late in his life. Nebraska Man was based on a single tooth later identified as a type of pig, but was not widely used as the basis for understanding human evolution, nor was it actually a part of the Scopes trial, as shown by

³⁵ Shimamura, et al., 1997. Molecular evidence from retroposons that whales form a clade within even-toed ungulates. Nature 388:666-670.

³⁶ Milinkovitch et al., 1993. Revised phylogeny of whales suggested by mitochondrial ribosomal DNA sequences. Nature 361:346-348.

³⁷ Hasegawa et al., 1997. Novel phylogeny of whales supported by total molecular evidence. Journal of Molecular Evolution 44 (Supplement 1):S117-S120.

³⁸ Graur, D. and Higgins, D.G., 1994. Molecular evidence for the inclusion of cetaceans within the Order Artiodactyla. Molecular Biology and Evolution 11:357-364.

³⁹ Gatesy, J., Hayashi, C., Cronin, M.A. and Arctander, P., 1996. Evidence from milk casein genes that cetaceans are close relatives of hippopotamid artiodactyls. Molecular Biology and Evolution 13:954-963.

⁴⁰ Smith, M.R., Shivji, M.S., Waddell, V.G. and Stanhope, M. J., 1996. Phylogenetic evidence from the IRBP gene for the paraphyly of toothed whales, and mixed support for Cetacea as a Suborder of Artiodactyla. Molecular Biology and Evolution 13:918-922.

⁴¹ Arnason, U. and Gullberg, A., 1996. Cytochrome b nucleotide sequences and the identification of five primary lineages of extant cetaceans. Molecular Biology and Evolution 13:407-417.

trial transcripts. Charles Oxnard (1973) did state that australopithecines are uniquely different from humans, but he also stated that they are uniquely different from apes. Many of the traits he studied were intermediate in nature between apes and humans, which is what is expected in an evolutionary lineage.

The following statement was prepared by Karen Ramsey Burns, Visiting Assistant Professor of Biology, UNC-Charlotte:

I read the statement from "Evaluation of NC Approved Biology Textbooks" (ENCABT) with amazement and disbelief. In the following paragraphs I will respond to specific parts of the statement with a few simple facts.

The ENCABT evaluation of Biology (3rd edition by Neil A. Campbell) takes issue with the statement on p. 661 "Australopithecines: The First Humans," with the remark: "*Others [hominid fossil], such as 'Java Man', were finally declared as misrepresentations, or denigrated to just apes, as Ramapithecus.*" The fossil known as "Java Man" was found by Eugene Dubois in 1891. Dubois first called the fossil remains Pithecanthropus erectus, meaning "erect ape man." It has since been assigned to the species Homo erectus. It was not "just ape" as stated in ENCABT. In fact, in the century since "Java Man" was found, numerous other examples of Homo erectus have been found by paleoanthropologists throughout Africa, Asia, and Europe. The quantity and quality of information has improved with each decade of discovery. The material is available for scientists to study and compare.

By the way, Java Man is not an Australopithecine. I do not know why it would be discussed under a heading on Australopithecines.

ENCABT goes on to state that Dr. Charles E. Oxnard is reported to have commented "*that these fossils (of Australopithecines) are uniquely different from modern man in many major respects.*" This is exactly what I would have expected him to say. Australopithecines existed approximately 1-4 million years ago. Australopithecines were uniquely different from apes, and they were uniquely different from modern humans.

The position of australopithecines in the evolutionary trend toward modern humans is clearly defined by the presence of an ape-like head, an intermediate brain size, and fully modern knees. The knees are the key to fully bipedal locomotion. The australopithecines walked like modern humans.

ENCABT also addresses the statement on p. 663 "The first hominid to migrate out of Africa into Asia and Europe was Homo erectus ('upright man'). The fossils known as Java Man and Peking Man are examples of this species." ENCABT responds to this

statement as follows:

Response: The word hominid suggests that man evolved from apes, for which there no real evidence. "Java Man" was found by Eugene Dubois, a Dutch physician who had determined that he would be the person to discover the "missing link". Sure enough, he found a skull cap, three molar teeth, and a thigh bone, which he named "Pithecanthropus erectus". After many evolutionists accepted this specimen as man-like, Dubois later admitted finding true human skulls in the same rock formations in which the bones of his specimen were found. Still later he changed his opinion about Pithecanthropus erectus, and considered the skull cap that of an ape or gibbon. Some textbooks still refer to this find as an example of man's evolution from apes, but there is no real evidence.

Java Man and Peking Man are examples of Homo erectus, but they are by no means the only ones. They are only a couple of the early finds, which received a great deal of publicity. Many more were found in subsequent years.

Dubois may have inadvertently erred in some part of his work. Anyone can make a mistake, but that does not change the facts. A century of work by several generations of scientists has validated the conclusions. Independent fossil finds by separate paleontologists in widely separated localities have been followed by the scrutiny of even more scientists. Fossil dating methods have improved and the picture is becoming clearer and clearer.

ENCABT goes on to argue *that "The word hominid suggests that man evolved from the apes."* This statement shows a misunderstanding of the science of taxonomy. Hominids are members of the primate family Hominidae. They are more closely related to each other than they are to other primates such as the apes (family Pongidae) or the monkeys (families Cebidae and Cercopithecidae).

In evaluating the textbook Biology: Visualizing Life by George B. Johnson ENCABT takes issue with figure 11.6 on page 225, with the statement, "*All candidates for the "ancestor" of Homo Sapiens have either proved to be fakes (Piltdown Man) or misrepresentations or apes, or fully human. Neanderthal Man was fully human, specimens of Homo erectus (Java Man and Peking Man) have been declared probable orangutans....*" Their statement is simply not true. First, any fakes have been proven to be fakes by the perceptive work of scientists themselves, operating under the ethical standards of the scientific community. Second, Neanderthal Man was not a modern Homo sapiens. Recent information about DNA discovered from Neanderthal bone has provided

evidence that the Neandertals may have been a side branch of the human family tree, not our direct ancestors and that it is unlikely that they contributed to our gene pool.⁴² (By the way, the word "human" is not a biological term. Most definitions of "human" are culturally biased. If it is to be used in a biologically precise format, it requires careful definition. Also note that the preferred English spelling of Neandertal is now without the letter "h.").

The successful DNA-typing of the Neandertal material is only the beginning of much more precise work on genetic comparisons of modern humans and his ancestors. I look forward to the results of future genetic analysis as we continue to explore the wonders of life.

The following statement was prepared by Linda Wolfe, Professor and Chair, Department of Anthropology, East Carolina University:

Primates began an adaptive radiation around 60 million years ago. During this early adaptive radiation, the basic primate traits evolved, including increased sociality, grasping hands and feet with nails, stereoscopic vision, lack of the wet nose, and relatively large brains. By 20 million years ago during the Miocene epoch, the distant ancestors of modern humans and apes appear in Africa, Europe, and Asia. Because of the scarcity of fossils, it is not now possible to directly connect the primates of the Miocene with modern apes and humans. However, the primate fossils of the Miocene do suggest that the anatomical basis for bipedalism and flexibility of the shoulder girdle evolved during this time. The earliest relatives of modern humans, known as hominids, appear approximately 5 million years ago during the Pliocene epoch. These hominids of the Pliocene and early Pleistocene epoch underwent an adaptive radiation and many fossils found from Ethiopia to South Africa are now known. During this time bipedalism evolved and the canine tooth underwent a change in size, shape, and function. There seems to be a number of different species with somewhat different anatomical features but the direct relationship between these Plio-pleistocene hominids and Homo sapiens is unknown at this time because of a critical lack of complete fossils. By 1 million years ago, most of the Plio-pleistocene hominids disappear except for the early members of our genus known as Homo erectus, found from several sites in Africa, China, and Indonesia. From the neck down, the skeleton of Homo erectus was very much like ours. However, they had slightly smaller brains and larger more robust faces than modern humans and probably were not capable of language as we know it. Archaic Homo sapiens with brain sizes similar to modern humans but who retained large robust faces and skeletons appear in the fossil record around 400,000 years ago. Modern appearing people with less robust skeletons who were capable of language appear after 100,000 years ago. Human evolution is mosaic of retained early primate traits (grasping hands, stereoscopic vision, and sociality), adaptations made to Miocene forests (a flexible shoulder girdle, an upright feeding adaptation which is a forerunner to bipedalism) and the derived traits which appear with the development of our lineage during the Pliocene and Pleistocene epochs

⁴² Kahn, P.A., and A. Gibbons, 1997. DNA from an extinct human. *Science* 277:176.

(bipedalism, an increase in brain size, a change in the size and shape of the canine tooth to function as an incisor, language). The science of human paleontology is relatively young and the fossil record is incomplete. However, new fossils are discovered almost every day which will add to our understanding of the complexities of human evolution.

E. EVOLUTION OF HORSES

The following statement was prepared by Robert Wayne Van Devender, Professor of Biology, Appalachian State University:

The authors of ENCABT attempt to rebut the statement, “The classic case of fossil genealogy is the story of horse evolution, published by Othniel C. Marsh in 1879” (Biology: A Journey into Life, 1994), with a quotation from Niles Eldredge:

*Response: Dr. Niles Eldredge, curator of Invertebrate Paleontology at the American Museum in New York, N.Y. has been quoted as saying: "I admit that an awful lot of that has gotten into the textbooks as though it were true. For instance, the most famous example still on exhibit downstairs (in the American Museum) is the exhibit on horse evolution prepared perhaps 50 years ago. That has been presented as literal truth in textbook after textbook. Now I think that is lamentable, particularly because the people who propose these kinds of stories themselves may be aware of the speculative nature of some of the stuff. But by the time it filters down to the textbooks, we've got science as truth and we've got a problem" [emphasis added] (Luther D. Sunderland, *Darwin's Enigma: Fossils and Other Problems*. Santee, CA: Master Book Publishers, 1984.).*

The quotation from Eldredge has essentially nothing to do with the treatment of the evolution of horses in the textbook under consideration. Contrary to the inference one might draw from the response in ENCABT, the textbook is not presenting Marsh's 1897 view of the evolution of horses and the accompanying diagram of horse genealogy in the textbook is not the figure produced by Marsh in 1897 (nor the one hanging on the walls of the American Museum of Natural History, for that matter). The figure is, instead, an artistic rendition of how some facts (fossils) fit together in time and space. If one tried to trace the “genealogy” of Equus (modern horses, asses, and zebras) from the diagram in the textbook, the best conclusion would be to say that perhaps Hyracotherium was really ancestral to the whole group, a conclusion shared by most experts in the field. The rest of the named forms represent cousins that were too divergent to be direct ancestors.

Further, the quotation on page 285 is clearly taken out of context. The subheading of the section that includes the quotation is “Evidence from the Fossil Record.” If the authors of the text were stating that the conclusions were fact, why would they present data in support of their arguments?

Notice that the quotation from the textbook calls the genealogy of horses published by Marsh in 1879 a “classic” case. The word “classic” does not mean that it is a currently held view, but rather an “outstanding example,” as I will attempt to clarify.

It is the nature of paleontology to collect fossils and to try to make some sort of sense or story out of them. Occasionally, we have fossil groups that are well represented in the fossil record, such as horses and horse-like animals. These groups are represented by enough fossils to tell us enough about the variations seen within species and time periods that we can interpret the differences seen among animals across time intervals. In other words, we can attempt to construct their “genealogy.”

Attempts to construct such evolutionary “family trees” translate pretty well into what modern genealogists do for people. When the basic data have been integrated, however, most genealogists are pretty sure that there are lots of discoveries left that will add whole new chapters to the “definitive history” of any particular family. This phenomenon is equally true for the evolutionary biologist trying to understand whatever bits of history can be gleaned from the available fossils.

Marsh’s interpretation of the evolution of horses published in 1879 is a classic case of fossil genealogy. I am familiar with early,⁴³ middle,⁴⁴ and late⁴⁵ versions of scientist’s interpretations of horse genealogy. In almost all of the various renditions, the basic topology obtains. The fossils force this uniformity. Thus in a rough sense, Marsh’s hypothesis was supported by all the later data. In detail, many of his groups were later found to be meaningless synonyms or to represent divergent side groups. Nevertheless, he did very well with the meager data available to him. Thus his interpretation is a classic or outstanding example of a fossil genealogy based on available evidence.

Concerning the evolution of horses, we really must return to the horse diagram that has hung in the halls of the American Museum of Natural History for so long. What is so wrong with it? Why is it lamentable that this diagram has been reprinted so often in textbooks? Certainly we have many times more data than were available 50 years ago, yet it is the interpretation of the fossils, not the evidence from the fossils themselves, that has varied so much over time. The earlier evolutionists saw “progress” in evolution and saw progressive changes in the fossil record of horses. Through time, forms either became more progressive or went extinct. Long ago we evolutionists killed the dragon of

⁴³ Gaudry, 1866, as reprinted in Rudrick, M. J. S., 1976. The Meaning of Fossils: Episodes in the History of Paleontology (University of Chicago Press, Chicago), p. 247.

⁴⁴ Young, J.Z., 1962. Life of the Vertebrates (Oxford University Press, NY), p. 734.

⁴⁵ Strickberger, M. W., 1996. Evolution (Jones & Bartlett Pub., Inc.), Boston, p. 51.

orthogenesis (directional progress toward some preconceived “goals”). We now perceive that different horse characters changed more or less independently throughout most of their history. Whole lineages died out even if they were very “progressive” with respect to some but not all characters. Surely Dr. Eldredge objected to the outdated thinking the captions purvey, not the data in the display.

In summary, the treatment of the evolution of horses (not just the isolated quotation) in Biology, A Journey into Life, is a reasonable summary of assessment of our current hypotheses. It is pretty unreasonable to ask the author of any text to be explicit about each segment of the scientific world-view, especially in a book for beginners in the field. By the nature of the beasts, textbooks must shorten, abbreviate, and encapsulate most of the materials they present. The original scientific works often contain so much data, analyses, and theory that only experts in the fields are capable of determining whether or not conclusions are justified. Interested students can get from the textbooks the gist of arguments and find out where to go to dig further into the issue. Only then can that same student read what was really said, by whom, and based on what data and logic.

F. EVOLUTION OF PLANTS

The following statement was prepared by Howard S. Neufeld, Associate Professor of Biology, Appalachian State University:

The ENCABT document states that *"We do not actually know the phylogenetic history of any group of plants and animals" (E.L. Core: General Biology. N.Y.: Wiley, 1961. p.299.) Thus, there is no "evolutionary perspective" of plants, and students should not be told that there is."* I will refute the assertions made by Capps' people that there is no evidence of evolution within the plant kingdom. I am a botanist by training, and I can tell you without any qualm that the evolutionary picture within the plant kingdom is clear and straight-forward. We know that primitive plants lacked a vascular system (a set of tubes that conduct water and nutrients throughout the plant, similar to our blood vessels). There is abundant fossil evidence showing that primitive plants lacked a vascular system. This prevented plants from becoming very large, and early plants were all short and restricted to moist habitats. As plants evolved through time, they developed a vascular system that allowed them to more fully exploit their environment, and plants expanded into more stressful habitats (i.e., deserts) and they also became quite large.

Later on, when the atmospheric carbon dioxide levels dropped (for reasons not quite understood yet) a new form of plant evolved, called a C4 plant. C4 plants have a more complicated way of carrying on photosynthesis, the process by which plants take carbon dioxide out of the atmosphere and make sugars in their bodies. This new way of carrying out photosynthesis is much more efficient when atmospheric levels of CO₂ are low, and also more water-use efficient, giving these plants an advantage in dry habitats. Some of our more important crop plants are C4, such as corn and sorghum. We have a detailed understanding of how this may have evolved. We know that it apparently did so in many different families (suggesting that it was not too hard to acquire these adaptations) and

that it has been very successful (some of our most noxious weeds are also C4, such as crabgrass!). Their assertion that we know nothing about plant evolution is patently false!

Finally, notice that both quotations about plant evolution are over 35 years old!! Modern texts on the subject are more forthright concerning evolutionary relationships among plants. The entire discipline of systematics is concerned with the evolutionary relationships among species of plants. This aspect of biology is well understood, even though there remains much to investigate. The big picture is in, and now its time to fill in the details.

PART III. POSITION STATEMENTS

A. NORTH CAROLINA SCIENCE TEACHERS ASSOCIATION (NCSTA)

The following information was sent by Tonya K. Hancock, President, NCSTA, to its members on May 24, 1997:

House Bill 511 is flawed in a number of ways:

1. House Bill 511 is very broadly drawn. It uses the terms “fact,” “theory,” and “belief” without defining the terms. House Bill 511 also says students shall not be taught evolution as proven fact opening the door to challenges related to reading, research, activity, and other assignments deemed by anyone outside the classroom as “proven fact.”
2. Science is not a belief system. Theories are not guesses or beliefs, but instead are those explanations which best fit the available evidence at this point in time. Throughout the history of science, discovery of new evidence has resulted in the revision, discarding, and replacement of theories. No scientific theory is “scientifically proven”; all scientific theories are tested and subject to revision.
3. If the purpose of House Bill 511 is to require teachers and texts to offer evolution as a theory in the scientific sense, it is unnecessary; they already do so. The North Carolina Standard Course of Study, which is required by statute GS 115C-81 to be taught in North Carolina’s public schools, treats evolution as a theory in every instance.
4. Legislation such as House Bill 511, if passed, is likely to cost taxpayers for useless litigations. In 1968, in its *Epperson v. Arkansas* decision, the Supreme Court outlawed bans on teaching evolution. In 1994, the Ninth Circuit Court of Appeals ruled in *Pelozo v. Capistrano* that evolution is not a religious belief but a scientific principle; the Supreme Court refused to hear an appeal of this ruling thus allowing the decision to stand.
5. Bills such as House Bill 511 have an intimidating effect on teachers. As a result many teachers will likely avoid teaching evolution, thus causing them to violate the North Carolina statute requiring the teaching of the North Carolina Standard Course of Study. Legislation which explicitly bans teaching evolution has been found unconstitutional; vague legislation that has a “chilling effect” is also likely to be found unconstitutional. In First Amendment Law, laws which have a “chilling” effect on behavior are often found as unconstitutional as laws which explicitly forbid that behavior.
6. House Bill 511, if passed, will place an enormous burden on teachers by requiring them to:
 - A. Violate the professional standards of the science teaching profession as set forth in position statements published by the National Science Teachers

Association, the National Biology Teachers Association, and the North Carolina Science Teachers Association.

- B. Spend unnecessary time screening instructional material to “protect students from seeing evolution presented as fact.” It should be noted here that the information in recognized national science textbooks represents the consensus of current scientific evidence. The scientific community does not recognize that evolution is riddled with “unproven misconceptions and untruths.” In addition state and local adoption procedures are designed to provide the best possible materials for classroom use.

7. All recognized national science curricula, including the National Research Council’s National Science Standards, the AAAS Benchmarks, standards set forth by the National Association of Biology Teachers, and the position statements of the National Science Teachers Association, include the teaching of evolution as a theory. Failure to teach evolution in our schools, whether due to intimidation or other causes, would severely impede our ability to graduate competent, scientifically literate citizens for the twenty-first century.

8. Enactment of legislation, such as House Bill 511, could have a serious impact on the climate for science-related industry in our state. If you were the CEO of a large corporation whose reason for existence was based on modern biological theory and practice, would you consider this bill an invitation to locate or expand your presence in our state?

B. UNIVERSITY OF NORTH CAROLINA MATHEMATICS & SCIENCE
EDUCATION NETWORK (UNCMSSEN)

The following is a UNCMSSEN position statement:

Introduction

The UNC Mathematics and Science Education Network’s position on the theory of evolution is that it is indeed a valid scientific theory substantiated by irrefutable evidence. The theory of evolution should therefore be supported and taught as a major unifying concept of science within all North Carolina K-12 science frameworks and curricula.

Scientific Theory

Human beings are engaged in a constant search for explanations as to the nature of the universe and their place within it. Out of this quest for reason and order the process of science was developed--a set of controlled, replicable guidelines allowing for the accumulation of hard data as evidence to support or reject a hypothesis. Hypotheses are proposed and tested repeatedly over time by a number of scientists. When evidence in support of a hypothesis has accumulated, hypotheses are then elevated to scientific theories. Scientific theories are then logical constructs widely accepted as factual among the scientific community. As were the theories of gravity and the atom, the theory of

evolution has been formulated in the described manner. The overall consensus of the scientific community is that evolution is indeed a valid theory.

Evidence for Evolution

Science as we know it today is a dynamic process...a body of knowledge based on observable, testable, pragmatic evidence. Scientific theories are therefore never irrevocably proven; they are only increasingly or decreasingly supported by evidence. The theory of evolution is continuously subject to further experimentation, investigation and question, much like any other scientific theory. Yet, it remains the responsibility of scientific endeavor to continue to rely on what is now known as scientific method to construct, test, support or debunk all scientific theories or hypotheses.

While today's scientists may utilize the scientific method to debate the pace and patterns of evolution, they do not debate evolution's occurrence. The fossil record and the diversity of existing organisms, combined with modern techniques of molecular biology, taxonomy and geology, provide exhaustive examples and powerful evidence for the well established components of current evolutionary theory.

Evolution and the Science Curriculum

The primary goal of science teaching is to produce a scientifically competent citizenry, one which knows how to distinguish between theories substantiated with sound evidence and theories which cannot be substantiated through evidence. Evolution is identified as being the central unifying role in the biological sciences. If we teach our student that the theory of evolution is not accepted as fact, we also put in to question scientific advancement in chemistry, physics, astronomy, and all other related fields, as all of these disciplines are built according to similar intellectual stratagems.

School curricula should therefore be determined, not by the political mood of the moment, but by scholarly and academic consensus. North Carolina students deserve an engaging, enriching science curriculum based on the process of the scientific method. Any action opposing the tenets which honor the methodologies of scientific investigation should be viewed as a disservice to North Carolina students and science educators.

C. NORTH CAROLINA ACADEMY OF SCIENCE (NCAS)

The following resolution was passed unanimously by the membership of the NCAS at its annual meeting in March, 1997. It was written in response to the initial version of House Bill 511; the Board of Directors of the NCAS has affirmed its opposition to the amended bill -- see PART I, H above:

The legislation has recently been introduced in the North Carolina General Assembly that attacks the teaching of evolution in North Carolina public schools. House Bill 511, entitled, "An act to amend the public school laws to ensure that evolution is not taught as fact in North Carolina public schools," asserts that:

"...the theory of evolution is a belief and not true science and should not be taught as fact..." and

“...the teaching of evolution as fact, when it can not be scientifically proven, requires students to accept the teaching by faith...” and

“...the technology used to define evolutionary theory is vague and misleading, and some public school teachers and all presently approved biology textbooks present evolution as fact with many unproven misconceptions and untruths...”

The North Carolina Academy of Science finds these assertions to be false and to present a clear danger to the primary goal of science teaching, which is to produce scientifically literate citizens. Teaching biology in an effective and scientifically honest manner requires classroom discussions and laboratory experiences on evolution. The opposition to teaching evolutions reflects confusion about the nature and process of science.

A scientific theory is an extensive explanation developed from well documented, reproducible sets of experimentally derived data and repeated observations of natural processes, not a guess or an unsupported belief. The processes of science are characterized by asking questions, proposing hypotheses, and designing empirical models and conceptual frameworks for research about natural events. The models and outcomes of a scientific theory are not decided in advance, but can be and often are modified and improved as new empirical evidence is uncovered. Thus science is an inherently self-correcting endeavor to understand nature and natural phenomena.

Therefore, in accordance with its longstanding position on these issues, the N.C. Academy of Science resolves that:

Whereas, the modern scientific theory of evolution is supported by an enormous quantity of scientific evidence from the fields of geology, physics, chemistry, paleontology, biochemistry, genetics, taxonomy, anatomy, physiology, and ecology;

Whereas, the scientific theory of evolution provides a unifying conceptual framework for modern biology, predictive, testable hypotheses about the natural world, and key insights leading to significant progress in biology and medicine;

The N.C. Academy of Science strongly opposes House Bill 511 and any other legislation that would effectively diminish the scientific literacy of students as it relates to a basic understanding of the scientific process, particularly with reference to the teaching of modern evolutionary theory in North Carolina public schools.

PART IV. SOURCES OF ADDITIONAL INFORMATION

- To obtain additional information on evolution and creationism, including The National Center for Science Education Membership Directory 1997, and back issues of Creation/Evolution, you may wish to contact:

National Center for Science Education (NCSE)

925 Kearney St.

El Cerrito, CA 94530-2810

Email address: ncse@natcensci.ed.org

Phone number: 1-800-290-6006

FAX number: 1-510-526-1675

- To obtain information on law as it relates to religion in the public schools, you may want a copy of the pamphlet “Religion in the Public Schools: A Joint Statement of Current Law.” The statement was drafted by 12 organizations (including the American Jewish Committee, American Muslim Council, Baptist Joint Committee, General Conference of Seventh-day Adventists, National Association of Evangelicals, National Council of Churches) and endorsed by an additional 24 religious and civil liberties organizations. The pamphlet is available without charge from the North Carolina Chapter of Americans United for Separation of Church and State (919-832-6786).
- Internet websites of interest:

National Center for Science Education: www.natcensci.ed.org

The National Science Teachers Association: www.nsta.org

The National Association of Biology Teachers: www.nabt.org

The National Science Foundation: www.nsf.gov

National Geographic Magazine: www.nationalgeographic.com

North Carolina Academy of Science: www.ncacadsci.org

APPENDIX

A. HOUSE BILL 511

1. Original Version Submitted to Education Committee of House

HOUSE BILL 511

Short title: Evolution Not Taught as Fact. (Public)

Sponsors: Representatives Capps; Aldridge, Barbee, Brown, Cansler, Davis, Decker, Eddins, Ellis, Hill, Howard, Kiser, McMahan, Nichols, Nye, Reynolds, Shubert, Starnes, Warner, Weatherly, C. Wilson, G. Wilson.

Referred to: Education

March 13, 1997

A BILL TO BE ENTITLED

AN ACT TO AMEND THE PUBLIC SCHOOL LAWS TO ENSURE THAT EVOLUTION IS NOT TAUGHT AS FACT IN NORTH CAROLINA PUBLIC SCHOOLS.

Whereas the students in North Carolina public schools should be taught truth; and

Whereas, understanding science is essential for the survival of a free, democratic society; and

Whereas, the Mission Statement of the North Carolina Teacher Handbook Science K-12 declares that all students become scientifically literate; and

Whereas, modern scientific methods have shown that life is exceedingly complex and there is no present satisfactory scientific explanation for the origin of life from nonlife; and

Whereas scientific literacy implies that students receive substantial knowledge of concepts and process skills which enable the individual to continue to learn and think logically; and

Whereas, science depends upon the use of proven facts and testable hypotheses; and

Whereas, the theory of evolution is a belief and not true science and should not be taught as fact, nor should student attitudes “be part of an achievement score”; and

Whereas, there are ample opportunities to teach biological facts that are true, useful, and relevant to the student and useful throughout life; and

Whereas, the teaching of evolution as fact, when it cannot be scientifically proven, requires students to accept the teaching by faith; and

Whereas, the technology used to define evolutionary theory is vague and misleading, and some public school teachers and all presently approved biology textbooks present evolution as fact with many unproven misconceptions and untruths; Now, therefore,

The General Assembly of North Carolina enacts:

Section 1. Chapter 115C of the General Statutes is amended by adding a new section to read:

“115C-81.3 Students shall be taught true science and not belief.

The State Board of Education and local boards of education shall ensure that students in North Carolina public schools are not taught evolution as proven fact.”

Section 2. This act becomes effective July 1, 1997.

2. Amended Version Approved by the Education Committee and the House
HOUSE BILL 511

Committee Substitute Favorable 4/29/97

Short Title: Evolution Not Taught as Fact. (Public)

A BILL TO BE ENTITLED

AN ACT TO AMEND THE PUBLIC SCHOOL LAWS TO ENSURE THAT EVOLUTION IS NOT TAUGHT AS FACT I

Section 1. The State Board of Education shall revise the Standard Course of Study in the science curriculum to reflect that evolution is taught as a scientific theory, not as proven fact. The Board shall make the necessary changes to the Standard Course of Study by July 15, 1997.

Section 2. This act becomes effective July 1, 1997, and shall apply beginning with the 1997-98 school year.

**B. “AN EVALUATION OF NC APPROVED BIOLOGY TEXTBOOKS”
(ENCABT)**

The full text of "Evaluation Of NC Approved Biology Textbooks" From Office Of Russell Capps is printed below:

EVALUATION OF N.C. APPROVED BIOLOGY TEXTBOOKS

The NC approved biology textbooks were evaluated to determine if they contain errors, inaccuracies and bias. The exaggeration, untruths and questionable evidence appearing in the textbooks which we have examined are rivaled by the lack of information and stimulating knowledge which is left out of the texts. None of the texts present the very interesting and mentally stimulating instincts of the various animals. Nest building, courtship rituals, hunting methods, social and child rearing activities are seldom mentioned. Physical differences of organisms are ascribed to evolution, with no explanation of how the organ or part evolved. The material presented would not appear to be designed to stimulate a student to undertake a scientific career.

The differences between the eggs of fish, amphibians, reptiles and mammals are ascribed to evolution in most of the texts with no description of the intricacies of these eggs, and the wonder of how respiration, nutrition and management of excreta are carried out. Furthermore, there is generally no effort made to explain just how this change occurred, and the stages through which the process had to have undergone. If the author does not understand how evolution resulted in these wondrous events the student should be so advised in expectation that he or she might want to seek to know, or to recognize the flaws in the theory. The material presented in most of these textbooks suggests the intent more of indoctrination than education.

There are several very serious deficiencies in all of the texts examined. Some of these deficiencies involve the origin of life, and it is difficult to imagine that the authors are ignorant of the facts. In discussing the possibility of life arising from non-living chemicals, all of the textbooks claim that some of the amino acids of life are formed when an electric current is passed through the atmosphere of oxygen, but it is not emphasized that

- 1) *20 special amino acids are necessary, and only a few are ever found;*
- 2) *the amino acids formed must be separated immediately from the watery mixture or they decompose rapidly;*
- 3) *The amino acids formed are a mixture of levorotary and dextrorotary forms whereas the amino acids of living organisms are 100% levorotary. Proteins made of a mixture of levorotary and dextrorotary would not function. These forms are called racemates, and this is an absolutely vital issue, yet the word "racemate" is not included in the glossary or index of any of the approved textbooks of North Carolina!!*
- 4) *If there was no oxygen in the atmosphere there would be no Ozone shield, and the ultraviolet radiation would rapidly destroy any life. Again, this difficulty is not addressed in any of the textbooks which we have examined.*

It seems of some interest that throughout most of the textbooks considerable discussion is given to the possible explanation of extinction, but no effort is made to explain steps by which new physical forms, new biochemical or immunological functions, or new organs develop. The new characteristics are simply ascribed to "evolution", never "how" or by what route. Science demands such explanation to be accepted by inquiring minds, and North Carolina students are not receiving this knowledge or inspiration.

The North Carolina Approved Textbooks of biology appear to be copying each other's dogma because all of them include the same or similar misinformation. North Carolina students and teachers deserve better.

Biology, Third edition. Campbell, Neil A. Benjamin Cummings Publishing Co. N.Y. 1993.

p. 435 Just a Theory? "Some people dismiss Darwinism as 'just a theory'... Arguing about evolutionary theory is like arguing about competing theories of gravity; we know that objects keep right on falling while we debate the cause."

Response: This statement is an attempt through unscientific comparison to equate the Theory of Evolution with the Law of Gravity, by denigrating the law of gravity to "just a theory". This is an obvious attempt to establish in the minds of students that evolution is fact. Dr. Colin Patterson (Senior Paleontologist, British Museum of Natural History, London), in the keynote address at the American Museum of Natural History, New York, NY on 5 November 1981 stated that he had asked a simple question to various groups: "Can you tell me anything you know about evolution, any one thing, any one thing that is true?" He received only silence from the geology staff at the Field Museum of Natural History (Chicago), and from the prestigious body of the Evolutionary Morphology Seminar in the University of Chicago until one person said: "I do know one thing-- it ought not to be taught in high school."

p. 511 "We do know that prokaryotes (bacteria and blue-green algae) were already flourishing at least 3.5 billion years ago, and that all kingdoms of life descended from those ancient prokaryotes." [Emphasis Added]

Response: There is no proof that any kingdom descended from another. The fossil record fails to show any descent from transitional forms. See what Dr. Clark and Dr. Gould say. Dr. Austin Clark of the U.S. National Museum who spent many years investigating the relationships of various groups of animals to each other, both fossil and living, affirmed in The New Evolution Zoogenesis: "No animals are known even from the earliest rocks which cannot be at once assigned to their proper phylum or major group. A backboned animal is always unmistakably a backboned animal, a starfish is always a starfish, and an insect is always an insect whether we find it as a fossil or catch it alive at the present day".

Stephen J. Gould of Harvard has written in Is a New and General Theory of Evolution Emerging?: "The extreme rarity of transitional forms in the fossil record persists as the trade secret of paleontology -- Darwin's argument still persists as the favored escape of most paleontologists from the embarrassment of a record that seems to show so little of evolution directly -- it [gradual evolution] was never 'seen' in the rocks."

p. 651 "Birds (class Aves) evolved from a reptilian ancestor during the great reptilian radiation of the Mesozoic era."

Response: This statement represents faith in the theory of evolution, yet there is no proof. W.E. Swinton of the British Museum of Natural History wrote in Biology and Comparative Physiology of Birds: "... there was no fossil of the stages through which the remarkable change from reptile to bird was achieved."

p. 655 "Mammals evolved from reptilian stock even earlier than birds."

Response: "the [evolutionary] transition to the first mammal, which probably happened in just one of, at most, two lineages, is still an enigma" (Roger Lewin, "Bones of Mammals' Ancestors Fleshed Out", Science, vol. 212, 26 June, 1981, p. 1492.).

p. 661 Australopithecines: The First Humans

Response: "Nebraska Man", which was featured in the Scopes Trial, and was ballyhooed with drawings in the press of a cave-man and his mate, but was based on a single tooth, later turned out to be an extinct pig. "Piltdown Man", which was acclaimed for 31 years, was found to be a hoax. Others, such as "Java Man", were finally declared as misrepresentations, or denigrated to just apes, as Ramapithecus.

Dr. Charles E. Oxnard, professor of anatomy and anthropology at the University of Chicago, after extensive studies regarding relation to form and function, concluded "that these fossils (of Australopithecines) are uniquely different from modern man in many major respects". These findings support the contention of Lord Solly Zuckerman, M.A., M.D., D.Sc. (Anatomy), that "...students of fossil primates have not been distinguished for caution when working within the logical constraints of their subject. The record is so astonishing that it is legitimate to ask whether much science is yet to be found in this field at all" (Beyond the Ivory Tower, Taplinger Pub. Co., New York, 1970. p. 64.).

p. 663 "The first hominid to migrate out of Africa into Asia and Europe was *Homo erectus* ('upright man'). The fossils known as Java Man and Peking Man are examples of this species."

Response: The word hominid suggests that man evolved from apes, for which there no real evidence. "Java Man" was found by Eugene Dubois, a Dutch physician who had determined that he would be the person to discover the "missing link". Sure enough, he found a skull cap, three molar teeth, and a thigh bone, which he named "Pithecanthropus erectus". After many evolutionists accepted this specimen as man-like, Dubois later admitted finding true human skulls in the same rock formations in which the bones of his specimen were found. Still later he changed his opinion about Pithecanthropus erectus, and considered the skull cap that of an ape or gibbon. Some textbooks still refer to this find as an example of man's evolution from apes, but there is no real evidence.

p. 416 - 670 (170 pages) - *The Evolutionary History of Biological Diversity* -- 170 pages out of 1190 (13.4%).

Response: Much of these 170 pages is pure conjecture. This much rhetoric would have the potential of suggesting to students that there is scientific authenticity in the theory of evolution. Biological diversity is acceptable as fact, but proof is lacking for evolution. This division heading suggests evolution as fact.

p. 676 "Basic Morphology of Flowering Plants: An Evolutionary Perspective."

Response: "... I still think that, to the unprejudiced, the fossil record of plants is in favor of special creation. If, however, another explanation could be found... it would be the knell of the theory of Evolution (E. J. H. Corner, of the Cambridge University Botany School, Contemporary Botanical Thought. eds. A.M. McLeod & L.S. Cobey. Chicago: Quadrangle, 1961. p. 97.).

"We do not actually know the phylogenetic history of any group of plants and animals" (E.L. Core: General Biology. N.Y.: Wiley, 1961. p. 299.)

Thus, there is no "evolutionary perspective" of plants, and students should not be told that there is.

Biology: A Journey Into Life -- Karen Arms, Pamela S. Camp, Janann V. Jenner, Edward J. ZaliskoSaunders College Publishing Harcour Brace College Publishers, NY 1994.

p. 285 "...we can trace the origin of mammals from reptiles in great detail in the fossil record." *Biology: A Journey Into Life -- Arms, Camp, Jenner, Zalisko (cont'd)*

Response: This statement is simply not so. "... Gould (Stephen J.) and the American Museum people are hard to contradict when they say there are no transitional fossils. You say that I should at least show a photo of the fossil from which each type of organism was derived! I will lay it on the line--- there is not one such fossil for which one could make a water-tight argument" [emphasis added] (Personal letter from Dr. Colin Patterson, Senior Paleontologist at the British Museum of Natural History in London, to Luther D. Sunderland, B.S. as quoted in Darwin's Enigma: Fossils and Other Problems, Luther D. Sunderland, B.S., Master Books, San Diego, USA 1984. p. 89.).

p. 285 *"The classic case of fossil genealogy is the story of horse evolution, published by Othniel C. Marsh in 1879."*

Response: Dr. Niles Eldredge, curator of Invertebrate Paleontology at the American Museum in New York, N.Y. has been quoted as saying: "I admit that an awful lot of that has gotten into the textbooks as though it were true. For instance, the most famous example still on exhibit downstairs (in the American Museum) is the exhibit on horse evolution prepared perhaps 50 years ago. That has been presented as literal truth in textbook after textbook. Now I think that is lamentable, particularly because the people who propose these kinds of stories themselves may be aware of the speculative nature of some of the stuff. But by the time it filters down to the textbooks, we've got science as truth and we've got a problem" [emphasis added] (Luther D. Sunderland, Darwin's Enigma: Fossils and Other Problems. Santee, CA: Master Book Publishers, 1984.).

Despite Dr. Eldredge's disclaimer, the exhibit remains on display in the American Museum.

"The real origin of horses is unknown" (T. Storer, zoologist, General Zoology. New York: McGraw-Hill, 1957. p.216.)

p.285 *"Whales have bony flippers because they evolved from land mammals with bony forelimbs."*

Response: There is no proven evidence that whales evolved from land mammals. "Like the bats, the whales...appear suddenly...fully adapted...for a highly specialized mode of life...they stand quite alone" (E.H. Colbert, Evolution of the Vertebrates, First ed. New York: John Wiley and Sons, 1955. p. 303.).

p.288 *"...embryos of mammals, including humans develop a row of gill slits... This suggests that these groups of animals descended from the fishes..."*

Response: This teaching is found primarily in school textbooks, although it was proved to be a fraud in 1874 by Professor Wilhelm His, Sr., a famous comparative embryologist at the University of Leipzig in Germany. Professor His accused Ernst Haeckel of falsifying his drawings of embryos to "prove" evolution. Haeckel confessed and reputable evolutionists acknowledge that this teaching is utterly false.

The embryos of mammals, including humans, have visible folds in the region of the neck at a particular stage in the formative period, but these folds produce varying structures such as the Thyroid gland and ear -- not gills. This claim, which is found in one form or another in all of the North Carolina Biology School Books, was shown to be false over 100 years ago, yet it is still claimed because it makes such a convincing story for evolution. Those who claim it as fact are either ignorant of biological fact or deceitful. It should be stricken from the textbooks and disclaimed by our teachers.

Biology: Visualizing Life George B. Johnson, Holt, Rinehart and Winston, NY, 1994

Evolution dogma prominent throughout the text, and implied as fact rather than theory.

p. 127 "Mutations act as a source of the variation that is needed for a species to adapt to changing conditions or a new environment, and, thus, evolve over time."

Response: "Most mutations are bad. In fact, good ones are so rare that we can consider them all as bad." H.J. Muller, "How Radiation Changes the Genetic Constitution", *Bulletin of the Atomic Scientist*, vol. 11 No. 9 (November 1955, p. 331). Dr. Miller is recipient of the Nobel Prize for his work with mutation.

"Mutation never produced anything new. They [mutant fruit flies] had malformed wings, legs and bodies and other distortions, but they always remained fruit flies" (Theodosius Dobzhansky [world renowned naturalist and an evolutionist], in *Heredity and the Nature of Man*. New York: Harcourt, Brace and World, 1964. p. 126.).

p. 225 figure 11.6

This is an evolutionary tree claiming to show the close relationship between humans and apes. The figure depicts "common ancestor of living apes and humans".

Response: All candidates for the "ancestor" of Homo Sapiens have either proved to be fakes (Pitldown Man) or misrepresentations or apes, or fully human. Neanderthal Man was fully human, specimens of Homo erectus (Java Man and Peking Man) have been declared probable orangutans, "Nebraska Man", so-named during the Scopes Trial and based on the finding of a single tooth, was debunked when the tooth proved to be that of an extinct pig, and more recently specimens of Australopithecine's have failed the test when Dr. Charles E. Oxnard, Professor of Anatomy and Human Biology at the University of Western Australia, after conducting highly technical studies relating form and function concluded that, "these fossils are uniquely different from modern man in many major respects" (*Fossils, Teeth and Sex -- New Perspectives on Human Evolution*, University of Washington Press, Seattle and London, 1987. p. 227.).

Biology: Kenneth R. Miller, Joseph Levine. Prentice Hall, Englewood Cliffs, NJ 1995

p.291 Fig. 13-15 "Horse Series"

Response: This Horse Series, which claims to depict the evolution of the horse, is a blatant falsehood, and should be so admitted by the authors. See response to "horse evolution," p.285 in *Biology: A Journey Into Life*.

p. 291 "But the revisions do not mean that evolutionary change itself is debatable or that evolutionary theory is merely a collection of vague hunches that are not supported by evidence. Evolutionary change is undeniable."

Response: By way of confusion, the Law of Gravity is again compared in the following paragraph, but called the Theory of Gravity, which would tend to equate the authenticity of the Theory of Evolution with the Law of Gravity. Here, again, the Theory of Evolution is declared to be fact. These textbooks should be rejected for promoting untruths.

Biology: The Unity and Diversity of Life, Seventh Edition. Cecie Starr and Ralph Taggart Wadsworth Publishing Company, NY, 1995.

p. 470 "Human Evolution: A Case Study"

Response: This textbook presentation strongly suggests to students that human evolution is fact.

p. 471 "The quality of 'humanness' did not materialize out of thin air. The story as the human species began more than 60 million years ago, with the origin of primates in tropical forests. ...our uniquely human traits emerged through modification of traits that had already evolved in ancestral forms. ...certain mutations produced workable changes in traits, which proved useful..."

Response: This paragraph strongly presents human evolution as fact with no supportive evidence of "traits" that had already evolved.

It is well established that mutations are usually harmful, and "never produce anything new" (Theodosius Dobzhansky, Heredity and the Nature of Man. New York, 1964. p.126.). It is a stretch to claim that the unique human brain, with the ability to use language, art, conceptualization, etc., developed through mutations, which are "usually harmful, and never produce anything new," and are not a source of new or more complex genetic material. This possibility has not been demonstrated to be within the bounds of natural selection. A science textbook should indicate the uncertainties in this hypothesis.

Biology: An Everyday Experience, Albert Kaskel, Paul J. Hummer, Jr., Lucy Daniel. Glencoe, Division of MacMillan/McGraw-Hill Publishing Company, NY, 1995.

Theory of Evolution fairly limited to Chapter 29 with only 18 pages (p.604-622) of a total 719 pages. Organisms described in remainder of the book without the differences being ascribed to evolution. However, like the other textbooks the usual mistaken dogma is included in Chapter 29, such as: p. 609, "Many new traits come from mutations." As pointed out earlier, the expert evolutionists caution that mutations are almost 100% harmful, and mutations are not a source of new or more complex genetic material.