

Creation Research Society Quarterly

Haec credimus:

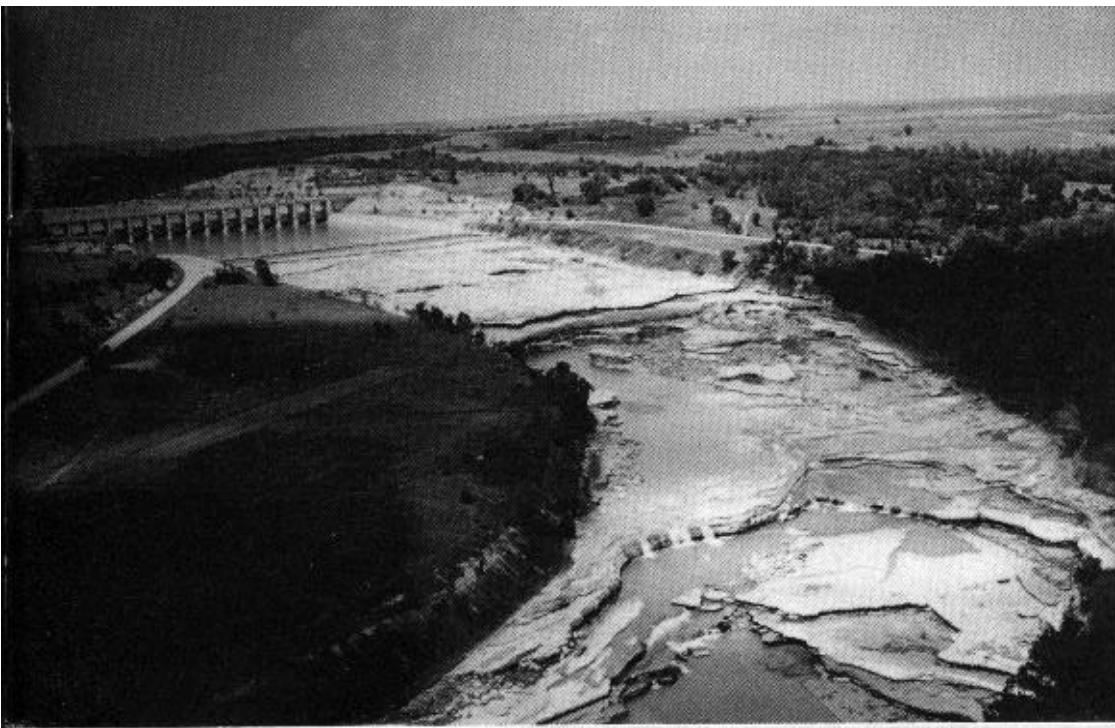
For in six days the Lord made heaven and earth, the sea, and
all that in them is, and rested on the seventh. — Exodus 20:11

VOLUME 31

SEPTEMBER 1994

NUMBER 2

**EXTENSIVE
EROSION
CAN
OCCUR . . .**



**IN A
BRIEF
PERIOD
OF
TIME**

CREATION RESEARCH SOCIETY

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VOLUME 31

SEPTEMBER 1994

NUMBER 2

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Book Review Editor: Don B. DeYoung, 200 Seminary Dr., Winona Lake, IN 46590.

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MEMBERSHIP/SUBSCRIPTION APPLICATION FORM

CREATION RESEARCH SOCIETY

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CREATION RESEARCH SOCIETY

History The Creation Research Society was organized in 1963, with Dr. Walter E. Lammerts as first president and editor of a quarterly publication. Initially started as an informal committee of 10 scientists, it has grown rapidly, evidently filling a real need for an association devoted to research and publication in the field of scientific creation, with a current membership of over 600 voting members (with graduate degrees in science) and over 1100 non-voting members. The *Creation Research Society Quarterly* has been gradually enlarged and improved and now is recognized as the outstanding publication in the field.

Activities The society is solely a research and publication society. It does not hold meetings or engage in other promotional activities, and has no affiliation with any other scientific or religious organizations. Its members conduct research on problems related to its purposes, and a research fund is maintained to assist in such projects. Contributions to the research fund for these purposes are tax deductible. The Society operates two Experiment Stations, the Grand Canyon Experiment Station in Chino Valley, Arizona and the Grasslands Study Site in Weatherford, Oklahoma.

Membership Voting membership is limited to scientists having at least an earned graduate degree in a natural or applied science. Dues are \$20.00 (\$24.00 foreign) per year and may be sent to Glen W. Wolfrom, Membership Secretary, P.O. Box 969, Ashland, OH 44805-0969. Sustaining membership for those who do not meet the criteria for voting membership, and yet who subscribe to the statement of belief, is available at \$20.00 (\$24.00 foreign) per year and includes a subscription to the Quarterlies. All others interested in receiving copies of all these publications may do so at the rate of the subscription price for all issues for one year: \$23.00 (\$27.00 foreign).

Statement of Belief Members of the Creation Research Society, which include research scientists representing various fields of successful scientific accomplishment, are committed to full belief in the Biblical record of creation and early history, and thus to a concept of dynamic special creation (as opposed to evolution), both of the universe and the earth with its complexity of living forms. We propose to re-evaluate science from this viewpoint, and since 1964 have published a quarterly of research articles in this field. In 1970 the Society published a textbook, *Biology: A Search for Order in Complexity*, through Zondervan Publishing House, Grand Rapids, Michigan 49506. All members of the Society subscribe to the following statement of belief:

1. The Bible is the written Word of God, and because it is inspired throughout, all its assertions are historically and scientifically true in all the original autographs. To the student of nature this means that the account of origins in Genesis is a factual presentation of simple historical truths.
2. All basic types of living things, including humans, were made by direct creative acts of God during the Creation Week described in Genesis. Whatever biological changes have occurred since Creation Week have accomplished only changes within the original created kinds.
3. The Great Flood described in Genesis, commonly referred to as the Noachian Flood, was a historical event worldwide in its extent and effect.
4. We are an organization of Christian men and women of science who accept Jesus Christ as our Lord and Saviour. The account of the special creation of Adam and Eve as one man and woman and their subsequent fall into sin is the basis for our belief in the necessity of a Savior for all people. Therefore, salvation can come only through accepting Jesus Christ as our Savior.

“CHRISTMAS SPECIAL” ON CERTAIN VOLUMES OF CRSQ

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NEW BOOKS AVAILABLE

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ERRATA

On page 5, *CRSQ* Vol. 31, the title of the book being quoted (see center “Quote”) should read “Scientific Literacy.”

On p. 31, *CRSQ*, Vol. 31, the first reference at the top of column 2 should begin with the name Kuenen, P. H.

On p. 49, *CRSQ*, Vol. 31, the caption of Figure 7d should read “From *top* to *bottom*” instead of “From *right* to *left*.”

Editors' Comments

Over the years there has been a paucity of creation-oriented professional geologists to produce CRSQ papers showing how research data fit with a young-earth creationist scenario. To try to fill this void, some otherwise gifted scientists who did not receive their graduate degrees in geology have "filled the gap" by authoring creationist earth-science books and CRSQ papers. Happily they were joined from time to time by some geological "professionals" who were willing to overcome what must continue to be a very strong peer-generated reticence to draft treatises contradicting such cherished historical philosophies as "biostratigraphic correlation," the "geologic column," and "uniformitarianism." In this issue you will enjoy the work of Mr. Jack Cowart and Mr. Carl Froede, Jr., both of whom are professional geologists.

You will likewise encounter the lucid writing and photography of Dr. Glen Wolfrom, Dr. Edmond Holroyd, and Dr. Eugene Chaffin who have each become experts on the subjects of the rapid geological work accomplished by the 1993 floods-of-record in the mid-western U.S., the boulders of Bangs Canyon, and Triassic basins of Virginia, respectively.

It is with a deep sense of loss, however, that we report the passing of a geologist who frequently published his own research findings in CRSQ and who was one of the original "team of ten" who founded the CRS—Dr. Wilbert Rusch, Sr. Readers will want to review the contributions that Bill Rusch made by reading a dedication to him (CRSQ 18:3) and a more recent tribute to him and the other membership secretarial workers (CRSQ 29:133-134). We convey our deepest sympathies to Mrs. Rusch and to the entire Rusch family.

Dr. Jon West's account of a polytropic universe will offer a model of our universe written by an astronomer who also happens to be a creationist. In recent years

the popular press has treated its readers with reports on data from the cosmic background explorer (COBE) dealing with the smoothness of the angular distribution of this radiation. Dr. West's article will help us understand what to think about this problem as well as the interpretation of redshifts, types and distributions of galaxies, and related questions.

Several years ago Dr. Jerry Bergman coauthored a book showing that "vestigial organs" really work. Now Dr. Bergman presents an important continuation of his studies in which we learn that even the sometimes pesky wisdom teeth actually supply evidence for wisdom in origins.

By means of a questionnaire that many of you filled out, Dr. Lane Lester has helped CRS look at itself. Inspired by some suggestions in that poll, he has developed a new CRSQ feature entitled "Copy 'n Share." Readers are invited to replicate, distribute, and otherwise use pages 95, 96 and 97 as they wish.

During the week of July 17-23, the Third International Conference on Creationism (ICC) was held in Pittsburgh. Geological, cosmological, biological and other papers were presented to try to elucidate further the creation model of science. The papers were of a very high quality, partially as a result of the team efforts of editors and reviewers. We congratulate the participants and organizers and look forward to seeing the further elaboration of the new models and ideas. We know that the Creator is wiser than the creationists. We hope that the ICC, CRSQ and other endeavors will not be viewed as ego-trips for non-evolutionists but as our attempts to understand and appreciate the Creator's rapid and recent activity in making the universe and all that it contains.

Eugene Chaffin and George Howe
September, 1994

LETTERS TO THE EDITOR

Human Fossils

I appreciate Michael Oard's gracious review of my book, *Bones of Contention: A Creationist Assessment of the Human Fossils*, in the March 1994 issue of CRSQ. Allow me to clarify two items.

Oard quoted me correctly in stating that *Homo erectus* was basically a smaller version of the Neandertals. However, that comparison refers more to cranial capacity than it does to body height. The cranial capacity normally given for *Homo erectus* goes from about 750 cc to about 1250 cc, and that given for the Neandertals goes from about 1250 cc to about 1740 cc or higher. Hence, by definition, *Homo erectus* has a smaller cranial capacity than do the Neandertals, and that is perhaps the main characteristic that separates them.

In the past, *Homo erectus* has also been presented as being a bit shorter or smaller in body size as well.

However, recent fossil discoveries in Kenya of fairly complete *Homo erectus* skeletons such as KNM-ER 1808 and KNM-WT 15000, both dated by evolutionists at about 1.6 Myr, reveal that *Homo erectus* may have been fully as tall as the Neandertalers and possibly as tall as modern humans. This is a rather new and (to the evolutionist) surprising discovery.

Oard also gives the correct 1976 figures for the discovery of the Neandertals at about 200 fossil individuals, and for *Homo erectus* at about 100 fossil individuals. The current figures are even more impressive: over 220 *Homo erectus* fossil individuals discovered to date, possibly as many as 80 archaic *Homo sapiens* fossil individuals discovered to date, and well over 300 Neandertal fossil individuals discovered to date.

Marvin L. Lubenow
Professor: Bible / Apologetics
Christian Heritage College
El Cajon, CA 92019

Comments on "Underwater Mudcracks" by M. J. Oard, 1994, CRSQ 30:213-214

Introduction

Michael J. Oard (1994) presented an excellent note discussing several issues, including the use of sediment and fossils as environmental indicators and how mudcracks can and do form underwater (i.e., syneresis mudcracks). In the note Oard asked several questions and raised two issues on which I would like to comment and elaborate.

Environmental Indicators

Oard (1994) pointed out to the reader that the combination of fossils and lithology seem to dictate the environment of deposition. This is a fundamental concept in uniformitarian stratigraphy and sedimentology. The uniformitarian model proposes that the processes and environments we see around us today can be carried back into the past with little to no change in rate. This concept is often phrased as "the present is key to the past." This concept of steady rate has, over the past 15 years, come under some question (Ager, 1993, pp. 55-72; Dott, 1983, pp. 5-23; Gould, 1984, pp. 9-34; Miall, 1990, p. 170; Seilacher, 1984, pp. 49-54). However, although this aspect of the uniformitarian model is currently under debate, the concept itself remains unchanged.

All of the carbonate and clastic (i.e., sand, silt and clay) material is dated *primarily* by the fossils which they contain (i.e., biostratigraphy). Additionally, paleo-environmental reconstruction is also based on the flora and fauna contained within the strata. This concept has created problems for the reconstruction of depositional environments for uniformitarian stratigraphers.

I agree with Oard (1994) and echo his statement that the young earth Flood modeler must not rely solely on fossils to reconstruct depositional environments. Fossils can misguide the creationist stratigrapher and sedimentologist when attempting to reconstruct the "original" depositional environments. Additional information must be obtained about the specific site and local area before any real environmental reconstruction can be attempted.

Mudcracks

The remainder of Oard's note addressed the formation of "mudcracks" and the deposition environments which they suggest. The uniformitarian model would suggest that mud cracks represent subaerial exposure, because they are found in that type of environment today. While I think that this is a rather myopic view, it represents the way that many depositional environments are reconstructed using the uniformitarian model.

Oard presents extensive documentation reflecting the fact that mudcracks have been found to form in subaqueous conditions (i.e., syneresis mudcracks). Many sedimentology textbooks reflect this same information (Reineck and Singh, 1980, p. 60; Boggs, 1997, pp. 183-184). However, other texts reflect the exact opposite information (Matthews, 1984, pp. 41-42; Friedman and Sanders, 1978, p. 227). For example, Dunbar and Rodgers (1957, p. 64) state (emphasis mine):

Mudcracks form in soft sediments containing clay minerals that shrink on desiccation. *Normal mudcracks cannot form under standing water.* They

are widely distributed over floodplains and the subaerial parts of deltas and on the floors of pools or ponds or lakes that have dried up.

Additionally, many mudcracks have been mistaken for trace fossils (Boyd, 1975, p. 74).

This confusion as to how and where mudcracks form tends to make their formation in subaqueous conditions either overlooked, ignored or misunderstood. Additionally, many geologists are amazingly hard to convince of new ideas unless someone who is recognized as a leader in the field presents definitive evidence to show that it can and does occur (while this has occurred it is not "general" knowledge among geologists).

I believe that the most likely reason that subaqueous mudcrack formation is generally not recognized is due to the catastrophic nature in which some mudcracks would have formed. I have seen what I believe are mudcracks which have formed in a possible turbidite sequence in the Sequatchie Formation at Ringgold, Georgia.

The sequence which contains the mudcracks (Figure 1) located at the Ringgold roadcut, in Georgia, is defined as a nearshore subaerial environment, due to the presence of those mudcracks and "nearshore fauna" found in strata above the mudcracks (Chowns, 1972, p. 7; Chowns and McKinney, 1980, p. 329; Rindsberg and Chowns, 1986, p. 160; Martin, 1992, pp. 107-111). However, I believe that this same sequence can also be shown to have been deposited under water via turbidity currents.

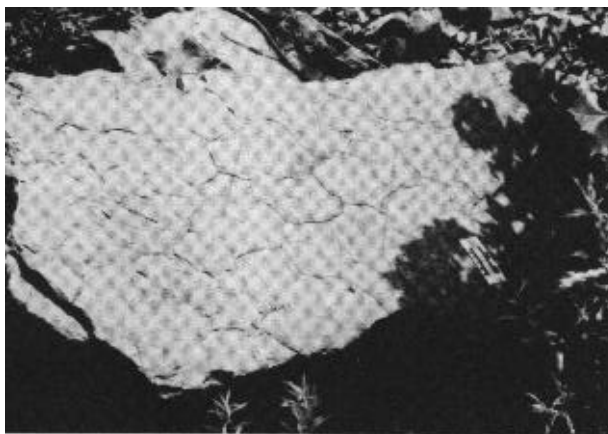


Figure 1. These mudcracks are relegated to a subaerial environment by the uniformitarian geologists investigating the site. However I believe that they represent syneresis mudcracks formed in a turbidite sequence. From the Sequatchie Fm, Ringgold, Georgia.

The near-shore interpretation for the Ringgold site is based, I believe, on the limited "environments" available to explain mudcracks in the stratigraphical record. While mudcracks are recognized as forming in turbidite sequences and have been well documented (Dzulynski and Walton, 1965, pp. 165-167), they are not generally recognized or acknowledged as such. The Ringgold site reinforces my belief that many "uniformitarian" environmental indicators tend to "force fit" a stratigraphic interpretation and place limits on possible depositional reconstruction.

My interpretation for the formation of these turbidite derived mudcracks requires catastrophic emplacement of elastic sediments during the Flood event. Following their deposition, these strata then dewatered at different rates, possibly resulting in the movement of connate waters through these formations which could result in a change in salinity, and/or shrinkage (both are recognized as causes in the formation of subaqueous mudcracks), resulting in the formation of syneresis mudcracks at various layer boundaries.

Once again, based on the rigid interpretation forced by the uniformitarian model, mudcracks are relegated to a nearshore, subaerial environment. I am grateful that the young earth Flood model does not force me into a decision based on preconceived ideas and rigid time constraints (i.e., millions of years) for the formation of strata or paleo-environments.

I believe that we offer a better explanation (i.e., young earth Flood model) to many of the stratigraphic problems with which the uniformitarian scientists continue to struggle. We need to perform field work and offer evidence to support the Flood model and hopefully through these efforts people may see that creationists offer a better alternative to the sedimentological and stratigraphic reconstruction of our earth.

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- Carl R. Froede, Jr.
2895 Emerson Lake Drive
Snellville, GA 30278-6644.

Can Ecosystems Evolve? and King of Creation BBS

I became a creationist during my senior year in college two years ago, and have studied creationism heavily since then. My skepticism towards atheistic evolution goes back to my high school days, for a reason I have not seen discussed anywhere in the creationist literature. I would be interested in discussion and comments concerning the following thoughts on the origin and maintenance of ecosystems.

Evolutionists allege that complex organic life develops from a less complex life through natural selection of beneficial mutations. If one member of a species suffers a degenerative mutation, it is weeded out and the species is continued by other members of the population. Thus, at the individual level degenerative changes can be safely eliminated without destabilization of the entire species. But what about ecosystems?

Just as individual organisms have allegedly developed to higher and higher levels of complexity over time, so also must ecosystems have developed. Beginning with some simple "proto ecosystem" life must have evolved to the incredibly intricate, carefully balanced worldwide ecosystem we observe in nature today. The problem for evolutionists is twofold.

First there is the problem facing the original primitive cells. What are the odds the first form of life would "just happen" to be in an ecological balance with the environment? Even the simplest cell produces a multitude of biochemical waste products, which would need to be recycled in some manner to allow life to survive for any significant period of time. Without any other life, what could prevent a buildup of poisonous wastes, and a steady loss of vital biochemical resources?

Would life not continue randomly forming, dying out, and forming again an astronomical number of times until an organism just right for its environment came into existence? It is difficult to believe natural selection on, at best, a single moderately diverse species could almost instantly produce organisms that would recycle all of one another's waste products. Further, why should natural selection favor such an outcome? With natural selection, an inferior individual or species dies out to be replaced by another; in this case there would be no replacement filling the poisoned niche. Life would have disappeared.

Just as abiogenesis is eliminated by probability arguments and consideration of the chemical principles involved, the spontaneous generation of an ecosystem is untenable for similar reasons. In fact, evolutionary theorists must explain not just the origin of the first cell, but something many orders of magnitude more complex: the origin of an essentially balanced ecosystem.

The second problem is even more serious. Just as individual creatures compete for the "survival of the fittest," so also do groups of individuals compete. This should apply to ecosystems as well. And just as random changes in a gene tend to have negative effects, so also random changes in an environment tend to impair the stability and survival of an ecosystem.

As long as we are looking at small local ecosystems, evolutionary theory is adequate. Among many small, dynamically changing ecosystems, a few could, by chance, become more complex. These could, in theory, replace the less complex surrounding ecosystems. As Bergman notes (1992), Occam's razor suggests the opposite; simpler ecosystems should prevail over more complex ones. But how can this be applied to the overall ecosystem of the entire world?

The earth's ecosystem has existed throughout the history of life. It is like a machine, running off solar energy, with various complex parts continually changing in a random manner. The law of entropy dictates that it should be running down, becoming more and more unstable with the passage of time. The law of parsimony (Occam's razor) dictates that it should become simpler, not more complex, with the passage of time. The first dictate seems to have ample verification in the environmental problems we face; both fly in the face of evolutionary theory. And neither can be evaded by an appeal to natural selection when there is only one ecosystem to select.

As a postscript to these comments, let me note that readers of the *CRSQ* who own a computer and a modem will be interested in the recent establishment of an electronic bulletin board system (BBS) focusing on creation science. Such a system offers creationists the opportunity to share research, information, correspondence and resources much more rapidly than through publication and more widely than is conveniently possible by mail. The rapid information exchange and the large stores of information freely available on a BBS make it an excellent nerve center. It is my hope that creationists will take full advantage of such an opportunity. The phone number (modem) for King of Creation BBS is (810) 356-0021.

Reference

- Bergman, Jerry. 1992. Some biological problems of natural selection theory *Creation Research Society Quarterly* 29:146-158.
Eric J. Blievernicht
21851 Carleton
Southfield, MI 48634

What Makes CRS Run? or What Does the Board of Directors Really Do?

A machine is defined as an "apparatus consisting of interrelated parts with separate functions performing some kind of work." The Creation Research Society is the professional organizational machine of creation science. In order to get its interrelated parts to accomplish work, some people have to see that the work gets done. That group of people is the elected Board of Directors (BOD). According to the Constitution the BOD must

consist of 12-18 members elected for three-year terms. Each year the BOD elects from its membership its six officers. The present officers are listed in the inside first page of each *CRSQ* along with history, activities, membership and statement of belief of the CRS.

Once a year, usually in April, the BOD meets from Thursday evening through late Saturday afternoon reporting on past activities and planning for future activities. The President appoints board members to five active committees: constitutional bylaws, research, publications, quarterly editorial and financial. On Thursday evening the executive committee (six officers, editor and five committee chairs) meet and plan the agendas for the five committee meetings that are held all day Friday. On Friday evening, an open meeting is held which entails CRS news reports and a mini-symposium by four BOD members on various scholarly activities. Books are on display and sold and refreshments are served.

Early on Saturday morning the BOD meets in closed session completing a planned agenda into the afternoon. Most board members fly or drive home on Sunday, staying Saturday night to acquire "super saver" airfares.

The president is the chief executive officer directing the functions of the other officers, editor and committee chairs. The vice president functions as the president requests and fills in for the president when the president is unable to act. The secretary prepares the minutes, conducts the BOD election each March and acts as a resource person on the constitution/bylaws. The membership secretary maintains the current membership lists and maintains a back inventory of back issues of the *CRSQ*. The financial secretary invests the monies of the various CRS endowment funds: laboratory fund, quarterly endowment fund and life member fund, and is a co-signer of legal documents. The treasurer receives/deposits general funds, pays bills, and keeps bank account records and other financial records of all other CRS funds. The editor of the *CRSQ* receives manuscripts and corresponds with authors and peer reviewers.

In 1993 the CRS Board hired its first full time paid employee, Dr. John Meyer, to be the director of the recently built Van Andel Research Center (VARC) at Chino Valley, Arizona. No CRS officer or board member receives any remuneration for services rendered. Dr. Meyer is responsible for developing and maintaining the physical facilities and research programs at VARC.

At the meeting each officer, the editor, each committee chair and research director gives reports on past yearly activities and presents resolutions for future activity. Other business covered at the meeting includes nomination of new members to the board, elections of officers for the coming year, election of fellows, decision on place and date of next year's meeting, fund raising, and new business. During the year board activity is accomplished by phone or mail.

The 16 members of the board are interested in serving you, the members of the CRS and the cause of creation. We invite your comments, questions, criticisms and concern. Any member desiring a copy of the constitution and bylaws of CRS should send the request to me at the following address:

Dr. David A. Kaufmann
Department of Exercise Science
University of Florida
Gainesville, Florida 32611

Our next board meeting is set for 20-22 April 1995 at Chino Valley (Prescott) Arizona. All members and friends are invited to visit our new facilities at VARC during the year. They are also invited to attend our Friday night open meeting and mini-symposium. Further details on its location and time will be published in the March 1995 issue of *CRSQ*.

CompuServe Debates

Readers of the Quarterly may be interested in reviewing and perhaps contributing to the ongoing discussion about creation versus evolution on CompuServe. They may jump in by going to the Dinosaurs Forum and finding the first thread in the Dino/Controversy section entitled "Creationism." (Currently up to 215 messages.) My interest was triggered when someone asserted that evolution is science while creation is not.

Although I have been aware of the Creation Research Society for several years, I was finally prompted to join after participating in this very lively discussion. By way of testimony, my acceptance of the creation model actually preceded my salvation experience by some twelve years. I had a Christian biology teacher in high school who gave his class three weeks to research and decide for ourselves whether or not evolution was valid. He gave us an extensive resource list of articles and publications which came mostly from secular scientific journals of the day (early sixties). Twenty-seven out of twenty-eight students in his class came to the conclusion that evolution was scientifically invalid.

Again, I would invite any CRS members who are so inclined to participate in this debate and others similar to it. I would also invite any Email correspondents. I am more interested in mathematics, cosmology and nuclear physics than biology.

Lucky W. Leavell, Jr.
4727 Grant Line Road
New Albany, IN
Email: 7153,2674 (CompuServe)
71534.2674@compuserve.com (Internet)

THE WISDOM OF SAVING WISDOM TEETH

JERRY BERGMAN*

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Abstract

Evolutionary theory concludes that humans evolved from ape-like ancestors, and in the process the jaw became smaller, leaving less room for the third molars. This conclusion was a major factor in the common past dental practice to remove relatively healthy wisdom teeth during adolescence. Recent empirical research has concluded that this practice is unwise and often needless. Third molars in general should be left alone, and if a problem develops, they should be treated as any other teeth, and efforts to deal with the problem should be foremost.

Introduction

A major conclusion of evolution theory is that as humans evolved, our jaw has shrunk from its larger ape size to the smaller human size. In the process, the jaw became too small for our third molars, often called the wisdom teeth. This view was explained by Ebbert and Sangiorgio as follows:

Once upon a time, our ancestors had larger jaws, so there was room in the human mouth for 32 permanent teeth, including third molars—wisdom teeth. But now our jaws are smaller. The result: There's no longer room in most of our mouths to house 32 teeth. So the last teeth we develop—our wisdom teeth—often become impacted, or blocked from erupting (1991, p. 108).

In the words of Liggett, as "primitive man learned to . . . break up his food with his hands . . . the jaw and brow ridge gradually became less prominent" (1974, p. 3). The third molars are often labeled vestigial organs, and offered as a major proof of human evolution from lower primates (Berra, 1990, p. 22; Harris and Weeks, 1973; Moore, 1962, p. 45). Consequently, the prevailing wisdom was

the wisdom teeth, or third molars, are vestigial structures for which there is simply not enough room, . . . the wisdom tooth, like the appendix is a vestigial organ. People today have smaller jaws but as many teeth as their antecedents. The result is that, for most people, there is not enough room in the mouth for wisdom teeth; they have no function but to give trouble (Schissel, 1970, p. 50,170).

However, these teeth are hardly vestigial: they aid in chewing our food as do all of our other 28 teeth (Bergman and Howe, 1990). The erroneous conclusion has resulted in the extraction of literally billions of teeth which was largely unnecessary according to current studies (Leonard, 1992). In the words of Leff (1993, p. 84) "dentists extract millions of those third molars each year—in most cases needlessly"—and fully nine out of 10 American teenagers who have dental insurance lose them. The cumulative cost of this operation is estimated to exceed "that for any other surgery, medical or dental" (Tulloch and Antczak-Bouckoms, 1987, p. 855). Is this cost justified? In an extensive study of aberrant maxillary third molars, Taylor rejected the "hypothesis that great variability indicates a genetic trend towards elimination of this tooth from the human dentition" (1982, p. 65). This view was evidently first widely propounded by Darwin, who stated:

*Jerry Bergman, Ph.D., NWT College, Rt. 1, Box 246A, Archbold, OH 43502.

... the posterior molar or wisdom-teeth were tending to become rudimentary in the more civilized races of man. . . . They do not cut through the gums till about the seventeenth year, and I have been assured that they are much more liable to decay, and are earlier lost than the other teeth; but this is denied by some eminent dentists. They are also much more liable to vary, both in structure and in the period of their development, than the other teeth. In the Melanian races, on the other hand, the wisdom-teeth are usually furnished with three separate fangs, and are generally sound; they also differ from the other molars in size, less than in the Caucasian races. Prof. Schaaffhausen accounts for this difference between the races by "the posterior dental portion of the jaw being always "shortened" . . . I am informed by Mr. Brace that it is becoming quite a common practice in the United States to remove some of the molar teeth of children, as the jaw does not grow large enough for the perfect development of the normal number (1896, p. 20).

Although Darwin felt that our soft diets may influence lack of jaw development, many later evolutionists concluded the evolution of the human face from our ape-like ancestors was a far more critical reason for the current wisdom teeth problem.

A Result of This Belief

Tragically, many dentists routinely advise extraction of all wisdom teeth, regardless of whether they are causing problems—some even remove wisdom teeth during adolescence if it only *appears* that they *might* later become impacted (Leff, 1993, p. 84). McGuire even once advised, "In most cases you will want to have them pulled" (1972, p. 173). The reasons given for removal include the belief of many oral surgeons, orthodontists, and general dentists that wisdom teeth can push the other teeth forward, forcing the front ones to overlap—a theory based more upon the philosophical assumption of evolution than scientific research (Southard, 1992). As Leff concludes, "There is virtually no evidence" to support the claim that the wisdom teeth are usually the cause of front teeth crowding (1993, p. 85). Little and Riedel (1988) in a long-term study found that for several reasons the front teeth tend to drift forward at least into middle age, whether or not the wisdom teeth have been removed. Southard in an excellent study concluded that "crowding cannot be prevented simply by extracting unerupted third molars" (1992, p. 76) and that "removing these teeth for the exclusive purpose of relieving interdental force and thereby preventing incisor crowding is unwarranted" (1992, p. 79). This crowding does not usually occur because the jaw is evolutionarily smaller, and thus not enough room exists for the teeth, but for other reasons (Henschen, 1966; Southard et al., 1991).

Some individuals have very small jaws—which is an individual trait occurring because *all* human dimensions vary according to a normal curve, and those toward the smaller end of the curve may sometimes experience problems. These cases, though, are relatively few and are not the norm. The major problem according to Taylor is not jaw size, but maxillary sinus size: "There is great variability [in the 3rd molars] and

... the tooth roots conform to the [maxillary] sinus, not vice versa. The sinus enlarges ahead of [molar] tooth root formation so that in a sense the sinus is dominant" (1982, p. 71).

The major problem resulting from removal of wisdom teeth, aside from the loss of these very useful molars, is the complication involved in tooth extractions. Problems that can result from removal include "infection and dry socket, trauma to the neurovascular bundle and temporary or permanent paresthesia or anesthesia of the lip, trauma to the lingual nerve, tongue numbness (temporary or permanent) root segments left in the socket and risk of damage to adjacent teeth" (Leonard, 1992, p. 82). One Michigan study found that more than 10 percent of all such operations cause complications which include inflammation of the tooth socket, infection, persistent bleeding and numbness of the lip and tongue (Leff, 1993, p. 85). Some of these problems were permanent. Extraction also has the potential of damaging the gums and causing bone loss which affects the support for the second molar.

Huggins concludes that a major reason why wisdom teeth should be left alone, if possible, is because even the best extraction technique leaves the tooth membrane in, and the top of the socket heals over "with skin and a few millimeters of bone—but down underneath is a hole" (1991, p. 44). Inside of this cavitation are frequently found autoimmune cells, monocytes and other indications of abnormalities which evidently can influence neurological problems because "when these cavities are cleaned out with a dental burr. . . patients with neurological problems sometimes experience a notable improvement within a few days or less" (1991, p. 44).

Numerous research studies have evaluated the total risks of surgery versus treating the problems sometimes encountered in wisdom teeth eruption. They have in general concluded that

based on the results of several studies and the opinion of a panel of experts . . . doing nothing until problems developed would typically cause half as much discomfort and disability as extracting all impacted teeth, and only a fraction as much distress as pulling all wisdom teeth in adolescence (Leff, 1993, p. 85).

Leff further suggests that "if your dentist recommends extracting a symptom-free tooth—or recommends extraction for your teenager—ask him or her to show you the problem (not just the extraction itself) on the X-rays." He also recommends that, unless there is clear evidence that the only course of action is to remove the wisdom teeth, the patient should obtain a second opinion "from a dentist who does not specialize in surgery" (Leff, 1993, p. 85; see also Tulloch et al., 1987). He concludes that if extraction is not the only option, and if one leaves these teeth alone, there is "an excellent chance they'll never be a problem" (Leff, 1993, p. 85).

The wisdom teeth typically erupt from ages 17 to 25 or older. Only about 30 percent become seriously impacted, usually because they are pointed in the wrong direction when they come in and push against the second molar. Claims that they usually disrupt other teeth and can cause irreversible damage do not hold

up under the scrutiny of recent scientific studies (Southard, 1992). The risks posed by impaction are “far smaller than the proponents of early extraction claim” (Leff, 1993, p. 84). This conclusion is based on “scientific evidence about impacted wisdom teeth, including several large studies involving thousands of cases” (Leff, 1993, p. 84). Recent research strongly opposes removing wisdom teeth in an attempt to ease the crowding of other teeth. This conclusion is quite a contrast to the previous perception held by most dentists for decades “particularly oral surgeons” namely that wisdom teeth were “essentially useless troublemakers—‘little time bombs,’” (Leff, 1993, p. 84).

Problems do occasionally exist with third molars that need to be attended to, such as one partially poking through the gum which can influence decay or gum disease of the adjacent molar. This concern can much better be dealt with by cleanliness, and removing the impacted teeth *only* if and when a problem develops that cannot be solved in a less drastic way. Actually, the number of cases where this is a problem is, at most, about seven percent. Infection can be a problem because bacteria accumulate beneath the gum flap still covering the tooth as it erupts. Local antiseptics and a trimming back the gum can most often effectively deal with this concern. Another problem is the possibility of cysts and tumors developing in the sack surrounding an impacted wisdom tooth. This abnormality, though, is relatively rare—fewer than one percent of all impacted third molars are surrounded by cysts (Moursheed, 1964). Further, as cyst development is generally extremely slow, this concern can be monitored and dealt with before it affects a significant amount of bone. Tumors are also rarely a problem—“roughly one in a million impacted wisdom teeth” in a study noted by Leff (1993, p. 84).

The Implications of This Research

The creationism world view is often criticized because it allegedly lacks predictive value. In the case of wisdom teeth, the assumption that the body was designed predicts that the wisdom teeth exist to serve a purpose and thus normally should be left alone. In harmony with this, if problems occur, they should be dealt with in similar ways as problems that occur with any other teeth. The evolutionary perspective, which taught that the human jaw has shrunk in the history of human evolution, would conclude that the wisdom teeth are generally problematic. Consequently, this perspective concludes it is often best that they are removed because the jaw has evolved so that it is generally too small for them. This view has dictated the dental policy for at least the past half century (Wood, 1978).

The empirical evidence now supports the creation position: the appearance of wisdom teeth are purposefully designed and are part of normal development, and consequently if one or more of them cause problems, they should be dealt with in the same way as any other tooth which causes problems—endeavor to save them (Tulloch et al., 1990). When the writer was in high school, one of his wisdom teeth became impacted, and only three developed. The dentist elected to remove all three because he believed that the human jaw now usually was too small for them, and that third molars should be removed even if they are not causing

problems because they will often cause problems later (the so-called adolescent removal). The now outdated advice for generations was: “Early extraction of impacted wisdom teeth is often advocated because the procedure is much easier than in later years, when the bone becomes more dense. Also, the younger the patient the better the procedure will be tolerated” (Wood, 1978, p. 183).

This prophylactic therapy is now regarded as wholly incorrect (Tulloch et al., 1990), although the change has come about only because of empirical studies and the realization that in the majority of cases the jaw is not too small (which is clearly the case in the writer’s situation—there was plenty of room there for not just four wisdom teeth, but possibly eight). Human variation is such that in a certain percent of cases, the jaw and/or maxillary shelf will be too small. This problem with variation is true of all other human traits as well. Consequently, people not uncommonly have trouble with other body parts for the same reason, but no one argues that alterations which may be necessary for a minority of the population should in general be utilized for everyone as a prophylactic measure (Leonard, 1992). This is only one of many examples in which evolutionary theory has drastically misled medical practice, and in this case resulted in the unnecessary removal of billions of teeth. A study by Tulloch et al. (1990) that is part of an effort to identify ineffective or wasteful medical procedures found that:

Universal extraction of wisdom teeth would cost more than \$278 million and would result in three million days of misery for America’s teenagers. . . . Removing only problem teeth would cost an estimated \$51.5 million and create 776,000 days of misery. . . . If surgeons removed only those wisdom teeth that actually caused problems. . . the nation would save at least \$150 million a year in medical expenses with no ill effects. And tens of thousands of people, mostly teenagers, would be spared the aches, pains and complications that can result from the surgery (Blakeslee, 1991, p. C9).

The Major Cause of Wisdom Tooth Impaction

One of the most extensive studies which attempted to determine specifically *why* wisdom teeth become impacted was done by Huggins on 22 cultures. He concluded that cultures, such as native American Indians which sleep their young children on their backs, develop “healthy teeth” and “crooked teeth and impacted wisdom teeth are uncommon” (Huggins, 1991, p. 44). Further, children who are tummy sleepers develop narrower faces with crowded teeth requiring orthodontic attention, and side sleepers develop crooked teeth and a tendency to develop crossbites in which the bottom molars overlap the top when biting down. The reason is these sleeping positions puts pressure on the thin membrane bones of the developing face, preventing them from developing properly. The six year study found that “back sleepers, however, had plenty of room for their teeth to develop, including space for wisdom teeth.” Although other factors exist, by far the most important, Huggins concluded, was the long term sleeping position of persons during the development of their primary teeth. He also confirmed this in his own dental practice. Of course children whose sleeping

position varies may develop less severe crooked teeth, or teeth with a combination of the above problems. Huggins concludes "the obvious conclusion is to grow your wisdom teeth in straight. Eat right so they do not decay. Clean them and keep them." If this pioneering research proves to be correct, it would largely eliminate the need to remove wisdom teeth or straighten crooked teeth. Tragically, the evolutionary hypothesis may have delayed looking for the actual cause of the problem. The solution would have been facilitated by the belief that, given proper health and environmental conditions, wisdom teeth will come in normally.

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BOOK REVIEW

Inventing the Flat Earth Columbus and Modern Historians by Jeffrey Burton Russell. 1991. Praeger Publishers. 117 pages. \$16.95.

Reviewed by Don B. DeYoung*

True or False: Christopher Columbus proved to a skeptical world that the earth was spherical instead of flat. Totally false, claims author Russell. In fact, no more people accepted a flat earth in 1492 than still do today. Russell gives an impressive number of quotes and references from medieval times to prove his point. He also reminds us that Eratosthenes had accurately measured the earth's circumference already in 200 BC. This data was *not* forgotten, as described in many school books. Instead, the "flat earth error," the idea that a flat earth was the popular medieval view, largely originated one hundred years ago.

Russell is a Professor of History at the University of California, Santa Barbara. He has traced the Columbus flat earth misconception to the influential writings of John W. Draper (1811-1882) and Andrew Dickson White (1832-1918). Both men believed that religion and science were at war (p. 37). They saw Christianity and creation in particular as obstacles that hindered science progress. (To his credit, Russell believes otherwise, suggesting that science could not have developed without the aiding hand of Christian theology, p. 46). Russell

charges that Draper and White wrote that the Medieval Church accepted a flat earth, in spite of contrary evidence, to promote the religion-science warfare theme and also to disparage the Church. It succeeded.

The flat earth error is still promoted, perhaps most recently and widely in *The Discoverers* by Daniel Boorstin (1983) Boorstin, top Librarian of Congress for 13 years, wrote that the Church of Columbus' day attempted to force a flat earth upon everyone. Boorstin's chapter 13-14 titles, The Prison of Christian Dogma and A Flat Earth Returns, reveal his bias. Author Russell shows how Boorstin used recent, questionable sources instead of original writings in researching the matter (p. 48). Why does the belief that Columbus was nearly alone in supporting a spherical earth still continue today? Russell gives three reasons (p. 51): (1) The continuing Bible-science debate, where false ammunition is used against the early church. (2) A false assumption that medieval people were ignorant. There is a baseless chauvinism that makes the voyage of Columbus the dawn of a new day in a dark, unthinking world. (3) Along with Draper and White, other popular writers like Washington Irving (1783-1859) also promoted the flat earth error.

Hats off to author Russell for challenging revisionist history, and defending the integrity of the early church.

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*Don B. DeYoung, Ph.D., Grace College, 200 Seminary Drive, Winona Lake, IN 46590.

POLYTROPIC MODEL OF THE UNIVERSE

J. K. WEST*

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Non-Technical Summary

Many scientists accept the idea that everything in the universe started with the big bang. This model sets the upper limit to the age of the universe at approximately 15 billion years. Even though no known physical force could start such an event, evolutionists accept this as a fact just as we as Christians accept God's act of creation. I will readily accept that God could do anything He chooses. He could have chosen to start his creation as a big bang but this does not easily allow for the creation to be a recent event. For example, God did not create Adam as a babe and then allow him to grow. God created him as a man, fully grown, fully aware of God and His creation. I see no reason why God could not have created the universe fully formed and physically stable. Therefore, our task is to discover what form and structure God used to stabilize the universe.

To that end we can look for patterns within God's creation. All life shows patterns of a common designer. The solar system of our planet shows a pattern of orbits. The stars within our Milky Way show a pattern of orbits about the center of our galaxy. Our galaxies all have one thing in common. They all show the pattern stars orbiting around some center. This is true despite which structure we see: spiral, irregular, globular, or spherical. Recent observations even show that groups of galaxies have a pattern or structure that may indicate that something bigger is attracting them.

The polytropic model of the universe is a simple physical and mathematical structure extending ideas of the patterns seen in God's creation to the universe. The universe may be a structure like a galaxy where we replace the stars by galaxies. The orbital motion causes the red shifts that we observe here on earth. The universe is smaller than the big bang model at approximately 600 million light years in diameter. We are somewhere near the center and everywhere galaxies move across the sky in their orbits. The details of the physics, mathematics and astronomy match the observations very well and give considerable insight to the mystery of the quasars. The polytropic model for the first time allows a direct measurement of the mass of the universe. It is found to be approximately 6×10^{54} grams. This universe is stable and is not expanding. It will not collapse. God could have created it recently just as He described for us in Genesis.

Abstract

The universe is either expanding or it is not. If it is expanding then the Big Bang may have been the cause. If it is not expanding then the Big Bang did not occur. In recent literature, there has been a significant number of objections and problems presented concerning the Big Bang. In this work, a non-expanding polytropic model of the universe is presented that can account for many of the observations previously attributed to the Big Bang and some observations that cannot be explained if the Big Bang did occur.

Introduction

The structure of the universe is currently considered to be an expanding ball of matter and space. This expansion was caused by an initial explosion known as the Big Bang (Sciama, 1977). The basic unit of matter in this expanding structure is the galaxy. The major observational evidence supporting the Big Bang Model of the Universe is (Kaufmann, 1973; Bouw, 1982): 1) the 3K cosmic background radiation, 2) the Hubble Law based on the expansion of galaxies away from our galaxy, 3) the apparently extreme age of quasars, and 4) the ratio of hydrogen to helium: H/He. Each of these observations presents problems when analyzed in detail. For example, formation of galaxies (Alpher and Herman, 1978) and the large scale structure of galactic clusters both create significant problems for the Big Bang model because the cosmic microwave background (CMB) is so completely uniform (Gulks, et al., 1990).

The Hubble relationship indicates that an expanding universe has an inexplicably large portion being "dark" matter (Bouw, 1982). Quasars also present an unknown energy source because their luminosity is three or four orders of magnitude greater than theoretically possible.

If quasars are 15 billion light years away as represented by a cosmological red-shift, then their energy source is not known. If their red-shift is not cosmological then much of the evidence for the expanding universe is eliminated (Alpher and Herman, 1978).

The structure of the universe is intimately related to the model of its origin. The Big Bang Model can be used to predict the cosmological source of the 3K background and the Hubble Law (Gulks, et al., 1990). Therefore, the structural model of a non-expanding universe will be presented that addresses these relationships and shows that expansion is not necessary to account for these observations.

Physical Models

There are a number of simple and useful physical models that allow a better understanding of more complex ideas. The Bohr model of the atom is still extremely useful; its simplicity allows for a deeper understanding of spectroscopy, exciton transitions, atomic orbitals, (Hench and West, 1990) and others. Another example is that of Pauling's valence model of chemical bonding. It is simple and still useful for explaining molecular ratios in chemical compounds. Complex things become easier to understand if they can be visualized using a simple model.

*J. K. West, Ph.D., is associate in engineering Advanced Materials Research Center, Department of Materials Science and Engineering, University of Florida, Alachua, FL 32615.

Another example is the simple model of the solar system that was put forth by Copernicus, improved upon by Kepler, and formalized by Newton. The idea is simple; the planets orbit about the sun and the earth is one of those planets.

Another example of an orbiting structure is that of the galaxies. We have observed that most galaxies are rotating. Nearby Galactic stars orbit about some center (Mihalas, et al., 1981; Gorenstein, et al., 1978; Whitney, 1971). There is however a difference between stars in orbit in a galaxy and planets in orbit about our sun.

The planets in our solar system follow what is known as Keplerian motion (Abell, 1969). That is, the inner planets have much higher orbital velocities than the outer planets. This is not true for stars in orbit about a galactic center. Most galaxies have inner stars with much lower orbital velocities than the outer stars. This is caused because the mass of a galaxy is distributed whereas more than 99 percent of the mass of our solar system is concentrated in our sun (Whitcomb, 1971).

It is proposed that the structure of the universe itself is much like that of a galaxy. If the mass of the universe is distributed then galaxies near the center of the universe should have lower orbital velocities than those further out from the center. It is also proposed that mass distribution follows a polytropic structure. This would be a first approximation to the distribution of galaxies orbiting about some center of the universe.

In the polytropic model presented below, it is assumed that classical physics will give a reasonable first approximation for the gravitational potential. Relativistic equations will then be applied where orbital velocities approach the speed of light.

Model of a Polytropic Star

The polytropic model was first developed as a solution to the structure of a normal star. A normal star is one in which the size or luminosity does not change over short time periods and obeys the following five equations:

$$\frac{dP}{dr} = -\frac{GM(r)}{r^2} \rho \quad \text{"hydrostatic equilibrium,"} \quad (1)$$

$$\frac{dM(r)}{dr} = 4\pi r^2 \rho \quad \text{"continuity of mass,"} \quad (2)$$

$$\frac{dL(r)}{dr} = 4\pi r^2 \epsilon \quad \text{"thermal equilibrium,"} \quad (3)$$

$$\frac{dT}{dr} = \frac{-3}{4ac} \frac{\kappa P}{T^3} \frac{L(r)}{4\pi r^2} \quad \text{"for radiative equilibrium,"} \quad (4)$$

or

$$\frac{1}{T} \frac{dT}{dr} = \frac{\gamma-1}{\gamma} \frac{1}{P} \frac{dP}{dr} \quad \text{"for convective equilibrium,"} \quad (5)$$

where $P(r)$, $M(r)$ and $L(r)$ are the pressure, mass and luminosity at radial distance r in the structure; ρ is the density, T is the temperature, G is the gravitational constant, κ is the opacity, γ is the exponent of the adiabatic gas law, and ϵ is the energy generation rate.

The polytropic solution to this system of related equations has been discussed in great detail by Eva Novotny (1973) and others.

A polytropic star is one in which the pressure obeys an equation of the following form:

$$P = \kappa \rho^{(1+\frac{1}{n})} \quad (6)$$

Since the pressure is an explicit function of density only, polytropic stars are determined by the equation of hydrostatic equilibrium (equation 1) and the equation of continuity of mass (equation 2). By combining these two equations and using dimensionless variables, one differential equation can be formed which defines the structure of a polytropic star of index n which is part of the exponent in pressure equation 6.

$$\frac{1}{\xi^2} \frac{d}{d\xi} \left(\xi^2 \frac{d\theta}{d\xi} \right) = -\theta^n \quad (7)$$

This is known as the Lane-Emden equation (Novotny, 1973). The variables are defined as follows with the subscript c indicating the core values:

$$\theta^n = \frac{\rho}{\rho_c} \quad (8)$$

$$\theta = \frac{T}{T_c} \quad (9)$$

$$\xi = \frac{r}{r_n} \quad (10)$$

where r_n is known as the Emden unit of length and

$$R = \xi_0 r_n \quad (11)$$

The polytropic model provides a good approximation to the structure of certain types of real stars and our sun (Novotny, 1973). This idealized model is often useful in qualitative and even in semi quantitative discussions and aids considerably in gaining an overall insight into the structure of stars.

A Polytropic Universe

This defines the mathematical formalism for a model of a polytropic universe in which galaxies orbit within a distribution of matter. Thus, the mass at a polytropic radius, x , can be determined by integrating the continuity of mass equation (2):

$$M_\xi = M \frac{[-\xi^2 \frac{d\theta}{d\xi}]}{[-\xi^2 \frac{d\theta}{d\xi}]_{\xi_0}} \quad (12)$$

and the temperature at this radius is

$$T = T_c \theta \quad (13)$$

with M being the total mass of the universe and T_c is the central temperature. This by no means implies that galaxies collide like an ideal gas. This distribution of galaxies would, however, create the gravitational potential under which the gas and dust in the universe might be governed. The scale factor, $\alpha \equiv r_n$, defined from equation 11 is

$$\alpha \equiv \frac{R}{\xi_0} \quad (14)$$

where R is the radius of the universe and ξ_0 is determined by the choice of n . Then

$$\xi = \frac{r}{\alpha} \quad (15)$$

Therefore the total mass, M , the total radius, R , and the polytropic index, n , are parameters of the solution.

A choice of the polytropic index for the universe is arbitrary but it could be re-selected to match astronomical observations more closely after this following example. Let us consider a polytropic universe where

$$n = 1.5 \quad (16)$$

The density of the universe (or any polytropic structure) then can be plotted from the core to its outer edge (see Figure 1) with $n = 1.5$.

POLYTROPIC DENSITY

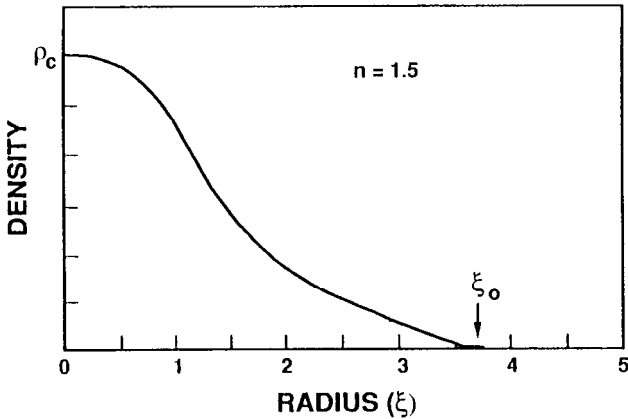


Figure 1. The calculated density of a polytropic structure with an index of 1.5.

Motion of the Milky Way

Having formulated a model structure of the universe, we need now analyze how our own galaxy will fit into this picture. One of the first questions to be answered is how our galaxy moves with respect to this model.

We can first assume that our galaxy is in a Newtonian orbit about the center of the polytropic universe. The equation governing its motion is

$$a_0^3 = P_0^2 (M_\xi + m_0) \quad (17)$$

where M_ξ is the mass of the universe inside the orbit of the Milky Way, a_0 is the semi-major axis of the Milky Way's orbit in the universe, P_0 is the orbital period in years, and m_0 is the mass of the Milky Way.

This can be simplified by using the fact that

$$M_\xi \gg m_0 \quad (18)$$

then the orbital equation becomes

$$a_0^3 = P_0^2 M_\xi \quad (19)$$

If we also assume a circular orbit, then the circumference is $2\pi a_0$ and the orbital velocity is given by:

$$\nu_0 = \frac{2\pi a_0}{P} \quad (20)$$

Solving for the period and substituting into the orbital equation yields.

$$a_0^3 = \left(\frac{2\pi a_0}{\nu} \right)^2 M_\xi \quad (21)$$

$$a_0 = \left(\frac{2\pi}{\nu_0} \right)^2 M_\xi \quad (22)$$

Thus.

$$\nu_0 = 2\pi \left(\frac{M_\xi}{a_0} \right)^{1/2} \quad (23)$$

The radius of the orbit a_0 can be re-written in reduced units using equation (15):

$$a_0 = \alpha \xi \quad (24)$$

Thus the orbital velocity becomes

$$\nu_0 = 2\pi \left(\frac{M_\xi}{\alpha \xi} \right)^{1/2} \quad (25)$$

Divide this equation by the square root of the total mass, $\sqrt{M}$ which yields

$$\frac{\nu_0}{\sqrt{M}} = \frac{2\pi}{\sqrt{\alpha \xi}} \left(\frac{M_\xi}{M} \right)^{1/2} \quad (26)$$

Multiply through by $\frac{\sqrt{\alpha}}{2\pi}$:

$$\frac{\nu_0}{2\pi} \left(\frac{\alpha}{M} \right)^{1/2} = \left(\frac{M_\xi}{\xi M} \right)^{1/2} \quad (27)$$

Define a reduced velocity, ω , as:

$$\omega \equiv \frac{\nu_0}{2\pi} \left(\frac{\alpha}{M} \right)^{1/2} \quad (28)$$

then

$$\omega = \left(\frac{1}{\xi} \frac{M_\xi}{M} \right)^{1/2} \quad (29)$$

The reduced orbital velocity, ω , of the polytropic universe can be determined as a function of the radius, ξ . Table 1 shows the calculational parameters for this model with the last two columns as calculated from this model. Figure 2 plots the orbital velocity of the universe around the center as a function of radius, ξ . In keeping with the hypotheses of a polytropic model, the Milky Way and many other galaxies show very similarly shaped orbital velocity curves (Mihalas and Binney, 1981), (see Figure 3). In fact, most of the known spiral galaxies exhibit maxima at large radii in their orbital velocity curves just as predicted by the polytropic model.

For this model of the universe, we must pick a position of the Milky Way with respect to the polytropic radius, ξ . We simply postulate that the Milky Way orbits the center of the universe at a radius, $\xi_\star$, where

$$0.200 < \xi_\star < 0.300. \quad (30)$$

The location of the Milky Way at $\xi_\star$ is shown in Figure 2. In fact, $\xi_\star$ could be anywhere in this range without greatly affecting the characteristics of the universe as observed from the earth as we shall see below. But first we must discuss the origin of the red-shift.

Table 1

Polytropic Model with $n = 1.5$

θ	ξ	$\xi^{1/2}$	$d\theta/d\xi$	$-\xi^2 d\theta/d\xi$	M_ξ/M	ω
1.0000	0.000	0.000	0.0000	0.0000	0.0000	0.00000
.9983	0.100	0.316	-0.0333	0.0003	0.0001	0.03493
.9934	0.200	0.447	-0.0663	0.0026	0.0010	0.06990
.9851	0.300	0.547	-0.0987	0.0089	0.0033	0.10445
.9737	0.400	0.632	-0.1302	0.0208	0.0077	0.13852
.9591	0.500	0.707	-0.1605	0.0401	0.0147	0.17146
.9151	0.750	0.866	-0.2238	0.1258	0.0463	0.24846
.8451	1.000	1.000	-0.2872	0.2872	0.1058	0.32527
.7166	1.400	1.183	-0.3494	0.6848	0.2523	0.42452
.5707	1.800	1.342	-0.3736	1.2104	0.4459	0.49771
.3504	2.400	1.549	-0.3503	2.0177	0.7434	0.55655
.1588	3.000	1.732	-0.2842	2.5578	0.9424	0.56048
0.0000	ξ_0	1.911	-0.2033	2.7141	1.000	0.52329

$$\left[-\xi^2 \frac{d\theta}{d\xi} \right]_{\xi_0} = 2.71406 \text{ and } \xi_0 = 3.65375 \text{ with } \omega = \left(\frac{M_\xi}{\xi M} \right)^{1/2}$$

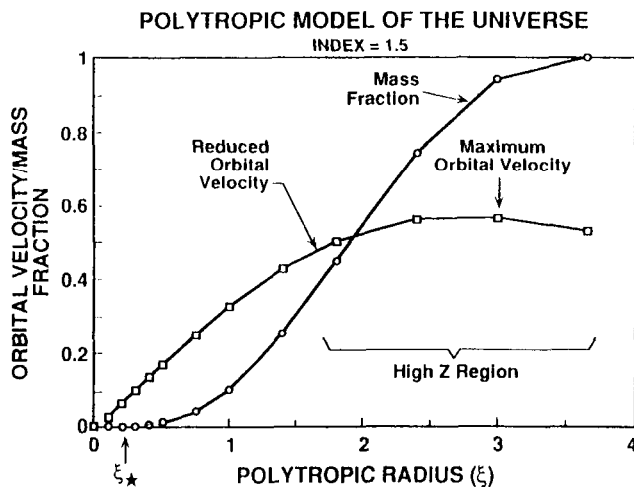
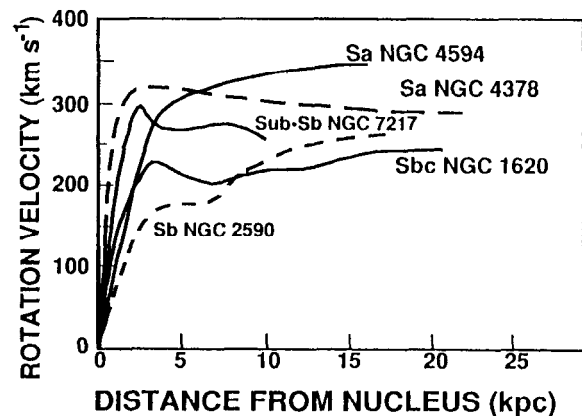


Figure 2. The orbital velocities of galaxies in a polytropic universe with an index of 1.5.

Transverse Doppler Effect

The Hubble relation clearly presents a picture of an expanding universe. Any other model, i.e., non-expanding, must account for this observation. A large number of galaxies have red-shifts, few have blue-shift. The polytropic universe can yield similar results if the relativistic form of the red-shift is applied to the motion of the galaxies that orbit the polytropic universe.

ROTATIONAL VELOCITY CURVES FOR SPIRAL GALAXIES



After Mihalas and Binney

Figure 3. Orbital velocities of stars in some nearby galaxies measured by doppler shifts.

The red-shift seen for galaxies is typically analyzed as a recession effect. The transverse component of the velocity, λ , is not generally measurable because of the extreme distances involved. The more general form of the Doppler Effect is derived in J. D. Jackson's "Classical Electrodynamics" (1962, p. 364):

Table 2. Transverse Doppler Effect.

v/c	$\Delta\lambda/\lambda$ Transverse Red-Shift ($\gamma = 90^\circ$)
0.1000	0.005
0.2000	0.020
0.3000	0.048
0.4000	0.091
0.5000	0.155
0.6000	0.250
0.7000	0.400
0.8000	0.667
0.9000	1.294
0.9797	3.988
0.9900	6.089

Table 3. Relative Velocities in the Universe.

Object	Velocity	Description
Earth	30 km/sec	Solar Orbit
Sun	230 km/sec	Milky Way Orbit
Andromeda	80 km/sec	W.r.t., Milky Way
Milky Way	600 km/sec	W.r.t., Local Galaxies

$$\lambda_r(\gamma) = \lambda_i \frac{[1 - (\nu/c) \cos \gamma]}{[1 - (\nu^2/c^2)]^{1/2}} \quad (31)$$

which is related to the transverse angle γ .

The change in wavelength, $\Delta\lambda/\lambda$, is usually defined as z , and it has the following form:

$$\frac{\lambda' - \lambda}{\lambda} = \frac{\Delta\lambda}{\lambda} \equiv z_{\text{tran}} = \left[\frac{1 + (\nu/c) \cos \gamma}{1 - (\nu/c)^2} \right]^{1/2} - 1 \quad (32)$$

Table 2 shows the relationship of the change in velocity, expressed as a fraction of the speed of light, c , with $z = \Delta\lambda/\lambda$.

We can see that the full range of observed galactic red-shifts fall within the values available for the transverse Doppler Effect. For example, generally the higher observed galactic red-shift reported by Gregory and Thompson (1982) is

$$z(\text{galactic}) \leq 0.4. \quad (33)$$

In contrast, the maximum observed red-shift for quasars is reported by Osmer (1982)

$$z(\text{quasars}) \approx 4. \quad (34)$$

Note also that there are very few objects in between the galaxies and the quasars, i.e., there is a gap in the data. Note also that the maximum observed z is 3.8 for Quasar 4C41.17 (Miley, et al., 1993). There is one extreme value of $z = 3.395$ reported for an optical galaxy (Eales, et al., 1993). This high velocity optical galaxy would be analogous to high velocity stars in our galaxy or a comet in our solar system having a highly elliptical orbit.

Relationship Between Red-Shift and Distance

Direct measurement of distances in the universe is limited at present to triangulation (called parallax) based on the shift in stellar positions as the earth moves

through its orbit about the sun. This direct measurement results in the definition of the distance unit known as the parsec (pc). A distance of one parsec is defined as the distance required to shift the apparent position of a stellar object one second of arc when the base of the triangle is one astronomical unit (A.U.) the radius of earth's orbit about the sun. Thus, 1 parsec is 3.26 light years. The best that can be done with this method of distance measurement is approximately 100 parsecs or 326 light years. This distance is still well within our own galaxy. All other distance measurements are indirect.

The remarkable story of the discovery of our galaxy and the scale of our universe is presented in numerous places (Whitney, 1971; Abell, 1969). The indirect methods that were developed to measure distances to extra-galactic objects have been carefully evaluated. They are self consistent and have been cross-checked thoroughly. The extremely large scale of the universe has been extrapolated from these measurements for normal galaxies. The only distance measurement for Quasars, however, is based on the Hubble Law.

In the 1930's Hubble correlated the recessional velocity of a galaxy to its distance; (Kaufmann, 1973; Abel, 1969; Hawking, 1988; Geller and Huchra, 1988, pp. 3-29). This relationship became known as the Hubble Law:

$$v = Hr \quad (35)$$

where

$$r = \text{distance to a galaxy} \quad (36)$$

$$H \approx 100 \text{ Km per sec per Mpc} \quad (37)$$

where

$$H = \text{"Hubble Constant"} \quad (38)$$

and

$$v = \text{recessional velocity} \quad (39)$$

$$r = \text{distance to a galaxy.} \quad (40)$$

The velocities of optical galaxies were initially determined from the non-relativistic form of equation 32:

$$z_{\text{rec}} = \frac{v}{c} = \frac{\Delta\lambda}{\lambda} \quad (41)$$

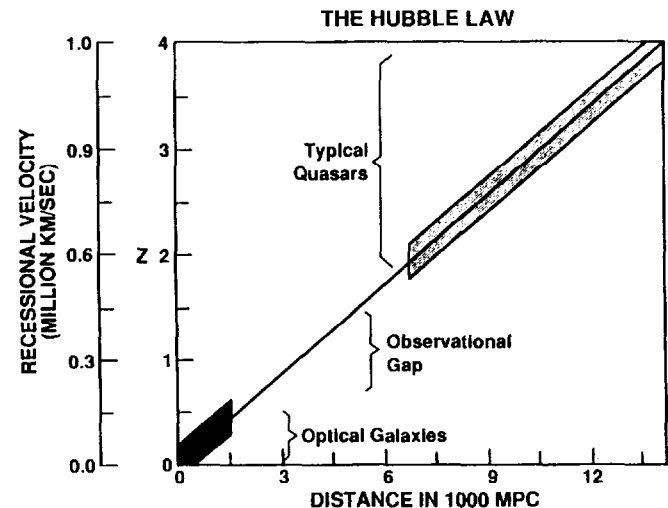


Figure 4. The Hubble Law showing the relationship of galaxies to Quasars.

Figure 4 shows the Hubble relationship for galaxies visible by optical means. The discovery was first made by comparing the absolute luminosity of the galaxies with the red-shift. The line in Figure 4 is as calculated from the Hubble Law. The shaded area represents the observational data where the distances are, in general, estimated from the luminosities.

The red-shift, z , is co-plotted along with the recessional velocities. Figure 4 shows the extent of the data for optical galaxies. Quasars, in general, have much larger z values. Only the optical galaxies have independent estimates for their distances. It is nearly impossible to measure the distance to the Quasars, apart from the Hubble Law. Their Hubble distances are extreme and this is the basis for the extravagant age currently assigned to the universe.

Distance to the Quasars

These objects were discovered in the early 1960's by astronomer Maarten Schmidt (Osmer, 1982) and designated Quasi Stellar Radio Sources. They quickly became known as the Quasars. Their optical spectra had been shifted into the IR and radio regions. The shift implied recessional velocities very near the speed of light (see Table 2). Using the Hubble law, their distances could be 10-15 billion light years and Quasars would be about 1000 times more luminous than a galaxy of 100 billion stars (Osmer, 1982; Courvoisier, et al., 1991). However, there is no way to verify or cross-check this distance except by their luminosity. Their luminosity has to be so great for their Hubble distance that no known physical phenomena can account for it.

The most distant quasar, by the Hubble relationship, is

$$d \approx 15 \times 10^9 \text{ light years.} \quad (42)$$

Based upon this Hubble distance, the calculation of the absolute luminosity required to produce its measured luminosity is L_0 ,

$$L_0 = 10^{47} \text{ ergs/sec.} \quad (43)$$

If it is a normal galaxy of approximately 10^{11} solar masses then the luminosity each star in a quasar must produce, is $L_\star$:

$$L_\star = 10^{36} \text{ ergs/sec.} \quad (44)$$

For comparison, our sun with one solar mass produces a luminosity of

$$L_{\text{sun}} = 10^{33} \text{ erg/sec.} \quad (45)$$

Now, this difference is truly remarkable since it requires that each star of a quasar must produce 3 orders of magnitude more energy than our sun and must have at least the same mass as our sun. This is clearly impossible.

The change in the luminosities is ΔL ,

$$\Delta L = 10^3 \quad (46)$$

Therefore, the distance must be reduced by a factor of:

$$(\Delta L)^{-1/2} = 10^{-3/2} = (31.6)^{-1} \quad (47)$$

because of the $(1/d)^2$ drop of intensity.

Based on their luminosity, that the distance, $r(\text{Quasar})$, to the highest z Quasar is approximately 474 million light years. In the polytropic universe this Quasar is predicted to be at the maximum of the radial velocity curve calculated for $n = 1.5$ (see Figure 2). This distance is

$$\xi = 3 \quad (48)$$

for the polytropic universe.

The total radius of the polytropic universe can now be extracted for this simple model. The outside edge of the polytropic universe is at ξ_0 , thus,

$$R = (\xi_0/\xi) \times r(\text{Quasar}) = (3.65375/3) \times 474 \times 10^6 \text{ light years} \quad (49)$$

$$R = 577 \times 10^6 \text{ light years} \quad (50)$$

for the radius of the polytropic universe with an index of 1.5.

A prediction can now be made for the proper motion of Quasars with this model. If the motion of the highest z Quasars is totally transverse, the proper motion, μ , in one year the Quasar would transverse approximately 1 light year with v/c being 0.9797:

$$\mu = \frac{1}{474 \times 10^6} \text{ radian/year} \quad (51)$$

$$\mu = \frac{1 \text{ radian/year}}{474 \times 10^6} \times \frac{57.3^\circ}{\text{radian}} \times \frac{3600 \text{ sec}}{\text{degree}} \quad (52)$$

$$\mu = 0.00044 \text{ sec of arc/year.} \quad (53)$$

This should be detectable in a few thousand years (Geller, et al., 1988; Bouw, 1982).

There are observations that jets from Quasars 3C273 have a proper motion indicating a velocity several times greater than the speed of light (Courvoisier, et al., 1991). This is a clear indication that the distance to this particular object is over-estimated. If the origin of its red-shift is orbital and not recessional, then the observed jets would have velocities less than the speed of light because they are 32 times closer (see equation 47).

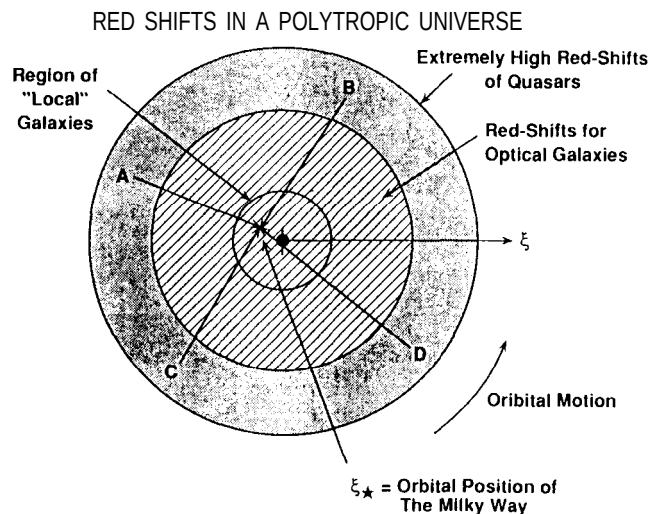


Figure 5. The observer at $\xi_\star$ in a polytropic universe will see a sky full of red-shifted galaxies.

Red-Shifts in the Polytropic Universe

The position of the Milky Way has been postulated to be in the central regions of the universe, at a radius of $\xi = 0.3$ (see figure 2 and equation 30). If an observer looks around the universe from this position, he will see mostly red-shifted galaxies. This is shown schematically in Figure 5. This postulate is not unreasonable.

For example, our earth is in the interior regions of our solar system. The difference in this analogy is that all of the planets in the outer regions of the solar system have much lower orbital velocities than our earth. In contrast, the orbital velocities of the galaxies in the outer regions of the polytropic universe can have extremely high orbital velocities compared to our galaxy, the Milky Way.

The key to this idea is that the red-shift comes from the transverse velocity, not the recessional velocity. Therefore, there is no general relationships between distance and red-shift except the radial velocity curve (Figure 2). Normal galaxies would then have a nearly linear relationship with red-shift and distance matching the Hubble Law. On the other hand, the Quasars would be in the high z region of Figure 2 and Figure 5 would have a non-linear relationship between red-shift and distance.

The Universe Filled with Red-Shifts

Our universe is filled with red-shifted objects. By referring to the polytropic model in Figure 5, an observer can see a red-shift in virtually any direction: A, B, C, or D. Almost all regions of the universe would indicate a red-shift from the transverse doppler effect. Secondly, the red-shifts would increase as the distance increases, only not linearly. In the region of "local" galaxies, we would predict to observe red-shifts, blue-shifts, proper motions that would be quite random. This is in fact the case (Mihalas et al., 1981).

The Curtis-Schmidt survey also indicates an anisotropic distribution of quasars. Figure 6 shows a summary of this survey as a function of direction (right ascension). Examining Figure 5, it can be speculated that quasars in region A would be easier to observe than those in region D. The distances to each of these regions are very different even though the red-shifts would be very similar. The geometry of the polytropic model would predict an anisotropic distribution in Quasars.

Missing Transitional Galaxies

In the study of quasars and red-shifted galaxies the observations are very interesting. Figure 7 shows the distribution of red-shifts of quasars for the Curtis Schmidt Survey (Osmer, 1982). There is a significant gap or drop in the observations around $z = 2$. There also seem to be no transitional objects between normal galaxies with $z = .4$ and quasars with $z = 1.8$ as also shown in Figure 4. This gap is very difficult to understand for a cosmologically expanding universe and is usually explained by selection effects (Geller, et al., 1988). However, with a polytropic universe the number density reduces rapidly as the radius increases (see Figure 1). Therefore, the distance to the Quasars is much less and their Hubble Law distances are not valid. This eliminates the observational gap. Finally, the highest velocities are very near the edge of the polytropic universe (see Figure 2). This matches the Curtis Schmidt survey very well (see Figure 7). There should be many fewer high- z Quasars because the density falls off significantly at the outer edge of the polytropic universe.

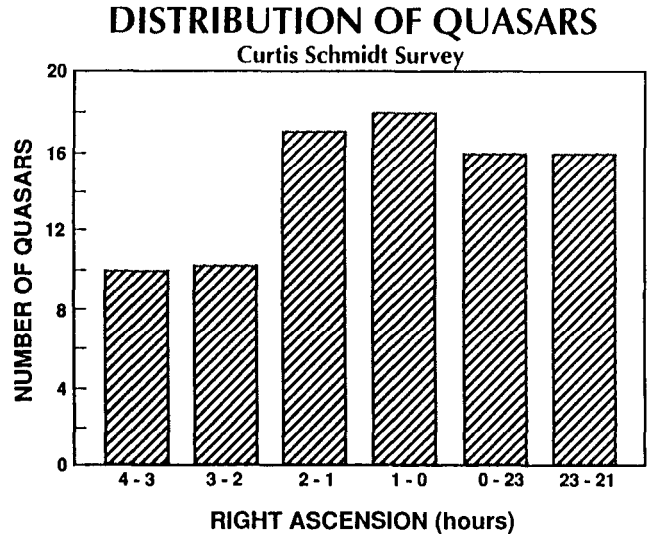
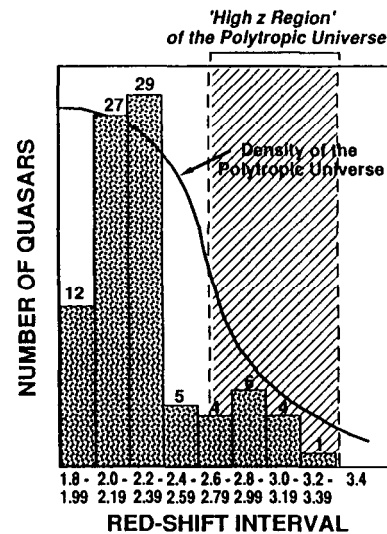


Figure 6. The distribution of Quasars is not uniform.

DISCONTINUITY OF QUASAR RED-SHIFTS



From Curtis-Schmidt Survey (After Osmer, 1982)

Figure 7. The number density and red-shifts of a polytropic universe match the observation.

The Missing Mass of the Universe

The problem of missing mass in the universe basically centers around the discussion of a closed or open universe. Schwarzschild (Bouw, 1982) developed the concept of a mass radius relationship which defines the size of a closed universe. This radius is known as the Schwarzschild Radius, R :

$$R = \frac{2 G M}{c^2} \quad (54)$$

where G = Gravitational constant, c = speed of light, and M = Mass of the universe. In Dirac's larger number cosmology, he estimates the critical mass for forming a closed universe:

$$M = 2 \times 10^{78} \text{ Nucleons} \times 1.67 \times 10^{-24} \text{ gm / Nucleon} \quad (55)$$

$$M = 3.34 \times 10^{54} \text{ gm} \quad \text{"Mass of the Universe"} \quad (56)$$

this yields a Schwarzschild Radius of approximately

$$R = 500 \text{ million light years} \quad (57)$$

for the universe. The missing mass is postulated because the distance to the quasars is approximately 20 billion light years based on the Hubble relationship. This inconsistency with the Big Bang model still persists. This missing mass problem is eliminated with a polytropic universe because its radius is approximately that of the Schwarzschild Radius (from equation 50).

$$R = 577 \text{ million light years} = 5 \times 10^{26} \text{ cm} \quad (58)$$

The problem of the missing mass also arises because the temperature of the universe is only 3K and unlike a star, it cannot prevent the collapse of a Big Bang universe. The universe appears to be expanding linearly but not explosively. Therefore, a large quantity of the mass is not observed. The polytropic model does not depend upon its mass to stabilize the structure. It therefore may yield a value of zero for the cosmological constant. The vanishing cosmological constant λ is preferred by most astronomers (Schwarzschild, 1989). The probability for creating this type of flatness from an explosion is unbelievably small.

The Mass of the Universe

With the polytropic model of the universe, and using the red-shifts and luminosities of the high z quasars, for the first time, it might be possible to weigh the universe. The reduced orbital velocity for all objects in the polytropic universe is given by equation 28:

$$\omega = \frac{v_0}{2\pi} \left(\frac{\alpha}{M} \right)^{1/2} \quad (59)$$

from table 1 and for $\xi = 3$ we find that

$$\omega = 0.56048 \quad (60)$$

Using a red-shift of approximately 4 and interpreting that as a transverse doppler effect, the Quasar velocity is determined to be (from table 2).

$$v/c = 0.9797 \quad (61)$$

Therefore the ratio α/M can be found to be

$$\alpha/M = 3.23 \times 10^{-9} \text{ in Astronomical Units} \quad (62)$$

The factor α can be determined from the radius, R , of the universe extracted from the luminosities of the Quasars (see equation 50).

$$\xi = R / \alpha \quad (63)$$

thus

$$\alpha = 9.99 \times 10^{+12} \text{ A.U.} \quad (64)$$

The mass of the polytropic universe, M , is then determined to be

$$M = 3.1 \times 10^{+21} \text{ Solar Masses} \quad (65)$$

or

$$M = 6.17 \times 10^{+54} \text{ gm} \quad (66)$$

This is approximately a factor of two larger than the mass of the Schwarzschild universe (equation 56). It is also a totally independent measure for the mass of the

universe and it indicates a solution to the missing matter problem of the Big Bang. There is no missing matter.

The 3 K Background Radiation

A critical prediction of the Big Bang theory is the 3 K microwave background black body radiation throughout the universe. It would require approximately 15 billion years for the universe to cool to this temperature (Sciama, 1977; Webster, 1977). The Big Bang model assumes that the matter and radiation were in equilibrium, i.e., the temperature of the radiation and the thermal temperature of the matter were equal:

$$T(\text{rad}) = T(\text{matter}) \quad (67)$$

After the radiation decoupled, the temperature of the radiation decreased as the radius of the universe increased:

$$T(\text{rad}) = A \times 1/R \quad (68)$$

In a polytropic universe, there must be an alternative but physically reasonable source for the background radiation. Akridge, Barnes and Slusher (1981) proposed that absorption and re-radiation can account for the 3 K radiation. Absorption of stellar light is well known phenomena in astronomy. Significant effort is required to correct for the reddening of light caused by scattering and absorption. Bolometric corrections (Novotny, 1973) are used to adjust the color of stellar observations and are functions of wavelength and celestial coordinates.

The 3 K cosmic background is postulated to be a result of absorption and re-radiation of star-light by inter-stellar gas and dust. In the polytropic universe the temperature, T_{ξ} , at a radius ξ_0 is given by

$$T_{\xi} = T_c \theta \quad (69)$$

Referring to Table 1, we can substitute the values of T_{ξ} and θ , at $\xi = 0.3$ and solve for the temperature at the center of the universe T_c .

$$T_c = 2.7 \text{ K}/0.9851 \quad (70)$$

$$T_c = 2.74 \text{ K} \quad (71)$$

Likewise we can calculate the temperature at $\xi = 0.750$ to be

$$T_{\xi} = (2.73 \text{ K}) (.9151) \quad (72)$$

$$T_{\xi} = 2.49 \text{ K} \quad (73)$$

Thus, the polytropic model of the universe predicts a decreasing temperature of the background radiation as the radius increases.

Even if the CMB can theoretically be caused by star light, this is not the most significant problem to the Big Bang model and the cosmic microwave background radiation. This problem is the uniformity of the CMB radiation. As the universe is scanned, the variation in the CMB temperature is less than 20 parts per million (Gulkis, et al., 1990). This smoothness represents the state of matter at the time when matter and radiation decoupled. This smoothness then must represent that of the current universe. This is not the case. There are very large structures of galaxies and very large regions of no matter at all, called voids (Saunders, et al., 1991). There are no explanations for the disparity of these

observations. Smoothness in the CMB requires that the universe be smooth if the Big Bang did in fact occur.

The observed smoothness in the CMB radiation can be interpreted as a measure of the smoothness of the distribution of interstellar gas and dust. The temperature of the CMB indicates that the local variations in the density of interstellar gas and dust is small. This is not surprising for a polytropic model of the universe.

Structure in the Universe

The literature (Gleick, 1986; Silk, Szalay, and Zel'dovich, 1983; Dressler, 1987) clearly indicates that the universe is not isotropic. The Big Bang model requires equilibrium between all matter and energy as initial conditions. Perhaps a complex model will eventually be developed to account for the anisotropic nature of our universe but several major theorists (Sciama, 1977; Hawking, 1988) are at least looking in directions away from the Big Bang Model. The anisotropic nature of the universe as presented by Hawking (1988) indicates the need to consider other structural models.

A polytropic model would allow large structures of galaxies to remain for extended periods. Large superclusters have been observed (Gregory, et al., 1982). Analogs of these structural features can be seen in thousands of spiral and irregular galaxies throughout the universe. Clustering of galaxies and voids would be expected in an orbiting polytropic universe.

Motion of Galaxies

Careful study of optical galaxies has led to some very interesting findings. The distribution of velocities of these galaxies is not uniform. There are very large velocity differences for galaxies that appear to be close to one another. Galaxy NGC 7603 has a companion with two-times the red-shift (Arp, 1987). Likewise, NGC 4319 and Markarian 205 have an optical bridge while their red-shifts are 1800 and 21000 km/sec respectively (Arp, 1987). The Big Bang expansion model as presently developed has little hope of predicting this anisotropic nature of optical galaxies (Dressler, 1987). Instead the primary conclusion from these data is that a large unseen mass or great attractor exists in our universe. The large differences in velocities between companion galaxies can indicate orbital like motion.

If one observes a highly elliptical orbit of a comet as it passes near a planet (for example Mars), their velocities could easily be different by an order of magnitude. Similar observations have been made of stars within the Milky Way. They have highly elliptical orbits about the galactic center and are called high velocity stars. High velocity galaxies indicate similar orbital motions centered about some "Great Attractor." An extreme velocity optical galaxy (Eales, et al., 1993) with $z = 3.395$ has been observed. These motions would be expected for the polytropic model. The most distant objects that are currently being observed are still the high z quasars. However, they are just closer than a linear expansion would predict. Only the observation of the extreme velocities of local galaxies would indicate the existence of a center to the universe.

The extreme velocity of the Milky Way as measured from variations in CMB (Gulkis, et al., 1990; Morgan, 1987) is shown in Table 3. The Big Bang would predict

nearly identical velocities for Andromeda and the Milky Way. The polytropic model would allow for large differences that could occur if the universe was structured similar to a galaxy. The center of the polytropic universe could be the "great attractor" that is indicated by these velocity differences. The Big Bang simply cannot predict the large velocity differences that we observe for our neighboring galaxies.

Gravitational Blue-Shift

Photons from the edge of a polytropic universe would have "fallen" into a gravitational well when we observe quasars. This potential well would cause blue-shifting and counteract the red-shifting caused by the transverse doppler effect. This shift z_{grav} is given by (Landau and Lifshitz, 1975, p. 250)

$$z_{\text{grav}} = \frac{\Delta\lambda_{\text{grav}}}{\lambda} = -\frac{1}{c^2}\Delta\Phi = -\frac{\Phi(r) - \Phi(o)}{c^2} \quad (74)$$

where the Newtonian gravitational potential, $\Phi(r)$, inside a spherical universe at a radius, r , would be

$$\Phi(r) = \frac{2}{3}\pi G\rho r^2 - 2\pi G\rho R^2 \quad (75)$$

The potential at the outer edge of the sphere of radius R and mass M would be $-GM/R$. The average density for this spherical universe is given by ρ and is assumed to be uniform.

By balancing gravitational, F_g and centrifugal forces, F_c , for a quasar of mass m , we can solve for r^2 .

$$F_g = -\frac{4}{3}\pi m G\rho r \quad (76)$$

and

$$F_c = -m\frac{v^2}{r} \quad (77)$$

Thus

$$v^2 = \frac{4}{3}\pi G\rho r^2 \quad (78)$$

Then

$$z_{\text{grav}} = -\frac{\frac{2}{3}\pi G\rho r^2}{c^2} \quad (79)$$

$$z_{\text{grav}} = -\frac{1}{2}\frac{v^2}{c^2} \quad \text{"Blue Shift"} \quad (80)$$

for a uniform spherical density, ρ . However, for a polytropic universe the density is not uniform and is given by equation 8, Table 1 and shown in Figure 1. The density is a function of radius and cannot be ignored in the equation for z_{grav} evaluated as the photons travel inward from the outer edge R to the position of the Milky Way at $0.2R$. Therefore, we should evaluate:

$$z_{\text{grav}} = -\frac{1}{c^2}\Delta\Phi(r) \Big]_{\frac{0.2R}{R}} \quad (81)$$

Substituting the spherical potential $\Phi(r)$:

$$z_{\text{grav}} = -\frac{\pi G}{c^2} \left[\frac{2}{3}r^2\rho - 2R^2\rho \right] \Big]_{\frac{0.2R}{R}} \quad (82)$$

$$z_{\text{grav}} = -\frac{\pi G}{c^2} [zero - \Phi(r = 0.2R)] \quad (83)$$

Because, at the edge of the polytropic universe, R , all terms in z_{grav} are zero

$$\rho(r = R) = 0. \quad (84)$$

Using Table 1 and equation 8, we find

$$\rho(r = 0.2R) = \theta^n \rho_c = (0.9934) \rho_c \quad (85)$$

Therefore, we obtain:

$$z_{\text{grav}} = \frac{-\pi G}{c^2} \rho_c (0.9934) \left[\frac{8}{300} R^2 - 2R^2 \right] \quad (86)$$

$$z_{\text{grav}} = \frac{-\pi G}{c^2} \rho_c (1.947) R^2 \quad \text{"blue shift."} \quad (87)$$

This leaves the central density of the polytropic universe as a free parameter. We have not used or defined the central density of this model until now. We do, however, observe red-shifted quasars. We can set an approximate upper limit to the central density from these calculations.

If we assume that z_{grav} is no more than 10% of z_{trans} in equation 32, using a series approximation, z_{trans} can be simplified to

$$z_{\text{trans}} \approx + \frac{1}{2} \frac{\nu^2}{c^2} \quad (88)$$

Setting $|z_{\text{trans}}| \geq 10 |z_{\text{grav}}|$ we get

$$\frac{1}{2} \nu^2 \geq 10 \pi G \rho_c [1.947 R^2] \quad (89)$$

Solving for r_c and substituting the polytropic model values into equation 87 we obtain:

$$\rho_c \leq \frac{1}{20 \pi G [1.947 R^2]} \nu^2 \quad (90)$$

and substituting values:

$$\rho_c \leq \frac{(0.9797)^2 (3 \times 10^{10})^2}{20 \pi (6.67 \times 10^{-8}) [1.947 (5 \times 10^{26})^2]} \quad (91)$$

$$\rho_c \leq 4.23 \times 10^{-28} \text{ gm/cc} \quad (92)$$

or approximately one half electron per cubic centimeter. This does not seem too far afield for a first estimate of a hypothetical core of a polytropic universe.

X-Ray Sources

X-ray telescopes, detectors, and observations are becoming an important field of astronomy and astrophysics (Lubkin, 1972; van der Klis, 1988; Saunders, et al., 1991). Their investigations are concentrated on possible mechanisms for x-ray generation. Many of the sources are being modeled by complex binary star arrangements with intense magnetic fields. Extra galactic x-ray sources are more puzzling.

The polytropic model of the universe yields some insight into this problem. This model predicts that some blue-shifted galaxies should be observed clustered about the polytropic center. They may be the observed x-ray sources. Thus, the polytropic model predicts mostly red-shifts with a small percentage of blue-shifts. X-ray detection technology does not have the energy (frequency) resolution of optical detectors. If the

Balmer Series of Hydrogen is blue-shifted into the x-ray region of 50 to 100 ev, the structure of the entire Balmer Series (3 ev wide) would be lost in the detector resolution. We would simply see an extra-galactic "x-ray source" not a blue-shifted galaxy.

Hard ultraviolet radiation is just as difficult to detect. However, if the polytropic model holds, it predicts an anisotropic distribution of UV and x-ray sources.

Conclusions

A polytropic model of the universe has been proposed with our galaxy lying about 5% from the core of the universe. These are the only two postulates for the model. Our position near the center of the universe is very much like the fact that we are near the center of our solar system. We are one Astronomical Unit (A.U.) from the sun. Our outermost planet, Pluto, has an orbital semi-major axis of 39.44 A.U. The earth, therefore, is only 2.5% from the center of the solar system. This is not a proof but it does at least allow for the postulate that the Milky Way could be close to the center of the Universe.

Red-shifted objects follow the orbital velocity relationship with distance because of the transverse doppler effect. Thus, the luminosity problem of the quasars is eliminated. This model would also predict that there is an upper limit to the z values of the Quasars as the velocity goes through a maximum value. The maximum proper motion is predicted to be 0.00044 second of arc per year.

The fall off in the Quasar density matches the fall off in density of the polytropic universe nicely. Because the polytropic universe is rotating about some center of mass, the mass and radius of the universe can be determined from the observations of the Quasars. There is no missing matter and the Schwarzschild Radius is consistent with the polytropic model.

The 3 K cosmic background is the result of stellar light absorption and re-radiation. The smoothness of the CMB is the result of interstellar gas and dust and direction to the "great attractor" may have a greater background temperature.

Structure and clustering of galaxies is expected just as similar structures are seen in galaxies throughout the universe. Filamentary or string like structures with large areas of void would be expected. The "great attractor" is not only predicted it is required for the structure to remain stable.

The model predicts that there should be a small fraction of blue-shifted extra-galactic objects. They should be shifted into the UV and soft x-ray region of the electromagnetic spectrum. The resolution of the hydrogen line spectra remains beyond the current technology.

Epilogue

I believe philosophical discussions of origins should be separated from scientific models. I also believe that God created the universe a short time ago as He recorded for us in Genesis. I also believe that His creation displays common designs throughout.

By presenting an alternative and viable model for the structure of the universe, it may be possible for other researchers to discover details of God's creation that are hidden because the wrong model is being used to interpret the observations. This is my goal and prayer.

Acknowledgements

The author gratefully acknowledges the support and encouragement of Dr. Larry L. Hench, Co-Director of the Advanced Materials Research Center. This work would not be possible without his involvement. The author acknowledges Dr. Robert Gentry for his suggestion for the use of the transverse doppler effect. Finally, the author acknowledges the help of the CRSQ editor and reviewers and expresses his thanks to all those involved.

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VIDEO REVIEW

The Discovery of Noah's Ark. A video written and directed by G. Edward Griffin. 1993. American Media, P.O. Box 4646, Westlake Village, CA 91359. One hour.

Reviewed by Don B. DeYoung*

This video is based on the book *The Ark of Noah* by David Fasold (1990). Both center around an elliptically-shaped rock formation that was exposed by a 1938 earthquake; it is located 17 miles south of Mount Ararat. The story begins by comparing the Genesis Flood account with those found in the Koran and also the Gilgamesh Epic. The Flood is indeed a universally known event in ancient writings.

There is a healthy debunking of the ark-sighting reports from Fernand Navarra and also the Soviet aviator Roskovitsky. Unfortunately, the people positively promoted in this video range all the way from questionable to professional: David Fasold, Ron Wyatt, Marvin Lukerman, a Kurd named Rasheet, Don Patten, and John Baumgardner, among others. John Morris (1992) has critiqued the ark studies of these men.

The video claims that the 600 foot long rock formation is the fossilized ark itself. All that remains visible is a hull-shaped depression. The video advertisement claims evidence for decks and interior chambers, but this is not shown. In fact, the site was partially destroyed with explosives by ark hunters in 1960!

Several parts of the video raise serious questions:

*Don B. DeYoung, Ph.D., Grace College, 200 Seminary Drive, Winona Lake, IN 46590.

1. The Flood mechanism is described as a near collision between the earth and a Mars-size object. This generated tides 30,000 times greater than present, sweeping over the continents.

2. Dozens of nearby "anchor stones," some weighing 20,000 pounds, are claimed to be from the ark. Why did Noah need a hundred tons of anchors? The function of these stones may instead be grave markers, common in the area.

3. Researchers are shown using dowsing rods to map out the floor beams of the ark. This doubtful technique is given the impressive title "molecular frequency generator discrimination!" More credible instruments also shown include metal detectors and ground penetrating radar.

4. It is suggested that there were many more than eight souls on the ark. This false idea comes from accepting the Koran account and rejecting 1 Peter 3:20. Also, animals on board are said to be for food and clothing, not for preservation. The video thus seems to imply a local flood, at best.

The video is quite well done and is entertaining. However, publicity seekers have already given a bad image to the search for Noah's ark. This video, promoting dowsing and also a revision of the biblical flood story, will not clarify the issue.

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PANORAMA NOTES

Reprinted CRSQ Volume 17

Introduction

The *Creation Research Society Quarterly* has been published since 1964 (30 complete volumes). In an effort to make these volumes available, all of the missing issues have been reprinted. Brief synopses have been written on volumes 1-16 and have appeared in the previous 16 Quarterlies. In each synopsis, major articles are reviewed to give a person interested in scientific creationism a general idea of the contents of that volume. Many of the articles are of continuing interest and value.

Personal

The theme of the June 1980 Quarterly was the origin of cultivated plants (see botany paragraph) and the cover of this issue contained a painting of the Queen Elizabeth rose which was chosen as the "world's favorite rose" in 1979. This rose was developed by Dr. Walter E. Lammerts, the founder of the Society and a world renowned plant breeder.

In a later Quarterly, Hedtke (1980b, pp. 181-185) discussed the correspondence between Asa Gray and Charles Darwin on theistic vs. atheistic evolution. Gray chose the former, whereas Darwin adopted the latter. Also see *Did Charles Darwin Become a Christian?* (CRS Books).

Anthropology and Language

Mehlert (1980, pp. 23-25, 21) claimed that the Australopithecines were not the evolutionary ancestors of man, but were more ape-like. "Evolutionary anthropology is in a state of disarray" Hummer proclaimed (1980, pp. 26-27) as he briefly substantiated his hypothesis. Jerry Bergman (1980, pp. 127-134) examined the topics of race and equality of intelligence noting the problems introduced by viewing them from an evolutionary standpoint. Also he questioned the survival of the fittest doctrine.

The same author (1981, pp. 214-216, 226) asked the question, "Is language an exclusive ability of man?" and reached the conclusion "... that there is a chasm between man and the animals regarding language ability, ..." (p. 214). John Klotz (1981, pp. 217-218, 226) explored the same topic and stated that "language is an exclusively human ability" (p. 217).

Astronomy

In articles that are now dated on the "shrinking sun" and solar neutrinos, Hinderliter (1980a, pp. 57-59; 1980b, pp. 143-145) offered some creationist interpretations for the data. Steidl (1980, pp. 60-64) presented a young earth interpretation on the search for solar neutrinos. In a brief treatise against both special and general relativity, Slusher (1980, pp. 146-147) noted that these hypotheses "... and their child, modern cosmogony, have several distinct failures when attempting to represent the real Universe" (p. 147). Bouw, (1980, pp. 174-181) in a unique article on the Star of Bethlehem, stated that all naturalistic explanations are not adequate and he concluded that the Lord's birth was in 2 B.C.

Biology

General

Brown (1980, pp. 87, 109) explained that *Archaeopteryx* is not a missing link between reptiles and birds. Smith (1980, pp. 106-109) discussed the effect of elevated atmospheric pressure on living organisms in relation to a postulated pre-Flood vapor canopy. Spontaneous generation of life and niche limits were examined by Tippetts (1980, pp. 168-174). This thoughtful essay highlights the futility of spontaneous generation as a productive hypothesis.

Botany

Tyler (1980, pp. 3-4) discussed late palaeolithic barley farming. In a comprehensive biogeography article, Howe and Lammerts (1980, pp. 4-18) presented the origin and distribution of cultivated plants from a creationist perspective. Topics explored were as follows:

- Cultivated plants have no ancestors
- Creation view fosters cultivation of new plant types
- The impact of the Fall on plant cultivation
- Effect of cultivation on plant species
- Polyploidy, plant breeding and agriculture
- Mutations, selection and horticulture
- The post-Flood dispersal of cultivated plants
- Vavilov's "centers" of crop plant origins
- History of corn
- The changes in wheat
- The origin of rose varieties
- History of the strawberry
- Origin of modern orchids
- Origin of apple

Also see Hedtke (1980a, p. 21) for a brief note on the origin of domesticated plants and animals. Carter (1980, pp. 22-23) collected some interesting geographical facts on maize. Howe (1981, pp. 219-226) developed a helpful creationist botanical guide of the trees and shrubs found along certain of the South Rim trails at Grand Canyon National Park. His post-Flood plant distribution speculations are worthy of study.

Zoology and Genetics

The domestication of animals from a creationist viewpoint was presented by Turner (1980, pp. 19-21). Refer to Hedtke (p. 21) for some remarks on this topic. Strickling (1980, p. 106) briefly examined the kind concept. Ralph Ancil (1980, pp. 123-127) formulated a proposal for a new creationist discipline of baramin genetics. Definitions, certain features and advantages of the model were explored.

Meteorology and Canopy Theory

Morton (1980a, pp. 40-41) disputed that the earth had an universally mild climate before the Flood. Dillow (1980, pp. 65-72) offered evidence from world mythology on the existence of a pre-Flood vapor canopy around the earth. Both Biblical and scientific data were given by Peterson (1981, pp. 201-204, 213) in arguing for the necessity of canopies around the pre-and Post-Flood earth.

Flood and the Ark

A computer study of large-scale waves possibly generated during the Genesis Flood was accomplished by Clark and Voss (1980, pp. 28-40). The possible effects of such large-scale tidal activity both at and below the surface of the water was examined. In a Hebrew word study, Akridge (1981, pp. 209-213) suggested that the Flood was more devastating than the English translations portray. The structure of the Ark was discussed by van der Werff (1980, pp. 167-168).

Geology

An extensive article on the Thornton Quarry deposits, south of Chicago, was written by D'Armond (1980, pp. 88-105). These deposits are viewed by uniformitarian geologists as a fossil reef. The author rejected this interpretation and proposed that the deposit is a result of catastrophic wave action during the Flood (tsunami wave deposition). In other words, the reef deposits at Thornton have an allochthonous origin. This treatise contains some original creationist thought and a complete model of transport and deposition was suggested. It could be studied along with the Clark and Voss paper (pp. 28-40).

Burdick (1980, pp. 111-114) critically examined the plate tectonics and continental drift concepts. Continental tilt was elucidated within a Flood model framework (Schmich, 1980, pp. 114-117). Geomagnetism was studied by Russell Akridge (1980, pp. 118-122, 117). He examined the dynamo theory which is employed to "explain" the variation of the earth's magnetic field with time and found it wanting. He claimed that the field generated by the Faraday-disc dynamo never reverses, it actually decreases exponentially. Lubenow (1980, pp. 148-160) presented significant fossil discoveries since 1958 in light of the kind concept. He stated that these finds offer no evidences for evolution. This well-written study reveals the bankruptcy of the evolutionary hypothesis and reinforces the creation model of science.

Morton (1980b, pp. 162-167), in a discussion of the distribution of sediments on the earth, speculated that at the time of the Flood, the earth was smaller than it is at the present time. In the final report in a series of four articles (Williams et al., 1981, pp. 205-208, 226) on rapid formation of calcium carbonate structures in the laboratory to simulate the precipitation of speleothems in caves, the effect of pressure differences on deposition was examined. An apparent incubation time before the onset of calcite precipitation was explored. It was concluded that under the proper conditions, rapid speleothem deposition could occur in caves. The series of papers detailed the possible conditions that could lead to accumulation of CaCO_3 structures and a model for post-Flood cave and speleothem development within a young earth framework was given.

Physics and Statistics

As an alternate to the special theory of relativity, Tom Barnes (1980, pp. 42-47) developed classical models for the proton and neutron replacing the nuclear forces with magnetic forces. Lee (1980, pp. 47-49) devised a paradox for the special theory of relativity, labeling it the triplet's paradox. Armstrong (1980, pp. 72-73, 59) completed his two part series on disproving naturalistic objections to the second law of thermodynamics. Sug-

gestions were offered on how to employ statistics in the creation-evolution controversy (Andresen, 1980, pp. 160-162).

Miscellaneous

Medical research on the beneficial effects of magnetic fields in bone repair was discussed by McLeod (1981, pp. 199-201) and implications related to the life spans of the patriarchs were noted. Tinkle (1980, pp. 55-56, 41) presented an essay on the place of belief in the origins debate and outlined which belief is more reasonable. A philosophical treatise on science and morals was written by McGhee (1980, pp. 110-111). Also contained in this volume of the Quarterly were technical notes, book reviews and letters to the editor.

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Emmett L. Williams*

The Human Mind and Language

Noam Chomsky, professor of modern languages at the Massachusetts Institute of Technology, is one of the world's leading linguists. He is a major advocate of the theory that language is innate, the learner simply has to fill in the specific rules in the empty slots of the inborn language mechanism. In the enlarged edition of his *Language and Mind* (Chomsky, 1972), he exposes the appeals to "natural selection" which are commonly made:

... the processes by which the human mind achieved its present state of complexity and its particular form of innate organization are a total mystery, as much so as the analogous questions about the physical or mental organization of any other complex organism. It is perfectly safe to attribute this development to "natural selection," so long as we realize that there is no substance to this assertion, that it amounts to nothing more than a belief that there is some naturalistic explanation for these phenomena. The problem of accounting for evolutionary development is, in some ways, rather like that of explaining successful abduction. The laws that determine possible successful mutation and the nature of complex organisms are as unknown as the laws that determine the choice of hypotheses.

Chomsky's critics, among whom are Konrad Lorenz (1980) and Robert Ardrey (1976), allude to various evolutionary theories in developing arguments against his thesis. But this is a huge begging of the whole question. Life itself is based on conceptual information, stored in wonderfully complex, three dimensional DNA genetic codes, three-dimensional hemoglobin molecules supplying oxygen to the body, complex cellular mechanisms allowing a nervous system to function, etc. The production of a modern computer requires the input of conceptual information. A few children playing in a junk yard could not produce a modern computer starting from scratch. So also, natural selection could not be expected to produce life without the benefit of blueprints or other conceptual information. And the ability of the human brain to formulate the rudiments of language would also seem to originate with this conceptual input from the Creator.

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*5093 Williamsport Drive, Norcross, GA 30092-2124.

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Jerry Bergman*

Rapid Deposition of Thin Laminae Sediments

Introduction

Austin, in his excellent guidebook on the Grand Canyon (1991, pp. 29-31), discussed the rapid deposition of laminae (sedimentary layers less than one cm. thick) particularly in silicate sediments. Several examples, such as deposition during natural catastrophes as well as results from sedimentation experiments in the laboratory, were noted. This evidence has important consequences since uniformitarians, when discussing the geologic column, usually speculate that each thin layer or lamina represents a "seasonal alternation of sedimentary conditions" (p. 29).^{*} Thus many laminae observed in a sedimentary sequence often are interpreted as millions of years of slow build-up of material. Austin showed that this uniformitarian postulate is not viable. Two studies discussed in this note concur with his statements.

Hurricane Deposited Laminae

Hayes (1967) presented evidence for the rapid formation of sand laminae on the beaches of Padre Island, Texas as a result of hurricane Carla in 1961. Also see

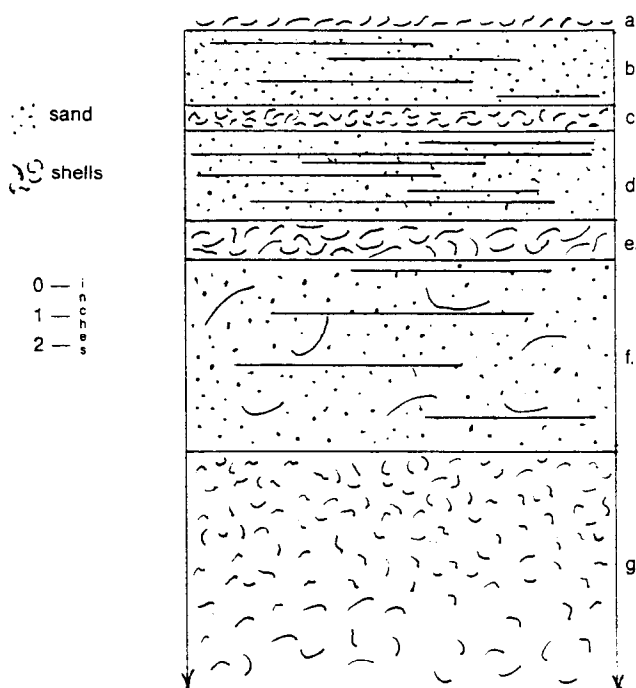


Figure 1. Idealized vertical cross-section of hurricane beach (after Hayes, 1967, p. 18).

- a. Surface shell pavement
b. Well-laminated sand
c. Fine shell hash zone
d. Same as b.
e. Medium-grained shell hash zone
f. Fairly to well-laminated sand (80%), large shells and shell fragments
g. Graded unit with fine-grained shell hash to medium-grained shell hash

*Northwest College, Route 1, Archbold, OH 43502.

Austin (1984, pp. 176-178). Figure 1 is a drawing of the cross-section of sediments observed in a trench dug in the hurricane beach** on Padre Island. The internal structure of the sediments consisted of terrigenous*** sand and shell fragments. B (Figure 1) is a 2.4-inches thick layer of well-laminated sand with each lamina averaging 0.05 inch in thickness. Thus there are approximately 48 laminae in the layer. D (Figure 1) is a 2.9-inches thick layer of well-laminated sand (average lamina thickness same as in B) with approximately 58 laminae.

These 106 laminae as well as the other laminated layers within the hurricane beach deposits were formed during one storm! This illustrates the importance of catastrophic events on sedimentation rates as opposed to slow, seasonal accumulation. The uniformitarian interpretation of the slow rate of deposition of the laminae in layers B and D would indicate decades of time rather than the actual days that were required.

Rainstorm Deposited Laminae

A rainstorm-induced sedimentation of laminae at the tidewater front of McBride Glacier, southeast Alaska in late summer, 1986 was observed by Cowan et al. (1988, pp. 409-412). As the authors stated:

The rain-induced event deposited a significant proportion of the yearly sediment accumulation in McBride Inlet during a period of several days (p. 412).

Sediments traps were suspended underwater above the bottom of the inlet to collect samples of runoff from the glacier. One trap collected 15.4 cm. of sediment after 19 hours which is equivalent to 19.5 cm / day (Cowan et al., 1988, p. 411).

*Also see Oard 1992a; 1992b for a creationist evaluation of varve formation (a seasonal deposition concept).

**Hurricane beach sediments—sediments deposited solely as a result of hurricane Carla (1961) on Padre Island beaches.

***Terrigenous sediments—derived from the land, composed of sand, clay and silt particles.

The trap contained a basal 6.6 cm of very thinly laminated fine sand overlain sharply by very thinly interlaminated silt and mud (p. 411).

Again note that hours, not seasons, were involved in the formation of the laminae. The authors concluded their paper with this statement:

Although such events are not catastrophic, they could produce thick and laterally extensive layers in sequences of glaciomarine sediments (p. 412).

Conclusions

Austin's suggestion that laminae in sediments can form rapidly is quite reasonable as seen in the two examples cited in this note. Rapid deposition of laminae can occur during catastrophic events and periods of intense erosion and sedimentation. It is not necessary to invoke slow, seasonal processes to explain the presence of sedimentary laminae sequences. Thus, by extrapolating this argument, the catastrophic events related to the Flood possibly would have caused rapid, vast sedimentation that could be interpreted as billions of years of work by natural processes from the uniformitarian viewpoint.

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 Emmett L. Williams*
 *5993 Williamsport Drive, Norcross, GA 30092-2124.

VAN ANDEL RESEARCH CENTER DIRECTOR'S COLUMN

The Van Andel Research is operating! A number of research projects are under development or are actually being conducted.

Some of the on-going projects include:

- Limits of natural variation in Ponderosa pine trees
- Rates of stalactite formation
- Origin and variation of Abert and Kaibab squirrels
- Meteor astronomy study
- Fossils of the Coconino Sandstone

Staff Considerations

A major goal for the Creation Research Society is to staff the lab with four or five full-time scientists and a full-time technician. However, it is devastating to morale to hire someone from another, secure position in another part of the country and then terminate them in a year or two due to inadequate funds. Thus, we are committed to the principle of hiring full-time staff only when we can do so on solid financial grounds. This would be evidenced either by sufficient endowment to cover the salary, a record of sufficiently increased giving to the

Van Andel Research Center to cover the salary, or hiring of individuals who have all or most of their support from previous positions or who are willing to raise their support through pledges from churches and friends. Because of the immensity of the task before us and the need for wise use of limited resources, forty-five to fifty hours would be considered a normal workweek.

Short-Term, Volunteer Staff

A major feature of the Van Andel Research Center is the Visiting Scientist Quarters. This motel-type accommodation is intended for visiting scientists and technicians working on approved projects. These quarters, equipped with a small kitchenette and laundry facilities, are intended to provide temporary housing for those involved in short-term projects at the lab or in the field in Arizona or Southern Utah. We can also provide water, sewer and electric hook-ups for visiting scientists, technicians and other workers who wish to bring their own recreational vehicles or campers. Interested researchers should contact me regarding the appropriate

ateness of the research center, facilities and equipment available for the project in mind.

Use of the Visiting Scientist Quarters may be especially appropriate for short-term investigators doing research during sabbaticals, vacations or other temporary leaves of absence from their present employment.

At the time of writing this column, we have a great need for experienced volunteers for continuing minor construction, finish work and landscaping. We could also use an experienced electronics engineer or technician to help us evaluate and if appropriate, repair a number of electronic devices which have been donated to us. Some older equipment is junk, some may be very valuable if calibrated and brought up to standards, but it often is not easy for a non-electronics type to know the difference.

Meaningful Retirement Work

While short-term, temporary help is important, continuity of projects demands long-term help—but not necessarily full-time help. It is in this area where we

can make great use of the time and talents of retired scientists, engineers, technicians and tradesmen (machinists, carpenters, welders, etc.).

Prescott, AZ, our county seat, has been recognized by *Money Magazine* as the best place in the U.S. to retire! Our area, free from the blistering heat and increasing crime of Phoenix and much warmer than the bitter winters of Flagstaff, offers an abundance of reasonable housing, outstanding medical facilities, and easy access to many classic recreation areas. It may be that, for the foreseeable future, retired volunteer scientists will provide the bulk of our research productivity. We can provide a highly rewarding and satisfying outlet for retirees who are committed to Biblical and scientific special creation and who are willing and able to donate at least part-time work for extended periods.

Please do not hesitate to write Box 376, Chino Valley, 86323 or call (602) 636-1153 for additional information.

John Meyer, Ph.D., Director
Van Andel Research Center
Chino Valley, AZ

BOOK REVIEWS

Darwinism by Peter J. Bowler. 1993. Twayne Publishers. New York. 120 pages. \$25 hardback; \$15 paperback.

Reviewed by Don B. DeYoung*

Books about Charles Darwin have provided employment for many British professors over the years. Dozens have been reviewed in the Quarterly, each with their unique insights and flavor. Peter Bowler, at The Queen's University of Belfast, Northern Ireland, has now given us a 120 page gem.

Natural selection is the main theme, defined by Darwin as *randomly* operated diversity, perpetuated differentially, depending on its adaptive advantage. Bowler shows how poorly received this concept was in Darwin's day. Contemporaries were indeed set on replacing the idea of *created* varieties in nature. However, they were not ready to let entirely random changes control life. The playwright George Bernard Shaw declared in 1924, "If it could be proved that the whole universe had been produced by [natural] selection, only fools and rascals could bear to live" (p. 46). Asa Gray talked sarcastically of the "scum of creation" (nonadaptive variants) that needed to be eliminated in every generation. He could not believe nature produced "crude, vague, imperfect and useless forms" (p. 43). Astronomer William Herschel called natural selection the "law of higgledy-piggledy," where end products were unpredictable and haphazard (p. 96). This reservation against natural selection is no longer voiced in evolutionary theory, to its own impairment. Consistent natural selection leads naturally to the pessimism of T. H. Huxley, who saw humanity trapped in a totally amoral universe. He held out no hope of civilization surviving on a long-term basis in so hostile an environment (p. 52).

There is some unintended humor in the book: Embryologist E. W. MacBride explained the hierarchy of animals in 1914, blaming the invertebrates themselves for their lowly state: "Invertebrates collectively repre-

sent those branches of the Vertebrate stock which, at various times, have deserted their high vocation and fallen into lowlier habits of life" (p. 29).

The silliness of social Darwinists is revealed by their recent attempt to replace the concept of love for others. They say that we think first of close relatives, and secondarily of people not related, because evolution has programmed us to behave in ways advantageous to our family genes (p. 78). Bowler correctly states that government funding, not science integrity, is the driving force for this type of strained Darwinism.

Many of Darwin's failed evolution evidences are presented without refutation: recapitulation, vestigial organs, and inferiority of "lower races." However, author Bowler has clearly shown the tensions of Darwin's day. The book reads like a lecture from an expert.

Bones of Contention; Controversies in the Search for Human Origins by Roger Lewin. 1995. Simon and Schuster. New York 348 pp. \$19.95.

Reviewed by Jerry Bergman*

Bones of Contention is an excellent, honest, well documented book about the controversies involved in determining the significance of fossils related to human origins discovered primarily in the 1960s to the 1980s. This readable, flowing book makes it very clear that in the past "racism of a particularly pure, intellectual form was a persistent theme of American and British anthropology" (p. 55). A major assumption was that human evolution from lower primates occurred and therefore the fossils uncovered must be evidence for evolution—no other interpretation could be considered. The fact is, as Lewin and the authorities that he quotes admits, "virtually all of our theories about human origins were relatively unconstrained by fossil data" and this is still often true today. This problem was well put in the statement that many human evolution "theories are . . . fossil-free or in some cases even fossil-proof" (p. 43).

*Don B. DeYoung, Ph.D., Grace College, 200 Seminary Drive, Winona Lake, IN 46590.

*Jerry Bergman, Ph.D., Northwest State College, Archbold, OH

A major requirement to prove evolution is the existence of a series of thousands of intermediate types between our alleged primate ancestors and modern humans. Ironically, the arguments, though, invariably focus on whether a certain fossil discovery is a human or an ape, causing researchers to dichotomize according to the assumption of stasis. The extremely limited evidence—a relatively small number of fossils have been discovered, most of which are very damaged and distorted by time, making interpretation difficult—is what produces the endless “bones of contention” This is even true for relatively well preserved fossils such as Lucy, one of the most complete alleged human fossil ancestors discovered to date.

A second major concern in proving that a fossil is ancestral to humans is that even if a fossil skeleton was exactly intermediate between humans and our hypothetical human primate ancestors, this would not prove that the fossil was in fact a human evolutionary ancestor. The latter requires a knowledge of history, specifically who begat whom, knowledge which is not possible without personal or reliable direct knowledge of the breeding generations. Given the scattered, fragmentary, controversial evidence, it is almost impossible to even determine much for sure about most extinct creatures. Determining what “hominid” or other fossils are transitional forms between humans and their alleged primate ancestors’ fossils is, as Lewin convincingly argues, exceedingly difficult. If evolution were true, though, what we would expect to find in the fossil record would be thousands, if not hundreds of thousands, of transitional types. Indeed, every fossil would be a transitional form in the slow evolution from early mammals to humans. Yet this is not found. The book highly confirmed, and did not contradict, the conclusion that many fossils are clearly part of some race of humans such as the Neanderthals. The rest are an extinct or modern type of primate, and virtually all fell quite comfortably in these two categories. Even if an exactly intermediate skeleton type was discovered, this would at best prove only that an organism intermediate between humans and monkeys existed in the past—it would in no way prove that humans specifically descended from that primate. Of course, a naturalistic interpretation would cause one to accept that conclusion, nonetheless, it is not a proved conclusion.

The enormous level of controversy in this area vividly illustrates both the importance of preconceived ideas, and the sparseness of evidence, all which is open to many interpretations. The personality conflicts and ego investments researchers have in their work in this field is legion—in Lewin’s words, many scientists possess their ideas as a jealous lover, and regard one who disagrees with their interpretation as a personal enemy (p. 23). The major drawback of the book is that the arguments, debates, and endless squabbling among paleontologists becomes incredibly tedious after a while—the book could easily have been condensed into two chapters instead of 348 pages. The controversies soon become very tiresome, and many are often pointless. Fortunately, many of the events that the author discusses I was aware of, and consequently could relate to, a fact which helped me to keep my interest. For someone with little knowledge of physical anthropology, though, the first few chapters as well as the last few chapters may be about all that they could assimilate.

A New Look at an Old Earth by Don Stoner. 1992. Schroeder Publishing Co., 13119 Downey Ave., Paramount, CA 90823. 192 pages. \$15.00.

Reviewed by Don B. DeYoung*

This book blasts the recent creation view as ignorant (back cover), a stumbling block to evangelism (p., 7), and entirely incompatible with reality (p. 16). Actually, most of the book isn’t quite so caustic—the author honestly struggles with issues. Hugh Ross has written the foreword and Don Stoner is clearly a Ross disciple.

There is little science presented. Instead the book is largely a biblical defense of Day Age thinking. Many of the statements, unfortunately, stretch Bible interpretation far past the breaking point. A sampling of Stoner’s thinking:

Numerical adjectives given to the creation days do not make them literal. After all, the end time is often called the last day, and this “is certainly grammatically analogous to (p. 44)” a numerical adjective.

The “evening and morning” formula in Genesis 1 may simply mean something like “from beginning to end” (p. 43).

Romans 1:20 implies that since God is eternal, the earth must also be ancient (pp. 16, 54). The universe looks old, and God does not lie. Therefore it *must* be old (p. 71).

“The mere fact that distant stars can be seen proves that they were there a very long time ago (p. 55).” The Spirit moving upon the waters in Genesis 1:2 may have been a cosmic density wave in the primordial nebula (p. 12).

Adam may not have been created with an appearance of age. Instead he “might have been created as a baby or even as an embryo” (p. 69).

These examples reveal the very “uncertain sounds” and poor logic which appear throughout the book.

Why does Genesis 1 sound so literal, if it actually is not? Why is the word “days” used instead of “ages”? Stoner believes that God hid the actual creation details (the big bang, progressive creation, and long ages) so readers could figure it out for themselves and make choices (p. 34, 70). What he really means by this is not clear. In a moment of reflection, Stoner admits that he might be entirely wrong: “this author’s attempts to correlate present-day scientific theories with the Bible should not be taken too seriously” (p. 110). And herein lies the key to the age debate, which Stoner does not see: Science alone will never determine the earth’s origin or age with certainty. The big bang is just one in a long parade of origin theories. Why then must Genesis be attached to this theory, and be forced to rise or fall with it? Certainly there is room for the refreshing possibility that Genesis may be literal history! And if recent creation is an obstacle to evangelism, the fault certainly is not with the view, but instead with man’s rejection of the supernatural, instantaneous creation.

The book contains several errors: The earth does not revolve on its axis, it rotates (p. 64). Also, recent creationists do not believe that dinosaur bones were created directly in rocks, as stated (p. 69). Dialog concerning the earth’s origin and age is important; this book makes a limited contribution.

*Don B. DeYoung, Ph.D., Grace College, 200 Seminary Drive, Winona Lake, IN 46590.

COPY 'N SHARE

THE HISTORY OF LIFE

LANE P. LESTER*

It has often been claimed that the evolution-creation controversy is a conflict between science and religion. This is given as a primary reason for keeping the creation alternative out of the science classroom. But the two powerful ideas of evolution and creation cut across the academic disciplines of science, religion, philosophy, and history. Both are developed from the findings of scientists and are appropriate subjects for science classes. But both go beyond the capabilities of science and require a measure of faith from their proponents.



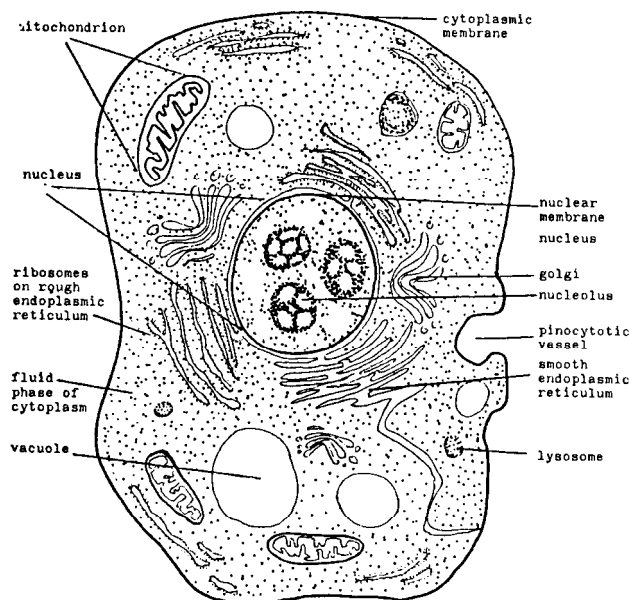
Although there are variations in both the evolutionist and the creationist camps, the controversy can be simplified to state that either evolution is true or creation is true. To eliminate one is to confirm the other. Many writers have concentrated on exposing the fatal weaknesses of the evolutionist position, thereby showing that creation is the superior scientific model. But rather than follow this same approach, I would like to provide a positive statement of the creation alternative and give you some of the evidence supporting it. I'll frame this in two somewhat simplified statements, one about the origin of life and one about the origin of species.

Origin of Life

The origin of life had to be by supernatural creation, because life is too complex to arise through natural processes. The living cell is, in many ways, like a chemical factory, but more complex than any designed by humans. Hundreds of chemical reactions are simultaneously going on in each cell. And the cell is not just a bag of chemicals reacting with one another. It is subdivided into many specialized compartments, just as a human factory is divided into areas with different functions. Both the physical design of the cell and the chemistry in it are clear examples of intelligent design.

There have been many attempts in the laboratory to show how life could have originated through natural

processes alone. Scientists have succeeded, usually using extreme measures, in simulating a few tiny steps of the total process of life. Anyone who expresses satisfaction with these attempts shows us one of two things. Either they have a poor understanding of the complexity of life or they have an incredible amount of faith in evolution. In spite of headlines about the creation of life in a test tube, scientists are nowhere near being able to demonstrate a natural procedure for the origin of the first cell.



Animal Cell Diagram with Electron Photomicrographic Details.

Origin of Species

A large number of different organisms had to be created supernaturally, because the processes of biological change are not capable of significant innovation.

Let's consider first the processes that produce change in individual living things. Then we'll look at a process that produces change in populations of living things. The physical characteristics that we and other members of God's creation possess are largely controlled by our genes. Both creationists and evolutionists agree that mutations are the only source of different genes. These are genetic mistakes, errors in transmitting the information of inheritance from one generation to the next. Mutations are almost always harmful or neutral in their effects. However, the evolutionist believes in mutations as the source of all the diversity of life on earth today. This would require the production of untold numbers of beneficial mutations. That the same handful of examples is always offered is again testimony to the faith of the true believer in evolution.

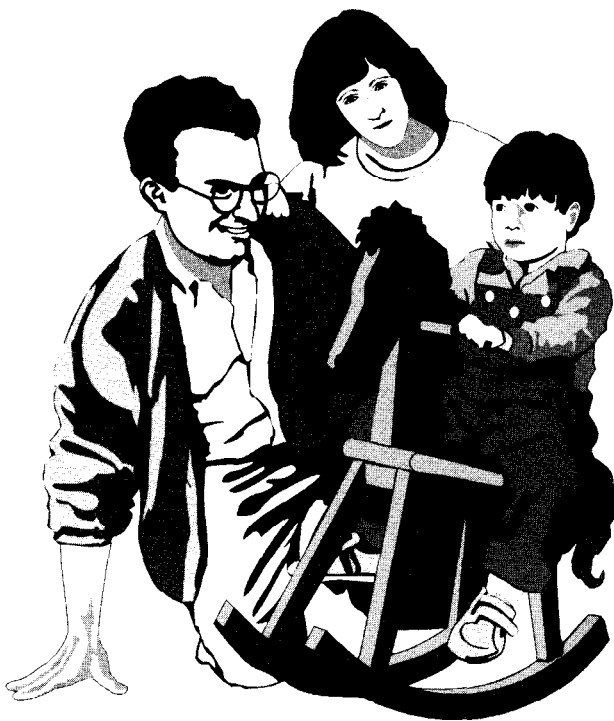
One of the favorite examples of beneficial mutations is the ability of bacteria to change so that they are resistant to antibiotics. Of course, that is beneficial

*Lane P. Lester, Ph.D., Director, Museum of Earth & Life History, Liberty University, Lynchburg, Virginia 24506.

only to the bacteria, not to the humans they infect. Insects, similarly, undergo mutations that make them resistant to insecticides. These resistance mutations are very beneficial to organisms confronted by these poisons. However, they do not produce the kind of change that is needed to convert one type of creature into another.

There are some beneficial mutations that produce large changes. Charles Darwin, during his voyage around the world, discovered wingless beetles on the island of Madeira. These beetles had undergone mutations causing the loss of wings, a good idea on a windy island. A similar example would be the blind fish that inhabit caves. Here mutations have eliminated organs which have no use in the dark. These changes are, indeed, significant, but notice that they involve the loss of existing structures. No one has ever seen a species undergo mutations that produce wings or eyes in animals that have never had them before.

There is, however, another process by which individuals can vary. Recombination explains why children look different from their parents. This shuffling of the genes can produce superior combinations of different genes. However, because we see that mutations are incapable of supplying useful variation, the useful genes that are there to be shuffled must have been created at the beginning.

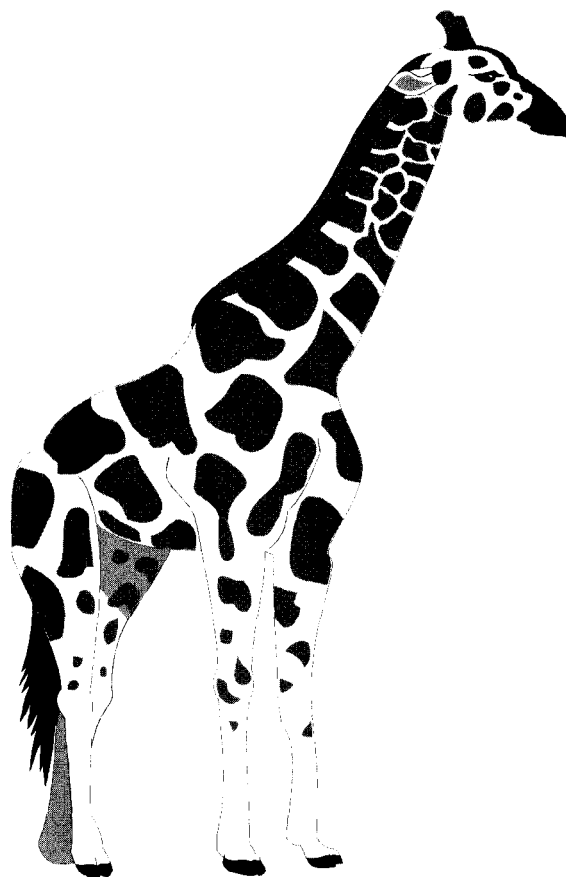


We have mutation and recombination as the processes by which individuals can change. But the history of life is primarily the story of populations, not individuals. What causes populations to change?

Charles Darwin correctly described natural selection as a powerful process in the history of populations. If some gene combinations have an advantage over others, their owners will leave more offspring for future generations. And this will cause a shift in the genetic make-

up of the population. But Darwin thought that because a little change was possible with natural selection, any amount of change could result. One reason for his mistake was his ignorance of genetics. For example, he thought that the giraffe could have gotten its long neck by stretching it and passing the results on to its offspring. It is interesting that, during the 1850's, when Darwin was doing his research, Gregor Mendel was discovering the principles of genetics. While Darwin was building a case for unlimited change, Mendel was finding an unchanging pattern of inheritance. What does natural selection accomplish? Using the genes provided by the Creator, natural selection makes it possible for populations to survive changes in their environments. It may also allow a population to migrate into a new environment. Finally, natural selection also prevents change as it eliminates or minimizes the effects of harmful mutations.

With these basic statements about the origin of life and the origin of species, let's try to put the history of life into a meaningful framework.



First Kinds

According to the creation model, each basic type of living thing was supernaturally created. Can we identify the created types today? It is obvious that some species are related, so species can't be the unit of creation. The higher taxonomic categories (genus, family, etc.) are subjective and can't serve this purpose. A new term is needed, and various ones have been proposed. In our book, *The Natural Limits to Biological Change*, Ray

Bohlin and I proposed the word prototype (first kind). Unfortunately for our egos, this word has not become popular. The clear-cut winner so far is baramin, which is derived from two Hebrew words meaning essentially created kind.

A baramin could be defined as the descendants of a single created population. So each baramin has its beginning at the creation, and unless extinct, continues to exist today in its descendants.

After the creation, each baramin population grew and subdivided as it spread over the earth. The processes of recombination and natural selection in new environments in many instances caused the members of the same baramin to divide into separate races and species. A question that arises is whether a small original population could provide all the variability seen today in that baramin. An example that suggests a positive answer is the inheritance of skin color in the human species. Humans come in many different shades of color, but it is genetically possible that the First Couple could have been the same color, had children the same color as themselves, and yet produced the entire rainbow of humanity. All this would have been possible without the necessity of mutations being involved.

There are many examples of multiple plant species that have come from the same baramin during historical times. Animals are harder to determine in this regard, but it is possible that the horse, donkey, and zebra are descendants of one baramin. The same may be true of at least some of the big cats: lions, tigers, etc.



Basic Designs

To appreciate fully the living world around us today, we need to have another word in our vocabulary, archetype (ancient form). This refers to basic designs used repeatedly by the Creator. There is an endless variety of examples known to biologists. One of the most fundamental archetypes is the living cell, the building block of all life. An example seen in most biology text books is the front limbs of different back-boned animals. The evolutionist believes that this is evidence of common ancestry, but it is just as logically evidence of the same Designer. Architects today will

use similar materials and techniques in several buildings, varying the basic design for the needs of the particular client.

Summary

With the above concepts about the origin of life and the origin of species, all the history of life and the great diversity of life today can be understood and appreciated. The known processes of beneficial change (recombination and natural selection) are capable of taking a group of created populations and developing them into the richness of life on earth today.

Further Reading

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Acts and Facts, Institute for Creation Research, Box 2667, El Cajon, CA 92021, donations appreciated. News about ICR, group of creation scientists. Includes articles on Biblical and scientific topics.

Creator, His Creation, P.O. Box 785, Arvada, CO 80001, donations appreciated. Fine little newsletter including excellent materials for children.

The Natural Limits to Biological Change, L. P. Lester and R. G. Bohlin, Word Books. The evidence of genetics shows the weaknesses of modern theories of evolution. Adult reading level.

What Is Creation Science?, Henry M. Morris and Gary. E. Parker, Master Book Publishers, P.O. Box 1606, El Cajon, CA 92021. Very readable overview of the creation-evolution controversy.

Evolution: The Challenge of the Fossil Record, Duane T. Gish, Master Book Publishers, P.O. Box 1606, El Cajon, CA 92021. The best treatment of fossil record.

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Dr. Glen Wolfrom
Membership Secretary
Creation Research Society
P.O. Box 969
Ashland, OH 44805-0969

YOUR VOICE WAS HEARD

LANE P. LESTER*

You received a questionnaire in the March, 1994, issue of the Creation Research Society Quarterly. At their May 22, 1993 meeting, the CRS Board of Directors had decided to seek the opinions of the membership on a number of issues, and the questionnaire was the vehicle used. Over 200 responses had been received by the time the Board met in May this year, and a statistical analysis of the results was provided to the Board members. Based on this study, the Board decided to explore a number of changes in the appearance and contents of the Quarterly, and you WILL see these in the months to come.



Copy 'n Share

You will find the first of the innovations on the very next page. This new "Copy 'n Share" feature is the result of a request from a pastor CRS member who said that he wanted more material that he could distribute to his congregation. We hope that you know some people who would be interested in receiving information about creation research written at a popular level. You are encouraged to take the "Copy 'n Share" feature to a print shop and have copies made that you can make available to others. It has been prepared so that it can be folded to produce a 5.5" x 8.5" booklet.

A New Look

In addition to your responses to the multiple choice questions, we were very much interested in the practical suggestions for improvement that were made. Some of these were considered at the Board Meeting, and more will be taken up as time goes on. All of the suggestions are being read; none are being ignored. Several members, some with expertise in the publishing industry, said that we could improve the appearance of the Quarterly in a number of ways. A commitment was made to investigate the changes to be made, and you may see other changes in the future. This page is an example of what is being considered.

Pictures, Please!

Many suggestions were made about the use of illustrations and photographs. Some simply wanted more pictures, while some had comments about quality and subject matter. For photographs we have to rely pri-

marily on the authors. For illustrations, we have additional resources beyond what the authors can provide. There is commercial clipart available that will sometimes be appropriate. And where something special is needed, only an artist will do. Artistic talent is not that common, and professional artists are rightly well-paid. Unless we are able to locate artists who will "give us a break," the costs involved will limit our ability to use original art.

Amateur Authorities

There seems to be a commonly-held misconception that only scientists with advanced degrees may submit articles for the Quarterly. The editors know that you may have expertise in an area without having any "letters" after your name. Anyone is welcome to submit a manuscript which will be reviewed by members who are knowledgeable in the subject of the paper. They will not know anything about the author and will judge the manuscript on its own merits. Small changes or large ones may be suggested. Or if the paper has value but is not appropriate for the Quarterly, the author may be advised of a more suitable publication.

This new feature is the result of a request from a pastor member . . .

Quote

And each member [of the legislature], before he takes his seat, shall make and subscribe the following declaration, viz: "I do believe in one God, the Creator and Governor of the universe, the rewarder of the good and the punisher of the wicked, and I do acknowledge the Scriptures of the Old and New Testament to be given by Divine Inspiration."

From the Pennsylvania constitution authored by Benjamin Rush and James Wilson. Quoted from: Anonymous. 1785. The constitutions of the several independent states of America, published by order of Congress. Norman and Bowen. Boston.

BANGS CANYON—A VALLEY OF BOULDERS

EDMOND W. HOLROYD, III*

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Abstract

Large boulders of Dakota sandstone are strewn completely across a broad valley in Bangs Canyon in western Colorado. The boulders near the bases of the sandstone cliffs at the valley sides form talus. The rest of the boulder distribution may be remnants of a rapid process that carved the valley. Giant boulders scattered as far away as 800 m from the cliff face seem to provide a counterexample to other Colorado Plateau cliffs where the talus stops abruptly near the base. This region has additional geologic features, such as peneplain erosion of the Precambrian strata; salt, coal and uranium deposits; and the large range of aeolian, riverine, lacustrine, marine and igneous deposits, which will be of interest for future studies by creationists.

Introduction

Weathering processes are constantly eroding cliff faces wherever they are found throughout the world. Weathered debris ranges in size from material as small as the original mineral grains to large boulders of rock, known as talus, which accumulate below the cliff faces. Theoretically the talus boulders should weather to pebbles as the cliff face recedes. Debris eroded from the cliff face should therefore become smaller and more rounded with distance from the cliff face. The resulting sand grains could then be easily removed by wind and water.

In a previous paper, Holroyd (1987b) introduced the idea of "missing talus" at some cliff faces at Mesa Verde, the Book Cliffs, and Monument Valley. In a photograph showing the west side of Mesa Verde in Colorado, sandstone blocks had eroded from the cliff face and had fallen onto the very soft and steep shale slopes below. However, there were no decaying sandstone remnants visible across the pediment, the flatter region beneath or beyond the slopes. He suggested, based on a similarity of elevations, that some locations having this abrupt cessation of talus may be shorelines of extinct lakes. Wave action may have pulverized previous talus and swept it away as sand. The author believes that the talus we now see would have fallen since the demise of the lakes.

This article precedes a more detailed discussion on the "missing talus" phenomenon, which is widespread in the Colorado Plateau region. The author will discuss a valley in which large decaying boulders are strewn across a landscape below the cliff faces at the edge of Bangs Canyon. A later article will document "missing talus" at selected study sites. Another will explore possible extents of lakes on the Colorado Plateau, showing how the "missing talus" sites tend to be along the shorelines of such hypothesized lakes.

No absolute time scale is being offered in this series of articles. The author is appealing only to a relative scale related to the rate of weathering of the boulders. This rate must vary with rock composition and with the nature of the weathering process. The minimal weathering of talus at the sites listed in Holroyd (1990) indicates its relative youth. By "youth" and "recent" the author suggests an ice age or post-ice age time frame. That weathering observation in turn puts the demise of the lakes as "recent". The topographic analysis suggested in Holroyd (1987b) and illustrated in

Holroyd (1990) required the "plugging" of the Grand Canyon in order to form lakes in the basins upstream. The Grand Canyon could not have coexisted with such lakes because it served to drain them. The author hopes to show through this series of articles that the carving of the Grand Canyon is also "recent."

Geology of the Uncompahgre Plateau

In describing the geology of the Uncompahgre Plateau region the author will use the standard geologic period names from stratigraphy. By this notation the author refers only to the depositional sequence and not to the evolutionary theory commonly associated with these period names.

Figure 1 shows a satellite view (north at the top) of the eastern part of the Colorado Plateau (western Colorado) with some geomorphic features identified. This is the region referred to throughout this and the next section of this article. The dark band (conifer trees) running diagonally across the lower part of the view is the Uncompahgre Plateau, capped with a narrow broken cover of snow. To the northeast a more extensive snow cover lies on the basalt cap of the Grand Mesa. The Colorado River flows from the northeast corner of the picture towards the southwest. Just west of the Grand Mesa it diverts around the north end of the Uncompahgre Plateau. Water is withdrawn from the river in this area to irrigate a broad section of the Grand Valley. South of the Grand Mesa the Gunnison River flows northwestward and joins the Colorado River at the city of Grand Junction. On the west side of the Uncompahgre Plateau are the Dolores and San Miguel Rivers.

The basement rocks of this region are Precambrian metamorphics and are believed to be remnants of a large mountain range oriented from northwest to southeast. Arkose rocks are found along both flanks. Arkose rocks are sandstones and conglomerates with at least 25 percent feldspar content. Feldspar can weather, unless rapidly buried, to clay minerals in the time available under normal uniformitarian deposition rates. Arkose rocks are therefore indicative of more rapid to catastrophic rates of deposition found, for example, in alluvial fans at the flanks of steep mountain ranges.

Weathering and erosion reduced the range to a peneplain, in a similar fashion as has been proposed for the Great Unconformity in the Grand Canyon. To the southeast of Figure 1 the unconformity contact outcrops in a small canyon on the west side of the village of Ouray, Colorado. There the Precambrian strata are

*Edmond W. Holroyd, III, Ph.D., 8905 W. 63rd Ave., Arvada, CO 80004-3103.

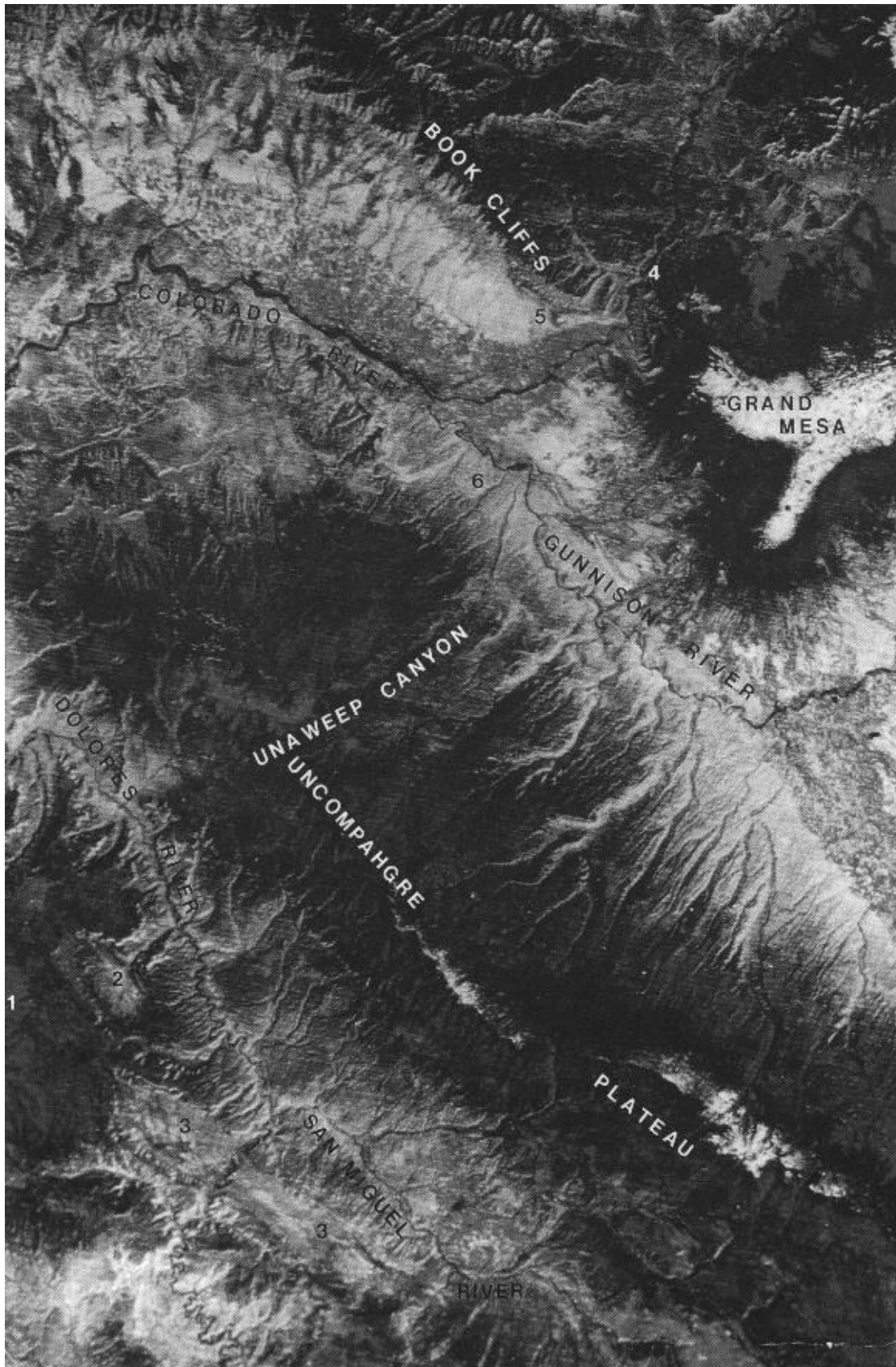


Figure 1. A Landsat satellite view of the Uncompahgre Plateau in western Colorado. Major features are labeled. Numbered features are identified in the text.

vertical in orientation, yet capped by a horizontal layer of Devonian and Mississippian limestones. Subsequent sedimentary layers visible from the road between Ouray and Ridgway include Triassic red beds, followed by Jurassic sandstones and shales, ending in the Jurassic Morrison Formation. The overlying layers, which line the eastern surface of the Uncompahgre Plateau, are of the Cretaceous Burro Canyon and Dakota Formations, composed mainly of durable sandstones, with some interbedded shales and Carboniferous layers. The Dakota formation is interpreted as the western shoreline of the westward-moving marine Zuni Sea. It is further postulated that the sea deposited up to a mile of the soft Mancos shale above the Dakota Formation. Its retreat brought the Mesa Verde Formation, "a series of thick, resistant, near-shore Cretaceous sandstones with many coal layers and carbonaceous shales" (Chronic, 1980). Holroyd (1992, Figure 5) illustrates some Dakota Formation plant fossils from the Uncompahgre plateau (sampled just to the east of the lower right corner of Figure 1) and discusses the rates of formation of the Morrison and Dakota strata in the Denver region.

Tertiary times brought the last widespread sedimentary layers, mostly to the fringes of the illustrated region. After the Laramide Orogeny they were capped or intruded by igneous rocks. The types of igneous rocks deposited include the volcanics of the San Juan and West Elk Mountains, basalt flows of the Grand Mesa and White River Plateaus, and laccoliths elsewhere.

Fault lines in the old Uncompahgre Mountain roots were reactivated under compressional folding during the Laramide orogeny and a subsequent regional uplift, and the present Uncompahgre Plateau was elevated. The layers above the hard Dakota sandstone have since been almost completely stripped of as much as two kilometers of overburden. Dendritic drainage channels on the eastern side of the plateau (Figure 1) have cut deep into the Precambrian rocks in places, exposing a colorful stratigraphic column. Colorado National Monument, at the north end of the Uncompahgre Plateau and southwest of Grand Junction, is a good place to view these strata. Many large dinosaur fossils are found where the Morrison Formation is exposed in these canyons. Additional information regarding the regional geology is found in Chronic (1980).

Other Regional Geologic Features

The region in and adjacent to that illustrated in Figure 1 has additional topics of interest. The geologic layering is relatively simple and needs further investigation from a creationist perspective. The initial erosion of this region could have been accomplished by the first part of the Flood. Deposition seems to have been initiated in the south and spread northward as the Flood period progressed. The last large depositional sequences and Tertiary orogenies are possibly from the end of the Flood through the subsequent ice age. The orogenies were followed by severe erosion to the present landforms.

In the lower left of Figure 1 the flanks of the La Salle Mountains are labeled with a white "1." The mountain core is a laccolith, a large igneous intrusion which lies unconformably above a region of salt anticlines. The two illustrated anticlines are Sinbad Valley (2) and Paradox Valley (3). Most rivers follow the axis of

a deep valley. The Paradox Valley, however, acquired that name because the Dolores River cuts across its middle (between the 3s) perpendicular to the NW-SE valley axis. Recent drilling has found Pennsylvanian period salt (NaCl) layers squeezed into a vertical thickness of over 4 km near the valley center. These salt anticlines are some of the largest contributors to the salinity of the Colorado River. The author suggests the interpretation of these deposits as possibly being suddenly precipitated from an eruption of subterranean superheated brine ("fountains of the deep") during the early stages of the Flood.

Just upstream from the mouth of the San Miguel River was the village of Uravan, dismantled about 1987. The name derives from the mining of uranium and vanadium. Both the uranium and vanadium were precipitated as bright yellow carnotite from circulating subterranean waters by the organic carbon in the regional rocks. Some petrified logs nearly totally coated with carnotite have been found (Hurlbut, 1959). The easy mobility of uranium and related elements in these rocks prevents use of that radiometric series for age determination. Any mobility of elements into or out of the rocks resets the "clock".

The crushed polonium halos in coalified wood illustrated by Gentry (1986) came from nearby deposits on the Colorado Plateau. He interprets the halos as requiring a significant compression of the Triassic, Jurassic, and Eocene (Cenozoic) strata in less than a couple of decades. That range of strata is the entire geologic column above the Precambrian rocks in the study region.

From the top of the Uncompahgre Plateau all strata gently tilt downward towards the northeast (see cross section in Chronic, 1980, p. 141). The strata are generally parallel to the surface along the flanks of the plateau. They dip underground at the Gunnison River and extend deep below the Grand Mesa to the east. Under the west end of the Grand Mesa the lower half mile of exposed strata consists of Cretaceous Mancos Shale. The upper half mile consists of the Cretaceous Mesa Verde Formation, several Tertiary sedimentary layers and a basalt cap.

The Mesa Verde layers contain commercially valuable low-sulfur coal seams (Cameo mine at "4" in Figure 1 and other mines along the southeast side of the Grand Mesa). This coal may fit with the log mat formation theory proposed by Steve Austin and illustrated at Mount St. Helens (Austin, 1986). Vegetative debris may have floated near the shore as the Zuni Sea retreated. It became grounded or sunk to the bottom, was covered with sediment eroded from higher terrain to the west, and was converted to coal.

One of the last Tertiary sediments deposited on the Grand Mesa was a thin layer identified as the Green River Formation. Just to the north of the Grand Mesa, at and beyond the top of Figure 1, this layer contains thick deposits of oil shale. These oil shales are believed to be derived from the lake which existed in the former Piceance Basin. The Uncompahgre Plateau is along the approximate rim of the basin while the Grand Mesa is approximately the southern shore of the lake. These oil shale deposits might be interpreted as immediately post-Flood, when the geologic chaos was settling down.

The regional geologic history since the basalt flow has been entirely of erosion. The elevation drop from

the western rim of the Grand Mesa to the rivers at Grand Junction is over a mile due to the removal of strata through the Mancos shale (white valley bottoms in Figure 1). Mesa Verde sandstone caps the Book Cliffs north of the Colorado River. The strata sequence there is the same as found at Mesa Verde. Just as in the photograph of Holroyd (1987b), sandstone boulders are falling from the cliffs near the 5 in Figure 1, forming talus which is limited in extent to the cliff base.

The specific region of interest in this article is Bangs Canyon, the minor valley just south of the 6 in Figure 1 and north of Unaweep Canyon. There are no roads in this region.

Canyon Formation

Cutting across the northwest end of the Uncompahgre Plateau is the large Unaweep Canyon, the Indian name meaning with two mouths. It looks like an abandoned river channel and now supports two small streams draining to the east and to the west. Lohman (1961) interprets the Canyon as an ancestral position of the Colorado and Gunnison Rivers. The valley presently has a flat bottom between vertical cliffs. Subsurface profiles, however, show the valley to be deeply V-shaped and filled with alluvium. Basalt rocks like those from the top of the Grand Mesa, east of the Plateau, have been found at the west end of the Canyon. As the Mancos shale eroded away from around the north end of the Plateau, a side tributary propagating southward from near the present city of Grand Junction eventually captured the Colorado and Gunnison Rivers and diverted them around the north end of the Plateau. The present streams draining Unaweep Canyon are not the cause of its formation.

With the removal of the Mancos shale from the east side of the Uncompahgre Plateau, streams, rills and gullies carved into the Dakota sandstone. These drainage features have cut deep into the surface of the Plateau. The water flowing through them seems insignificant compared to the sizes of the canyons. The author believes that precipitation was much more abundant in the past (see Oard, 1990), or perhaps the rocks were softer when the channels were started.

Another scenario came from a discussion among students in a geology course held in Montrose, Colorado, in Autumn 1985. The originator of this suggestion is unknown to the author, but it is worthy of consideration. The Morrison Formation was thought to have been made up of layers of multicolored shales and sandstones deposited in perhaps a Piedmont environment by various rivers and streams flowing eastwards from a high range of mountains. Some of the last stream beds may not have been solidly filled with firm material before the more durable Dakota sandstones began to be deposited. Ken Stoy has related to the author that his water well drilling is always slow in the hard Dakota sandstone. When he reaches the Morrison the drill digs much faster in the shales. In some spots, however, he passes through a siltstone between the Dakota and the Morrison (possibly related to the Burro Canyon Formation) which offers almost no resistance to the drill. Perhaps such siltstone was the last material to fill sluggish stream beds before the Dakota layers. Such siltstone would be a natural weakness, directing the channeling of water at the base of the Dakota

aquifer. In some areas the Dakota could be undermined and slump into a vacated siltstone channel. The slump would attract surface waters as well. The end result would be that today's canyons on the eastern slopes of the Uncompahgre Plateau could have had their positions determined by the last river positions in the Morrison or Burro Canyon depositions. They could thereby be the retracings of fossil rivers.

Austin (1991) promotes a mechanism called sapping. Water-saturated sediments can slump catastrophically into lower basins. They can leave behind large valleys with steep walls, amphitheaters, or possibly dendritic canyons. Austin (1984, 1986) shows an excellent example of this in which a canyon was formed suddenly (on March 19, 1982) in the volcanic ash deposits north of Mount St. Helens. Neither the Toutle River nor the stream now occupying that canyon caused its formation.

The sapping scenario can work on the Uncompahgre Plateau. Morrison shales form unstable strata much like the Mancos shales. A slump in the Morrison would undermine the Dakota, and both layers would be flushed downstream.



Figure 2. Some giant boulders in the east end of Unaweep Canyon dwarf the adjacent trees.

A Unaweep Inspection

Unaweep Canyon has a paved road through it, making access easy. Figure 2 shows some of the boulders at the eastern end of the canyon, looking north to the cliffs on the far side. The adjacent trees are pinyon pines and junipers perhaps about six meters tall. These boulders are well-rounded by weathering but are still giants. Their sizes are likely to be related to joint patterns in the undisturbed Dakota strata. However, no joint inspection was made in this study.

Figure 3 looks southeast at the nearby southern rim of the canyon. The landscape is covered with talus from the Dakota sandstone rim rocks. Looking north from the same spot is Figure 4. It shows rocks in the foreground resting on Morrison shales. The large boulders extend to the northern rim about a mile behind. They are not confined to the bases of the cliffs.

The orientations of the sandstone boulders were found to be seemingly random. Tumbling would be expected for the talus near the cliffs. Further erosional slumps and underminings in the Morrison shales appear to change boulder orientations and, to a lesser extent, their positions. A subsequent article will show an exam-



Figure 3. Talus from the southern rim at the east end of Unaweep Canyon.



Figure 4. Large boulders extend from the foreground at the east end of the canyon, across the valley, and to the northern rim of Unaweep Canyon nearly a mile away.

ple of similar boulder movement in a Grand Canyon tributary as determined from rephotography after the passage of a century.

Many boulders far from the cliffs could not have rolled there recently from the canyon cliff faces because of deep intervening gullies. They may be near their original resting places after their removal from the receding cliff faces. Alternatively, boulders near the valley center could have been placed there from upstream sources by major floods, including debris flows. They could even have had subsequent movements as a result of later flood waters. However, any such floods which would move tree-sized boulders in directions other than downhill must be catastrophic. A detailed mapping of boulder sizes and locations in the Unaweep Valley and adjacent valleys could yield data relevant to the mechanisms of boulder placement.

Bangs Canyon Data Sources

About five miles north of Unaweep Canyon, on the northeast side of the Uncompahgre Plateau, is another watershed drained by Bangs Canyon. It exposes the same geology as Unaweep Canyon. It is undisturbed by any roads or dwellings, though trails (mostly from cattle) can be seen from the air. I noticed the canyon on an airline flight from Montrose to Grand Junction. I

was watching the cliffs and talus patterns and then noticed that the distribution of large boulders stretched completely across this valley. This was a counterexample to the "missing talus" phenomena I was searching for. The valley is essentially inaccessible except on horse or on foot.

An opportunity for further study came when the Colorado Civil Air Patrol held an exercise at the Montrose airport. Members were given certain regions to fly over and "search" for a potential downed aircraft. I asked if a pilot could be given the Bangs Canyon region as a target and photograph the rocks there. This could simulate searching for and documenting a crashed plane and any survivors. First Lieutenant Carman W. Dunn of the Montrose Search and Rescue Squadron flew the mission in a Piper Cub using my 35 mm Nikon camera and 50 mm lens on June 14, 1987. He found the canyon and, as instructed, took pictures from various altitudes and orientations. Some show the general canyon. Many show the individual rocks and trees.

Most of the slides were scanned in color into computer files for later image processing. For those slides selected for analysis the computer resolution is 0.5 meters/pixel or better. (A pixel is the smallest dot in a computer image.) For additional referencing I acquired two 1:40,000 scale black and white aerial photographs from the National Aerial Photography Program (NAPP), frames 1096-94 and 1096-95 taken on September 5, 1988. The appropriate parts of the NAPP photographs were enlarged and scanned into computer files at 1.3 m/pixel. The Bangs Canyon part of the Island Mesa Quadrangle topographic map was scanned into a computer file at about 3 m/pixel. The topographic map portion was the basis for subsequent georeferencing, the attachment of geographic coordinates to an image, for all photography.

A view of this canyon as seen from another airline flight, looking upstream towards the Uncompahgre Plateau highlands, is shown in Figure 5.

Analysis Style

Most computer analyses were performed with the Map and Image Processing System (MIPS) software

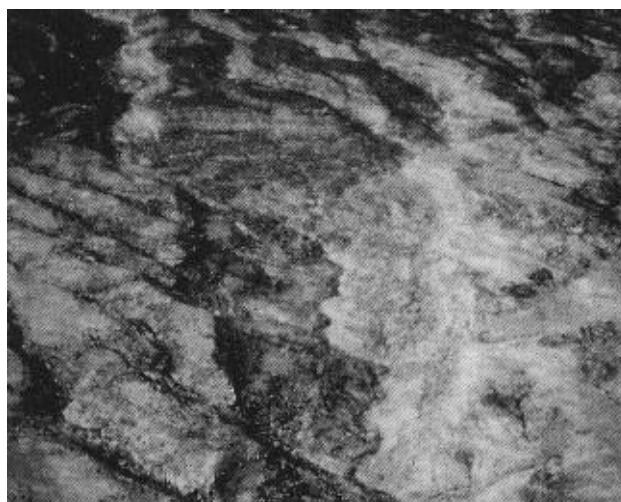


Figure 5. An aerial view of Bangs Canyon, looking upstream (southwest) towards the Uncompahgre Plateau highlands.

from MicroImages, Inc. (1991). The topographic map was georeferenced using latitudes and longitudes interpolated from the map. The NAPP photographs were then georeferenced by pairing numerous landmarks (stream bends and intersections, cliffs, clearings) identifiable in a split-screen view of both the aerial image and the map. Similarly, the 35 mm photographs were georeferenced by pairing the same features (and individual trees and rocks) visible in both the slides and NAPP photographs. Care was taken to minimize problems resulting from the viewing parallax in both types of aerial photographs, especially at cliffs.

All slides are assumed to be taken at non-vertical angles. The projection of individual slides onto a flat map would turn its rectangular area into a polygon and at best a trapezoid. The MIPS software was used to trace the slide outline and landmarks (streams, ridges, clearings) into a vector, or line, format. The resulting skeleton outline of the view was then warped (electronic rubber sheeting) to fit the NAPP view, according to the georeferencing. The interaction between the undulating topography and the viewing angles results in a mismatching between landmarks when the warped outlines from the slide are drawn on top of the NAPP image. By this process two slides were identified that had minimal warping and errors. They were taken nearly perpendicular to the sloping surface.

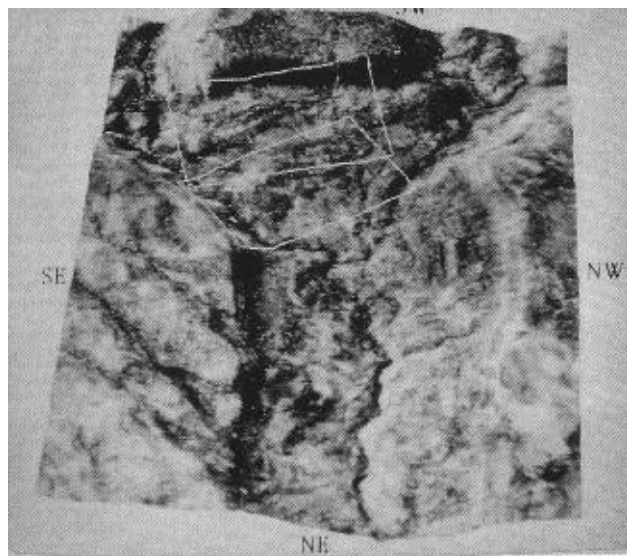


Figure 6. A computer generated 3D perspective view of Bangs Canyon from the northeast similar to Figure 5. The two white boxes outline the views of photographs used in this study.

The coverage of those two photographs is shown by the white surface-hugging boxes in the 3D perspective views of Figures 6, 7, and 8. To make these views the elevation contours of the topographic map were traced using the MIPS automatic line following routines. The software then converted the results to a digital elevation model (DEM), an array of numbers giving the elevation of the land at each pixel, at the 3 m/pixel horizontal resolution of the topographic map. An enlargement of a NAPP aerial photo was degraded to the same resolution. The MIPS software was then used to drape the aerial photo image over the DEM and look at it in 3D

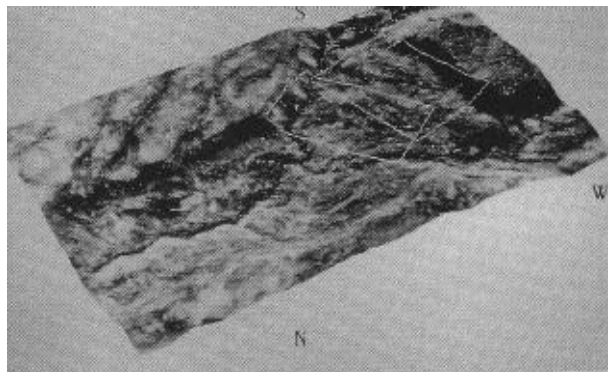


Figure 7. A 3D perspective view of Bangs Canyon from the north.

perspective from any position. Figure 6 is a view from the northeast similar to Figure 5 but from a steeper viewing angle. Figure 7 looks from the north, and Figure 8 is from the west. These computer generated images with natural shading should help one understand the valley structure near the study area.

Figure 6 shows a pair of streams join to the right of the study area and then cut across a corner on the right. Similarly another pair join on the left and cut across the far left edge of the study area. The two resultant streams join just beyond the bottom of the study area and flow to the bottom of Figure 6. Those stream channels provide an effective barrier to keep modern talus from rolling into the study area from the northern and southern rims of the canyon. That leaves only the cliff to the southwest as a present source of talus.

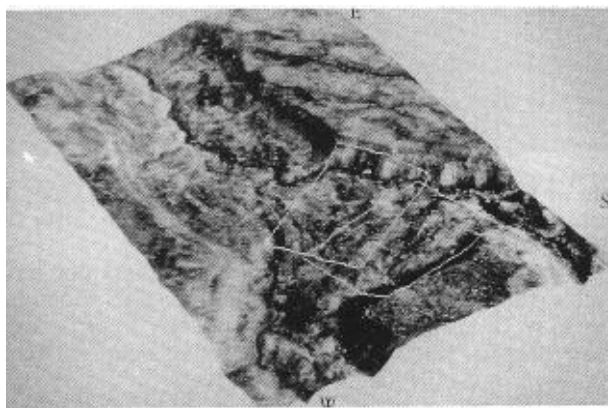


Figure 8. A 3D perspective view of Bangs Canyon from the west.

The computer images of the two slides were traced by moving a cursor around features in the viewing area. The perimeters of all visible boulders were drawn while confirming the identification by viewing the original slide photograph under a 10-40 power microscope. Many tree locations were marked with points (nodes). Streams, trails, ridges, and slide edges were marked with different classes of lines. This process is known as digitization, converting a picture into a series of points and lines. The boulder outlines are drawn in Figure 9 along with contour lines. The edges of each field of view of the individual photographic frames overlap in a trapezoid area near the figure center. In the overlap area the boulder outlines from the upper right picture were removed. Parallax errors of up to 10

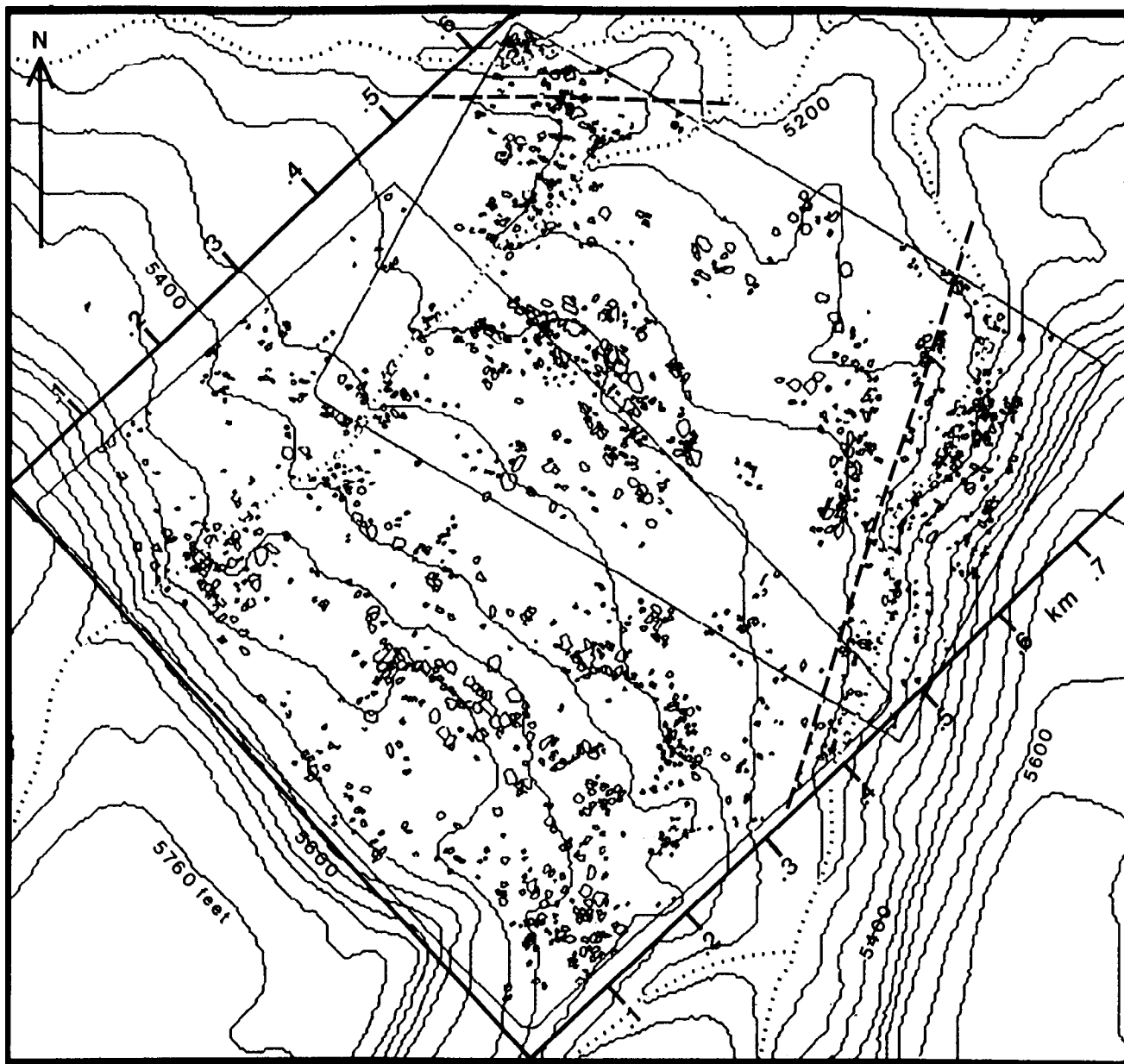


Figure 9. The boulder outlines in the study area and the coordinate system for position measurements. The dashed lines show where boulders were excluded from the study area to minimize possible contamination by talus from the cliffs to the north and east. The dotted lines are streams.

meters in position were found there, giving an indication of the size of errors in absolute accuracy caused by lens distortion, topography, and computer warping algorithms.

The MIPS software was then used to make a list of characteristics of every boulder, including its center geographic position (the Universal Transverse Mercator system was used to give a grid of meters north and east of a standard reference), maximum dimension (length), perimeter, cross sectional area, and roughness. The latter is the name MicroImages, Inc., gave to a parameter used by Holroyd (1987a) for identifying the shapes of snow particles. It is the product of the perimeter and the maximum dimension divided by the cross

sectional area of an object. It starts at a theoretical 4 for a circle and increases as the perimeter or internal detail increases in complexity. Pointed or feathery snow particles can have a value exceeding 50. For rocks the roughness parameter should get smaller as a boulder weathers and becomes more rounded.

A computer program was written to sort the boulders with respect to distance from the southwestern cliff. The rotated coordinate system is shown in Figure 9. It is obvious that the zero distance position is not everywhere exactly at the cliff, but that should only blur the results slightly. A northern and a southeastern corner of the view were excluded to avoid possible talus from the other cliffs rolling up the far sides of the stream banks.

Boulder Distributions

The boulders that were mapped in the aerial photographs are buff colored (matching the Dakota Formation) and were lying on reddish soils (weathered shales of the Morrison Formation). Boulders less than 2 m across were not considered because of the 0.5 m/pixel resolution used in this study. The horizontal distribution of boulders in Figure 9 shows a scattered clustering and vacancy pattern littering the landscape. There is a major cluster on the east (right) that represents talus fallen from the cliff in that vicinity. That cluster was excluded from further analysis by allowing no boulders east of the nearby dashed line. The clusters nearest the southwestern cliff could be weathered outcroppings rather than remnants of the Dakota Formation. There are lenses of buff colored sandstone within the Morrison that resemble some of the Dakota layers above. Dinosaur fossils are sometimes found in such sandstone lenses. An expedition to this study area will be necessary to clarify the origin of the boulders in the clustered regions.

Elsewhere, apart from the clusters, the boulder distribution appears to have no obvious pattern. The rocks are certainly not clustered at the base of the cliff to the southwest, but are well represented nearly everywhere. That is the important point, contrasting with the distributions at other cliffs to be presented in the next article of this series.

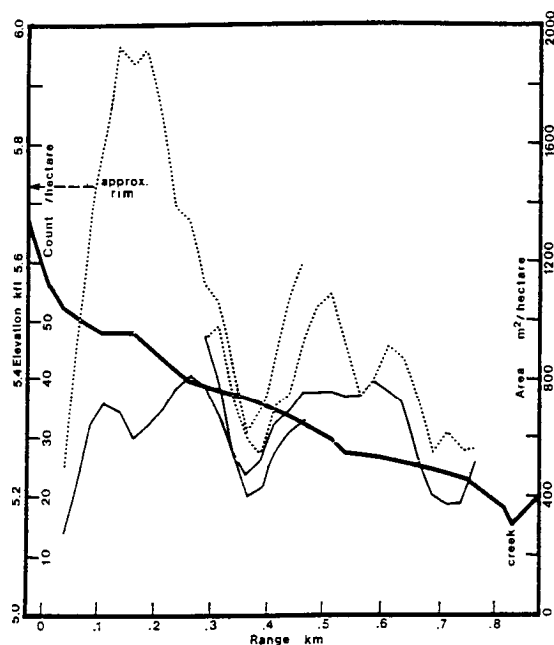


Figure 10. Distributions of Bangs Canyon boulders with respect to distance from the cliff: thick line—elevation, thin line—boulder count, dotted line—boulder area.

Figures 10 and 11 show the variation of several measurements with distance from the cliff. The thick line in Figure 10 gives the elevation of the land along the center of the study area. The rim is at an elevation of about 5725 feet. At the center of the view the rim is recessed from the origin of the coordinate system. The profile becomes level at ranges near 150 m. That is a location of a suspected outcrop of tan sandstone that interferes with this study. There may also be a minor

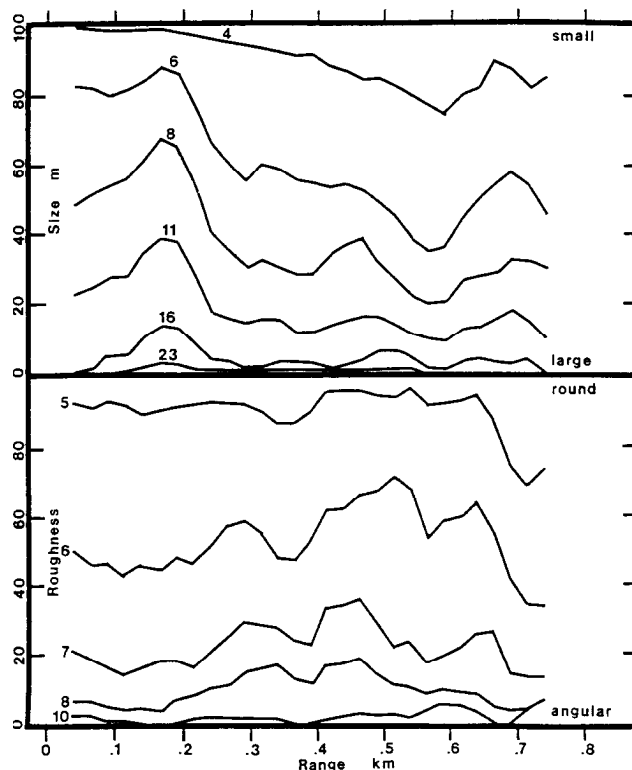


Figure 11. Distributions of Bangs Canyon boulders with respect to distance from the cliff: top—boulder size spectra, bottom—boulder roughness spectra.

outcrop near range 500 m. The stream is intercepted at 825 m. The elevation change from the rim to the stream is about 175 m (570 ft).

The rest of the parameters in Figures 10 and 11 were calculated at a range resolution of 25 meters, smoothed with a running mean of three values, and plotted at the center range. The thin line curves of Figure 10 show the number of boulders per hectare as calculated for each photograph separately. In the overlap area the view closest to the cliff shows fewer boulders. This is because 1) the photographs look at somewhat different areas at the same ranges in the overlap region, 2) there are inaccuracies in the registration process from parallax on undulating terrain and lens distortions, and 3) some rocks may have been missed in each photograph. While there are large variations in this density of boulders, there appears to be no significant downward trend with distance.

The dotted lines of Figure 10 show the total area covered by boulders in square meters per hectare. The two photographs are again described separately. There is a major peak in coverage at the ranges near 150 m. This is the suspected outcrop region. Near 500 m is another possible outcrop region, though minor. There are differences again in the overlap region, but a minimum in boulder area at about 375 m is evident in both lines. There seems to be a weak trend of decreasing area covered by boulders with distance from the cliff. Considering only ranges beyond 250 m to avoid the major peak from the possible outcrop, the trend has a slope of $-0.5 \text{ m}^2/\text{hectare per m}$ of range, with only 15 percent of the variation explained by range.



Figure 12. A large grounded boulder from a recent debris flow in the Grand Canyon at river mile 127.7 left.

In Figure 11 the two photographs are combined in the overlap region because the presentation is a spectral analysis. In both halves the ordinate is the cumulative percent of all boulders. The top half of Figure 11 shows the size spectrum. The thresholds are the maximum dimensions (approximate diameters) of the boulders in meters. These boulders are not small! At least some are larger than 16 meters in every range interval, and the small ones are near 3 meters across. The size series, though rounded to integers, is the set of powers of the square root of 2. (This is the same series known to photographers for the f-stops on a camera lens.) The reason for choosing a logarithmic size scale is because, to a first approximation, size distributions of natural "particles" tend to follow a log-normal distribution. The general trend in the figure is for the threshold lines to fall to lower values with distance from the cliff. This means that the boulders are decreasing in size. The peak at about 175 m is the suspected outcrop. This size trend is in agreement with the decreasing area curve of Figure 10. It is also in agreement with expectations that decaying rocks far from the cliff should be smaller than those more recently shed from the cliff edge. It is not in agreement with the observation that in an instantaneous fall of talus the larger boulders will tend to roll farther away from the cliff.

The cumulative size distribution of all 1545 boulders measured in this study (with a few duplicate entries in the overlap area) was plotted on log-probability graph paper. The data points nearly followed a straight line, confirming the approximate log-normal distribution of the sample. The line was compared to those of a perfect log-normal distribution and to distributions intentionally truncated at their small end. The comparison suggested that perhaps ten percent of the boulder distribution was smaller than the 2 m threshold. The size distribution of the top of Figure 10 is therefore not greatly affected by the truncation at 2 m.

The bottom half of Figure 11 shows the spectrum of roughness values. Only boulders at least 6 m in size are considered in this part because the computer digitization technique introduces artificial angularity to smaller boulders. The round boulders are plotted at the top and the angular at the bottom. There are some fluctuations in the spectrum but no general trend with distance. This result is contrary to what is expected for talus resulting from steady state cliff erosion. One would

expect boulders far from the cliff to be more rounded and thus have lower roughness values.

Discussion

This article on Bangs Canyon boulders has presented an analysis of a valley in which large boulders litter the entire landscape. They are not confined to the bases of the cliffs lining the valley. The cliffs still appear to be shedding talus which accumulates at their bases. In an article to follow there will be several sites described at which the coverage of talus ceases abruptly near the cliff base. Bangs Canyon therefore seems to present an interesting counterexample to the "missing talus" phenomenon. The obvious question, therefore, is "Why is this valley so different?"

A study region was defined in which there was good photographic coverage at high resolution with a minimum of distortion. Study boundaries were set so that talus from other cliffs would be unlikely to have rolled into the study area. The most unusual feature of the boulders in the study area is that they extend to about 800 m from the cliff face. In the "missing talus" study areas the boulders range to only a few hundred meters away.

A major structural difference between Bangs Canyon and the "missing talus" sites is the direction of the slope of the strata with respect to the cliff edge. At Bangs Canyon water from an extensive upslope watershed should flow towards the cliff edge and exit there. The seepage should accelerate the erosion of the soft shales and siltstones, undermining the Dakota sandstones. At the "missing talus" sites at Mesa Verde, illustrated by Holroyd (1987b), and at the Book Cliffs north of Grand Junction, Colorado, the strata slope away from the cliff edge. Ground water there flows away from the cliff edge and does not contribute to cliff recession. At Monument Valley the slope is insignificant and there is minimal watershed at the higher elevations. Ground water seepage there is minor.

The Dakota sandstones of the Uncompahgre Plateau are a major aquifer. They collect an abundance of ground water from the snow pack and rainfall at the crest of the plateau and channel it to lower elevations. This process creates artesian well conditions in the valley east of the plateau. A 200 foot deep well drilled by Ken Stoy on my former property near Montrose found two different levels of pressurized water, including one at the boundary between the Dakota and Morrison Formations. The well had to be capped to prevent water from flowing out naturally. Such pressurized water would exploit rock weaknesses, such as fossil stream channels filled with only siltstone, and accelerate the undermining of cliffs in the region, particularly at such weaknesses. That tends to support the theory that the present valleys of the Uncompahgre Plateau are retracing fossil streams at the top of the Morrison Formation.

The pressurized water in the Dakota Formation also supports Austin's sapping hypothesis. It would cause catastrophic slumping of the landscape, leaving behind sharp cliffs at the site of the structural failures.

The two parts of Figure 11 may both be explained by the sapping hypothesis. In a catastrophic slumping of the land it is possible that the largest boulders would settle out of a moving slurry first while the smaller ones continue farther with the flow. This is the opposite from an instantaneous fall of talus from a cliff, in

which the largest boulders tend to roll farthest while the smallest fragments are stopped more rapidly by frictional sliding. The size spectrum of Figure 11 shows the larger boulders closer to the cliff edge.

The roughness spectrum of Figure 11 is perhaps more revealing. The hypothesis on roughness is that boulders become more rounded with aging and thus tend towards smaller roughness numbers. The spectrum showed no significant trend of roughness with distance from the cliff edge. This speaks against a steady state erosion of the cliff edge. It is, however, in good agreement with a catastrophic formation of the canyon. All of the boulders in the center of the valley would be of similar age in a catastrophic failure and therefore have comparable roughness values.

A catastrophic sapping would create a slurry or debris flow that would prograde across the valley floor, which consists of the top layers of the Morrison Formation. Boulders within the debris flow could be of any orientation. Sandstone lenses in the Morrison would be resistant to erosion by the slurry and would become outcroppings, such as may be found near range 150 m. Subsequent erosion of the exposed Morrison shales would undermine the grounded Dakota sandstone boulders and let them tilt further to a wide variety of orientations, just as is found.

The debris flow mechanism is presently an important means of erosion, transport, and deposition within the Grand Canyon (Webb et al., 1988, 1989). This author was invited by Webb to examine on 14 April 1991 a recent debris flow at a minor side canyon at about mile 127.7 left. It started in the shales above the Redwall cliffs and plunged into the rubble at the cliff base 1.3 km upstream from the Colorado River. An intense rainfall may have wetted and softened the red clay binding that rubble. Presumably a second or continuing intense rainfall shortly thereafter provided the lubrication to flush the mass of rock and clay downstream in a catastrophic debris flow. The flow scoured many parts of this side canyon. Most of the material was ejected from the hanging valley into the Colorado River channel, where it created a new rapid and beach. Some of the debris grounded itself before falling over the lower cliff to the river. Figure 12 illustrates one of the giant boulders moved in the debris flow. The people standing on it provide a scale. The lighter colored rocks are unweathered debris from this recent debris flow. The canyon walls are of brown Tapeats sandstone and the canyon floor is of black Vishnu amphibolite. The size of the giant boulders here and elsewhere in the debris flow are comparable to those in Bangs Canyon.

One reviewer rightly observed that the bulk of this analysis assumes that the large boulders are near the locations of their original deposition after being removed from the cliff face. The subsequent sliding and tilting from further erosion of the Morrison was presumed to be minor. No consideration was given to the possibility that the boulders might have been redistributed by later floods. Floods can indeed move giant boulders of the size (6 m median) measured in this study. However, such floods must be catastrophic in magnitude. Such a possibility has no major effect on the conclusion that the boulder distribution results from catastrophic processes. Debris flows in this part of Bangs Canyon would follow near the main channels,

found to the north and east of the study area shown in Figure 9. Debris flows could leave trails of boulders paralleling the channel, like a glacial lateral moraine. The banding in boulder locations in most of Figure 9 instead parallels the cliff face to the southwest. There is one band just west of the dashed line defining the eastern boundary of the study area. That band could indeed be a debris flow remnant along the east channel. Therefore there appears to be merit in a further study of Bangs, Unaweep, and other canyons of the Uncompahgre Plateau. The full extent of boulder distributions over the entire canyon systems could be mapped to try to distinguish between primary boulder positions and subsequent redistributions from debris flows, either of which would be evidences for catastrophic processes.

The evidence of Bangs Canyon seems to present an example of catastrophic canyon formation by sapping. Pressurized groundwater, possibly aided by an abundance of surface melt water and/or precipitation, undermined the resistant sandstones at weaknesses in or just above the Morrison Formation. The debris left the canyon as a slurry or debris flow. A trail of boulders grounded out of the slurry and still litter the landscape today.

Boulders then began to fall from the remaining cliff edges. The exposed shales in the valley center eroded more rapidly thereafter, deepening the valley and rearranging the large boulders. The author believes that the canyon formation is geologically recent because the remnant boulders in the valley center have not eroded away by normal weathering processes.

Looking ahead to a future article, the "missing talus" sites are consistent with a large lakeshore at an elevation somewhere between 5000 and 6000 feet. Bangs Canyon is in that range. Elsewhere it is thought that wave action along the shoreline may have pulverized previous talus material. If the shoreline extended into Bangs Canyon, the water may have helped erode exposed shales and boulders. The narrowness of Bangs Canyon and its orientation to the northeast may have limited the power of storm-driven waves within it. On the other hand, a lake in the region may have left water-saturated terrain that would be more prone to have a catastrophic failure after a sudden demise of the lake. The timing of the formation of Bangs Canyon with respect to the lake system is left unresolved in this article. A proper study for that purpose will require a more extensive aerial mapping of the boulders in Bangs and adjacent canyons, showing the highest and lowest elevations at which these giant boulders are found.

At the start of this study of Bangs Canyon it was thought that the boulders littering the landscape were the result of talus formation. The unusually large range of boulders from the cliff edge seemed to be an interesting counterexample to the "missing talus" phenomenon. Now, however, the sapping hypothesis of Austin and debris flow mechanism of Webb et al. seem to be a more reasonable explanation for the boulders across the valley floor. Talus resulting from slow cliff recession is probably located at the valley edges only, beneath the cliffs. That talus material is not abundant enough to have affected the distributions presented in this article. Such minimal talus deposits is another indicator of the geologic youth of Bangs Canyon. Bangs Canyon therefore seems to be worthy of further study,

both from aerial photography and on the ground. Perhaps some way can be found to distinguish between boulders that are sapping or debris flow remnants and those that are from more recent falls of talus.

Acknowledgments

This is a remote sensing study of a nearly inaccessible canyon that the author has seen only from the air. The study could not have been done without the photographs taken by Carman W. Dunn on a Civil Air Patrol practice mission. Scanning of the slides was provided by MicroImages, Inc., Lincoln, Nebraska. Several of the features in the MIPS software were written by MicroImages in response to the needs of this study. The MIPS software used in this study was provided jointly by MicroImages and a grant from the interest on the Creation Research Society Laboratory Fund. The author greatly appreciates the contributions of the donors to this fund and the donations of expertise from MicroImages, Inc. The debris flow expedition in the Grand Canyon was provided by Department of the Interior agencies through the invitation of Bob Webb.

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THE 1993 MIDWEST FLOODS AND RAPID CANYON FORMATION

GLEN W. WOLFROM*

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Abstract

The processes which creationists postulate may be responsible for rapid canyon formation were vividly demonstrated during the floods which occurred in the Midwest during the summer of 1993. Erosion damage to spillways at three sites is described: Tuttle Creek Lake on the Big Blue River at Manhattan, Kansas; Coralville Lake on the Iowa River at Coralville/Iowa City, Iowa; and Milford Lake on the Republican River near Junction City, Kansas. Each location involved not only the removal of overburden, but also rapid erosion of the underlying strata. Details of duration, water volume, and water flow rates are presented and, where possible, these data are compared to those of prehistoric flood catastrophes. It is shown that extensive erosion in a short period of time is possible even in relatively well-consolidated and lithified strata, and that the pattern of erosion sometimes is remarkably similar to certain features found in the Grand Canyon. Additionally, brief descriptions of strata and fossils are provided.

Introduction

The Creation Research Society has an ongoing project to investigate instances of rapid erosion and to further develop a creationist model for canyon formation. Creationist thinking on the potential for rapid canyon formation has been recently chronicled in this journal (Williams, 1991; Williams, Meyer, and Wolfrom, 1991, pp. 93-97; Williams, 1993). A decade ago Austin (1984) chronicled rapid erosion and canyon formation on Mount St. Helens following the 1980 volcanic eruption. In this paper three examples will be presented showing the erosive power of vast quantities of turbulent water, moving swiftly under pressure, and laden with sediment: Tuttle Creek Lake on the Big Blue River at Manhattan, Kansas; Coralville Lake on the

Iowa River at Coralville/Iowa City, Iowa; and Milford Lake on the Republican River near Junction City, Kansas. The Tuttle Creek area will be discussed in some detail later in the paper, but first the two other locations will be briefly surveyed. All three cases provide exceptional opportunities to observe firsthand the conditions which creationists postulate are capable of rapid canyon formation, even in limestone bedrock.

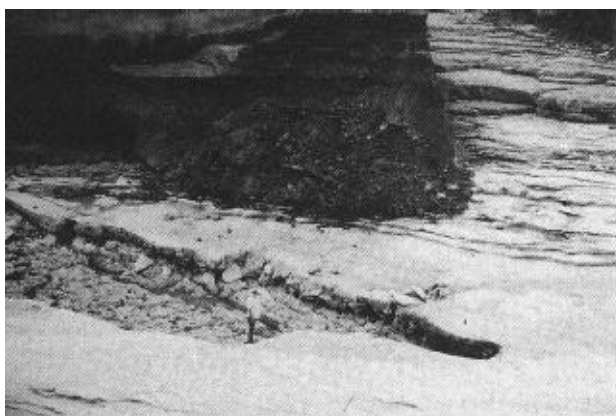
Milford Lake

On 20 July 1993, water began flowing through the emergency spillway of Milford Lake. Three days later the earthen spillway dam and the road atop it (Kansas State Highway 244 Spur) were breached, producing extensive erosional damage as a result of the rushing flood waters (Figure 1). Water flowed through the

*Glen W. Wolfrom, Ph.D., is Membership Secretary of the Society.



1a.



1b.



1c.

Figure 1. Flood damage at emergency spillway of Milford Lake. Photographs by U.S. Army Corps of Engineers. a. Photograph taken on 23 July 1993 a few hours before the breach occurred. b. Breach in dam (10 August 1993). Note person standing in channel of eroded bedrock near center of photo. c. Eroded bedrock above the spillway dam (10 August 1993).

spillway channel for two weeks (through August 3), reaching a peak flow estimated at 19,000 cfs (cubic feet per second) on July 27 (Bierks, 1994).

It is noteworthy that erosion occurred in the spillway both above and below the dam (Figure 2). In the approach channel above the spillway dam, both valley



2a.



2b.

Figure 2. Aerial views of flood damage at emergency spillway of Milford Lake. Photographs by U.S. Army Corps of Engineers. a. View downstream during the flooding (25 July 1993). The road indicates the location of the spillway dam. b. View upstream after the flood waters had receded (6 August 1993). Again, the road marks the location of the spillway dam.

sediment fill and the top layer of shale (Holmesville Shale) were removed exposing and eroding the underlying Fort Riley Limestone. Of special interest is the pattern of erosion which occurred above the dam. In Figure 2b one can readily see structures which are remarkably similar to side canyons and temples (or buttes) found at the Grand Canyon. Erosion of the limestone continued in the channel below the spillway.

Coralville Lake

Coralville Lake, named for the nearby town which was in turn titled for the area's fossil coral formations (Figure 3), was subjected to the historic floods of 1993 which devastated Iowa and the adjacent midwestern states. Water began to overflow the concrete emergency spillway on 5 July 1993 and continued for a period of 28 days. A maximum estimated flow rate of 17,000 cfs was reached on 24 July following closure of the normal outlet gates for seven hours due to downstream flooding of the Iowa River (Rogers, 1993). The water level in the lake at this time was nearly 4.5 ft higher than the top of the spillway.

Figure 4 provides a view of the resultant erosional damage below the spillway, with the concrete spillway

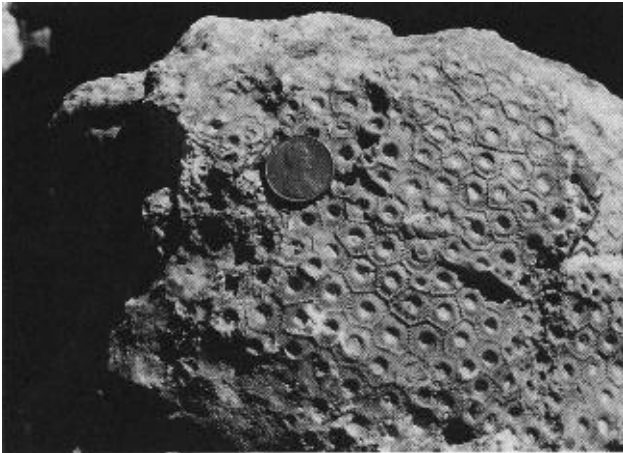


Figure 3. Fossil coral (*Hexagonaria*; Anon., 1993) at Coralville Lake spillway.



Figure 4. Erosion damage in spillway channel at Coralville Lake. The concrete spillway is visible in the background.

itself visible in the background. A 15-foot channel was eroded into the underlying bedrock (Anon., 1993), exposing limestone which by uniformitarian standards is said to be of Devonian age (viz., some 375 million years old). As is evident in the photograph, a steady stream of visitors (park rangers stopped counting at 150,000) has taken advantage of this rare opportunity to view these rock formations both horizontally and vertically. In addition to the corals mentioned earlier, a number of other fossils could be observed in plenitude, especially brachiopods and crinoid stems (Figure 5). Also observable were fossilized ripple marks and worm burrowings. The public was not allowed to remove materials from the site, but some specimens were excavated for further study by the Iowa University Geology Department.

Particularly impressive was the bony plate from an armored fish (Figure 6) reportedly discovered by a four-year-old boy. Local geologists have identified the creature as the placoderm *Dunkleosteus* (Rogers, 1993), the largest of all Paleozoic animals, having enormous jaws and growing to lengths of 30 ft (Thompson, 1982, p. 759). The armored head shield, hinged at the neck, occupied one-third of the total body length (Anon., 1975). Sometimes called *Dinichthys*, they are reported

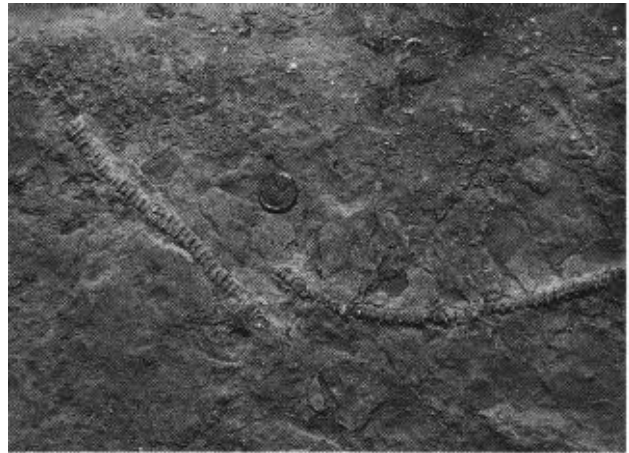


Figure 5. Fossil crinoid stems at Coralville Lake spillway. Crinoids (sea "lilies") are marine invertebrates of the class Crinoidea, phylum Echinodermata.

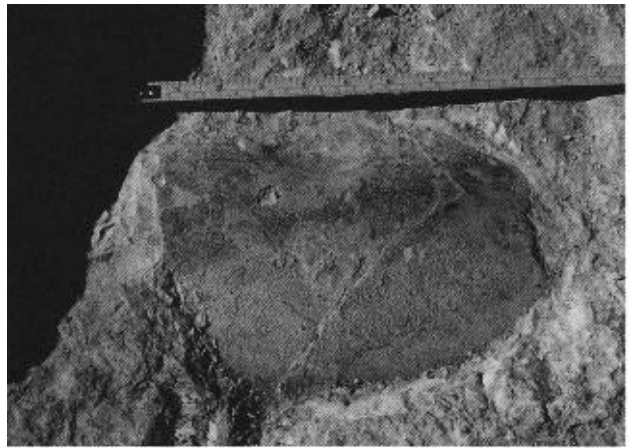


Figure 6. Fossil bony plate from the placoderm *Dunkleosteus* (Rogers, 1993) at Coralville Lake.

to have been common in the Devonian but became extinct at the end of that period.

Tuttle Creek Lake

On a grander scale is the erosion that occurred below the spillway at Tuttle Creek Reservoir when all 18 floodgates were opened (Figure 7). In fact, the area is now referred to as the "Grand Canyon of Manhattan," the "Little Grand Canyon," or simply the "Manhattan Canyon." Kansas State University geologists have stated that the Grand Canyon of the Colorado and the Manhattan Canyon were formed by similar forces (Archer et al., 1993; Blakeman, 1993), but that the recent flood waters "carved out this small canyon much faster than water and wind sculpted the Grand Canyon" (Blakeman, 1993).

Prior to July, 1993, the area below the flood spillway was a gently sloping, grassy recreational area used for dirt bikes. Erosion was initiated in early July when some water was released (10,000 to 25,000 cfs) through the gates just to keep the rising flood waters from running uncontrolled over the top of the spillway (Archer et al., 1993). However, the water level in the reservoir continued to rise, and on 23 July all 18 flood-

gates were opened, greatly accelerating the erosional processes. In fact, this was the first time since the project was completed in 1962 that any of the gates had been opened. When the gates were closed 17 days later, it was discovered that the landscape of the spillway channel had been transformed into a craggy, variegated, and multilayered canyon. As at Coralville, geologists and laymen have been presented with a unique opportunity to have a horizontal view of thousands of square meters of strata that usually are observable primarily in vertical sections (e.g., roadcuts, hillsides, etc.).

Table I. Daily (0800 hr) Rates of Flow from Tuttle Creek Reservoir*

Day	Outflow (1,000 cfs)	Source
July 17	0.10	Outlet gates
July 18	1.58	↓
July 19	0.10	↓
July 20	16.25	↓
July 21	22.50	Spillway + outlet gates (ca. 5,000 cps)
July 22	26.50	↓
July 23	44.50	↓
July 24	55.80	↓
July 25	60.00	Spillway gates
July 26	60.00	↓
July 27	59.00	↓
July 28	58.00	↓
July 29	57.00	↓
July 30	56.00	↓
July 31	54.00	↓
August 1	53.00	↓
August 2	48.00	↓
August 3	46.00	↓
August 4	43.00	↓
August 5	38.00	↓
August 6	34.00	↓
August 7	30.00	↓
August 8	25.00	↓
August 9	20.00	↓
August 10	15.00	Outlet gates
August 11	15.00	↓
August 12	15.00	↓

*U.S. Army Corps of Engineers (1993)

Table I shows data, provided by the U.S. Army Corps of Engineers (1993), giving the flow rate from the reservoir during the period of 17 July through 12 August. The maximal flow rate of 60,000 cfs was reached in the first few days after opening all the gates, and flows greater than 50,000 cfs persisted for more than one week. The maximum flood level above the top of the concrete spillway was higher than a three-story building (31.77 t), forcing 27 million gallons (234 million pounds) per minute, seven million tons of water each hour, moving at about 30 miles per hour (mph) through the gates (Archer et al., 1993). The water from the spillway was not flowing in a smooth or laminar fashion, but rather

... it was turbulent, rolling, rocking, and cutting as it moved, carrying tons of sediment that acted like a chisel, a drill, a grinder, and a thousand bulldozers, all in one. The resulting mass of water hit the loose and poorly consolidated sediment and rocks below the spillway lip like a massive explosion lifting, cutting, and churning its way. ... carrying along hundreds of tons of boulders, gravel, sands, shale, and limestone which it had just torn loose as it roared over the rock surface (Archer et al., 1993).

Table II. Stratigraphic Sequence at Tuttle Creek Spillway *

	Member†	Thickness (ft)	Formation	Group	
↑ Above spillway			Beattie Limestone	C o u n c i l	
	Morrill Limestone	3.5			
	Florena Shale	7.6			
	Cottonwood Limestone	6.9			
		25.4	Eskridge Shale		
← Spillway gates →	Neva Limestone	17.8	Grenola Limestone		
↓ Below spillway	Salem Point Shale	8.4			
	‡Burr Limestone	4.1			
	‡Legion Shale	1.5			
	‡Sallyards Limestone	2.6			
	‡	23.3		Roca Shale	
	‡Howe Limestone	4.9	Red Eagle Limestone	G	
	‡Bennett Shale	4.0			
	‡Glenrock Limestone	1.9			
	‡	23.0	Johnson Shale	v	
	‡Long Creek Limestone	7.3	Foraker Limestone	e	
	‡Hughes Creek Shale	36.9			
	Americus Limestone	4.2			

* Archer et al., 1993.

† Members are often further divided into zones (U.S. Army Corps of Engineers, 1993).

‡ Rock layers exposed by the flood waters.



Figure 7. Aerial view of Tuttle Creek Lake spillway area. Photograph by U.S. Army Corps of Engineers.

Figure 7 shows an aerial view of the entire area. The spillway apron itself is approximately 840 ft wide by 580 ft long, and the length of the outlet channel from the top of the concrete apron to the bottom of the photo is about 2900 ft. Figure 8 provides a panoramic view of one of the most severely damaged areas several hundred yards below the spillway (approximately the area in the center of Figure 7). The spillway is to the northwest (left), and additional erosion occurred downstream of the area shown in this photograph. For scale, people walking just below the tree line on the far side of the canyon are barely visible. Structures can be seen which are again remarkably similar to those observed in the Grand Canyon, such as side canyons (alcoves or amphitheaters), caves or undercut ledges, and even temples or buttes within the canyon itself. Figures 9a through 9c, taken at progressively greater distances downstream from the spillway, demonstrate the process and the effects of headward erosion as evidenced by undercutting of the strata.

A portion of the eroded region in the center of Figure 8 is viewed from south to north in Figure 9b. If

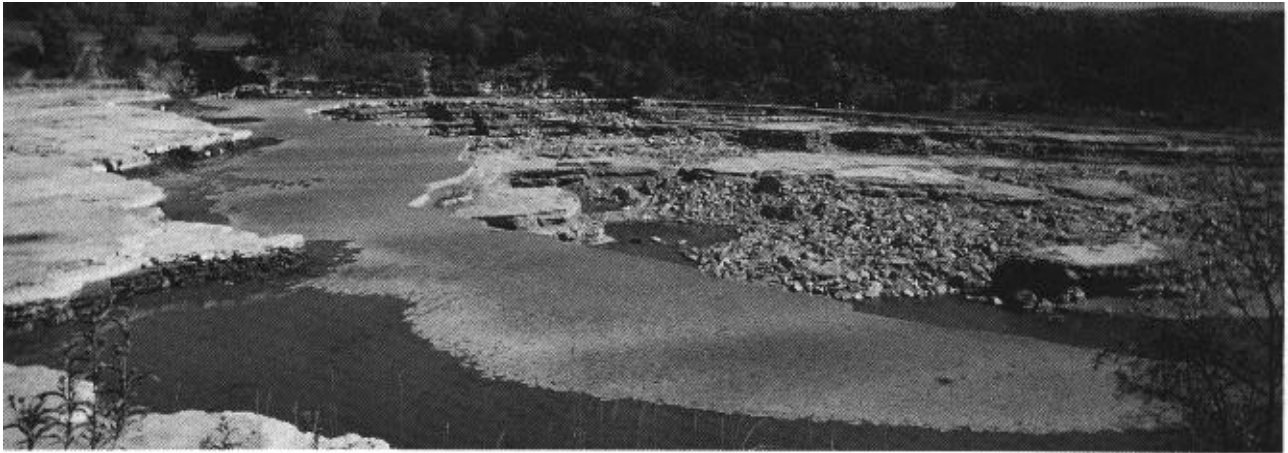
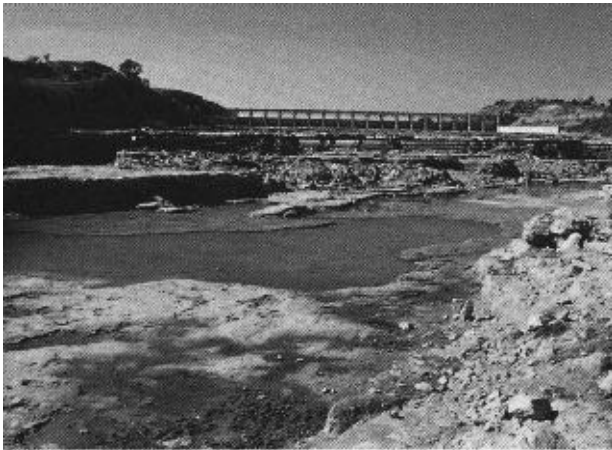


Figure 8. Panoramic view of erosion about 440 yards below apron of Tuttle Creek Lake spillway. People are barely visible walking just below the tree line on the far side of the canyon. Width of the canyon channel at this point is approximately 580 ft.



9a.



9b.

Figure 9. Photographs taken at progressively greater distances downstream from spillway apron: a. ca. 500 ft; b. ca. 1300 ft; c. 2800 ft.

the person at the top of the ledge is assumed to be six ft tall, then one can calculate that more than 30 ft of lithified materials were eroded away by flood waters at this location alone. In total, from the spillway apron to the base of the hill downstream, nearly 100 vertical

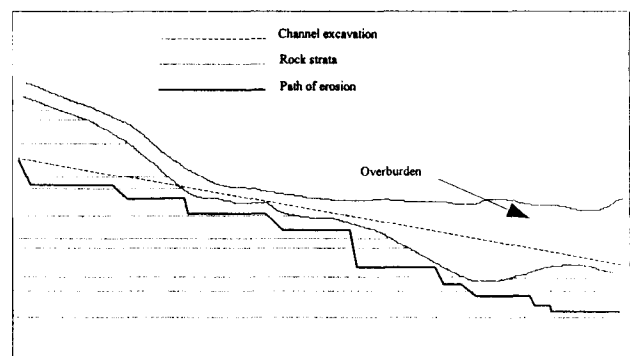
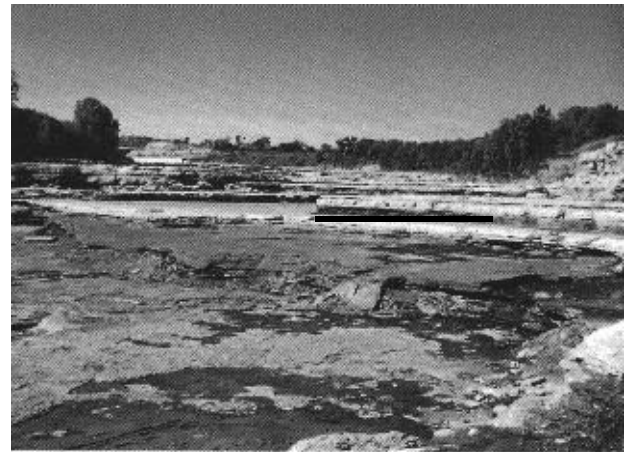


Figure 10. Hypothetical representation of erosion which may occur in a spillway outlet channel.

ft of rock have been excavated (Archer et al., 1993). However, one will not find 100 vertical ft removed in any one location. The area was already gently sloped and, at the time of construction, overburden and some strata were removed as the spillway channel was excavated. Erosion, following the grade of the excavated channel, was accelerated at various sites due to condition of the strata and the physical processes involved (see below). Based on the findings at the Manhattan



Figure 11. Fossil animal burrows (*Planolites?*; Thompson, 1992, p. 735) at Tuttle Creek Lake spillway.

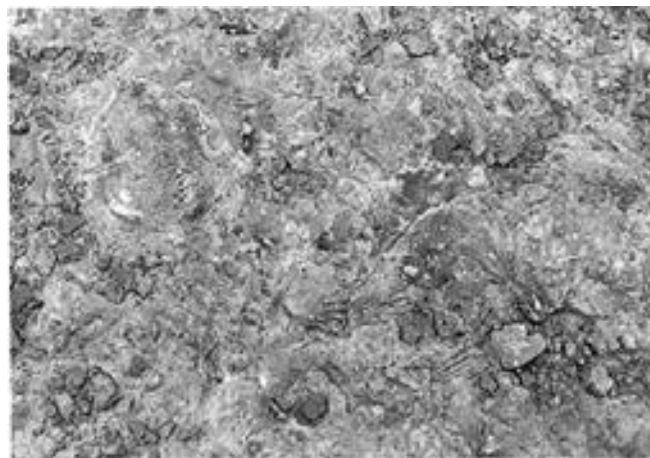


Figure 12. Poorly preserved fossil brachiopods at Tuttle Creek Lake spillway.

site, Figure 10 illustrates a hypothetical representation of erosion in spillway outlet channels.

Geology of the Manhattan Canyon

The strata exposed below the spillway have been identified as Paleozoic, representing late Pennsylvanian through early Permian systems which, in evolutionary time, are represented to be about 290 million years old (Archer et al., 1993). Shown in Table II is the relevant stratigraphic sequence of the area. The concrete spillway itself rests upon the Neva Limestone and the underlying Salem Point Shale. A variety of both invertebrate body and trace fossils may be found in the newly exposed strata (Archer et al., 1993). For example, worm(?) burrows (Figure 11) and poorly preserved “beds” of brachiopods containing thousands of individual organisms may be observed (Figure 12). Also preserved in the strata are what appear to be “mud cracks” (Figure 13). Austin (1991a, pp. 32-33) noted that such structures are more properly known as shrinkage cracks, and cannot be interpreted to be actual mud



Figure 13. Fossil shrinkage cracks with camera gadget bag for scale. Tuttle Creek Lake spillway.



Figure 14. Cross joining of the limestone at Tuttle Creek Lake Spillway. Photographed area is that atop the ledge and to the right in Figure 9b.

cracks without further investigation. Shrinkage cracks can result either from extended periods of desiccation prior to burial, or by syneresis of wet sediments after burial.*

One notices the repeating pattern of limestones and shales. Detailed examination of the fossil assemblages associated with these strata suggests that the area was alternately exposed to marine and marginal or non-marine environments (Archer et al., 1993). Williams and Howe (1993, pp. 51-52) discussed the interfingering of marine and continental sediments in the Big Bend area which may have resulted from tectonic activity during the Flood. For example, the continental area near a shore could sink, allowing marine water and sediments to transgress the region, which in turn could be followed by regression of the marine water allowing additional deposition of continental material. Such patterns of regression/transgression could then have been repeated time and again during the Flood.

*For a detailed discussion of shrinkage cracks, see: Oard, M. J. 1994. Underwater “mudcracks.” CRSQ 30:213-214.

The Means of Erosion

The rock strata below the spillways at both Coralville and Tuttle Creek are marked by joints (fractures) which represent structural weaknesses (Archer et al., 1993; Anon., 1993). Such joints, which are roughly parallel and may extend through strata for long distances horizontally and vertically, likely contributed to the rocks being ripped away by the fast moving water. Cross jointing of the limestone at Tuttle Creek is illustrated in Figure 14. As alluded to earlier, the erosive action was doubtlessly aided by the velocity of the water and its sediment load which consisted of abrasive matter such as sand, gravel, boulders, etc. Physical processes associated with macroturbulent flow, which contribute to erosion of bedrock during catastrophic flooding, have been elucidated by Austin (1991b, p. 88). These include:

1. Cavitation—a rock pulverizing process resulting from the implosion or collapse of vacuum bubbles (see also Holroyd, 1990a and 1990b)
2. Plucking, or the hydraulic lifting of large blocks of bedrock—a suction process which results from the vortex action of a “kol”

Could such processes have been active in these cases of rapid canyon formation? Hydraulic plucking obviously occurred, since large blocks of limestone bedrock were scattered haphazardly downstream at both Coralville and Manhattan.

That cavitation may have taken place is not as evident. Holroyd (1990a, p. 24) instanced data from the Bureau of Reclamation indicating that cavitation may occur at fluid flow speeds greater than 30 meters per second (67 mph). Austin (1991b, p. 88) cited NASA data which suggest that cavitation may be associated with fluid flows as slow as 30 ft per second (20 mph). It was in fact earlier noted that water moved down the Manhattan spillway at about 30 mph, suggesting that conditions conducive to cavitation could have existed during the canyon’s formation. Figure 15 shows the pitted limestone surface at one particular location in the Manhattan Canyon, which may indicate the effects of cavitation. It is also possible that continued pulverizing and weakening of the rock and subsequent erosive action could obliterate any direct physical evidence of cavitation.



Figure 15. Pitted surface of limestone at Tuttle Creek Lake Spillway.

Table III Comparison of Recent and Prehistoric Catastrophic Floods

Location	Maximum Discharge Rate (cfs)	Maximum Current Velocity (mph)	Volume of Water Released (cubic miles)
1993 Floods			
Coralville	17,000	--	--
Milford	19,000	--	--
Tuttle Creek	60,000	30	0.00044 ⁵
Prehistoric catastrophes			
Bonneville Flood ^{1,2,3}	15,000,000	16	380
Missoula Flood ^{1,2}	386,000,000	45	500
Altay Mountains, Siberia ⁴	>635,000,000	101	240

¹ Conley, 1982.

² Maley, 1987.

³ Malde, 1968.

⁴ Baker, Benito and Rudoy, 1993.

⁵ Calculated from Table I for July 25 through August 9.

Comparison to Prehistoric Floods

It is interesting to compare these modern flood catastrophes with some prehistoric floods inferred from geologic evidence (Table III). The Bonneville Flood (Maulde, 1968; Conley, 1982; Maley, 1987) occurred when waters of prehistoric Lake Bonneville were catastrophically released into the Snake River Plain, through Red Rock Pass in southwestern Idaho, creating erosional features known as scablands. Carved into the basalt were coulees (or “new” channels, some several miles long and 150 ft deep), alcoves (or dry falls), and rock basins (or potholes) up to 120 ft in depth. Cavitation is thought to have contributed to formation of the alcoves. Large basaltic boulders (10-30 ft in diameter) were transported several hundred miles downstream, and in some areas were deposited in beds up to 300 ft thick.

An ice dam holding back the waters of glacial Lake Missoula during a pre-late Wisconsin glaciation (Flint, 1971, p. 232) was breached, creating a deluge, known as the Missoula Flood (sometimes referred to as the “Spokane flood”), over a 550-mile course across three states (Conley, 1982; Maley, 1987). Carving its way through the basaltic bedrock, the water produced giant ripple marks (detected only from the air some are 20-30 ft in relief, two miles long, and 200-300 ft apart), canyons (miles long and over 200 ft deep), and dry falls. In eastern Washington state the affected 15,000 square mile area is called the “Channeled Scabland.” The Grand Coulee, a chasm 50 miles long and 906 ft deep, is thought to have been eroded during this time by cataract retreat, a process similar to headward erosion. Some geologists have recently proposed that during the late Pleistocene epoch Lake Missoula filled every 30-70 years, and a series of 40 or more floods may have taken place in this area.

A cataclysmic flood in the Altay Mountains of Siberia has recently been described (Baker, Benito, and Rudoy, 1993). It too resulted from the rupture of an ice dam on a large glacial lake during the late Pleistocene, and it produced land forms which are said to rival those in the Channeled Scablands of the Northwest. According to Baker et al. (1993), giant gravel waves were developed, requiring water levels greater than 1900 m (6200 ft) for their formation. A huge gorge, measuring 1.2 miles wide by 1,960 ft deep, is thought to have been “cut rapidly by headward erosion . . . in a manner

similar to that seen in scabland channel erosion by the Missoula outburst floods."

The geologic effects of these prehistoric floods, manifested in a matter of days, were undoubtedly caused by the same physical processes which created the damage in the 1993 Midwest floods. Readily apparent, however, is the fact that, in both cause and effect, these prehistoric phenomena were many orders of magnitude larger than the modern events described in this article. These prehistoric floods, in turn, would surely pale in comparison to a water catastrophe, or a series of catastrophes, capable of forming the Grand Canyon of the Colorado.

Conclusions

Such examples of rapid canyon formation relate directly to ideas about how the Grand Canyon may have been formed. Creationist and uniformitarian treatment of this topic was the subject of a series of CRSQ articles (Williams, Meyer, and Wolfrom, 1991, 1992a, 1992b). Though many creationists acknowledge that enormous quantities of fast flowing, sediment laden water were likely responsible for the Grand Canyon's formation, the immediate source of such water is a matter of much discussion. Some have agreed that gigantic lakes on the Colorado Plateau, formed perhaps by remnant Flood waters during late-Flood and post-Flood continental uplifting, may have provided the needed quantities of water (Holroyd, 1987, p. 16; Austin, 1988, pp. 50-54; Brown, 1989, p. 83; Austin, 1991b, pp. 86-87; Williams et al., 1992b). Oard (1993), on the other hand, recently presented various geological problems which provide difficulties for this theory.

Austin (1991b), in discussing the breached dam hypothesis, asked, "Could Grand Canyon represent the eroded spillway from gigantic lakes whose dams have failed?" The erosion damage below spillways, as a result of the 1993 midwestern floods, provides further indirect evidence suggesting that the concept, at least, is possible even in relatively well-consolidated and lithified strata. One must also be aware of the potential for canyon formation upstream from a breached dam, as demonstrated at Milford, as well as downstream. In addition to the extent of the erosion observed in relatively short periods of time, the pattern of erosion produced structures which are remarkably analogous to the side canyons and temples found in the Grand Canyon. Is it possible that such features would not result from uniformitarian processes, but can only be produced by catastrophic events? Undoubtedly, creationists will continue to address these and other proposed mechanisms which allow for the rapid, catastrophic formation of canyons.

These sites may afford other opportunities for creationist research into the subject of rapid canyon formation. The further study of exposed fossils, however, will be severely limited by the rapid weathering which began taking place soon after exposure. If possible, additional detailed field work will be conducted in specific areas.

Acknowledgments

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THE USE OF TRACE FOSSILS IN REFINING DEPOSITIONAL ENVIRONMENTS AND THEIR APPLICATION TO THE CREATIONIST MODEL

JACK H. COWART AND CARL R. FROEDE, JR.*

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Abstract

Trace fossils are evidence left by animals in the rock record (such as tracks, trails, burrows and borings) that can be used by the creationist modeler to: (1) more accurately interpret depositional environments and (2) more confidently defend the creationist model. Trace fossils are useful in these regards, because they reflect animal responses to a wide variety of environmental conditions, such as abundance of nutrients, photic levels, salinity, temperature, pressure, oxygen levels, and predators, to which lithologic materials cannot easily respond. Trace fossils are important because: (1) they are found in numerous rocks devoid of body fossils, (2) they have a narrow facies range, (3) they are almost never transported, and (4) they span most, if not all, of the sedimentary record. By being able to interpret these "contemporaneous witnesses," the creationist modeler has another "arrow in the quiver" in the argument against the concepts of uniformitarianism and geological evolution.

Key Words: trace fossils, ichnology, depositional environments, ichnogenera, ichnospecies, ichnofacies.

Introduction

Accurate interpretation of aqueous depositional environments represented by the stratigraphic record requires the use of multiple geologic disciplines. Traditionally, these disciplines have been stratigraphy, sedimentology, paleontology and paleoecology. A recently employed discipline that has proven to be powerful in the interpretation of marine and non-marine depositional environments is Ichnology, or the study of trace fossils. (Ichnos is the Greek word for "trace.")

Specifically, Ichnology is the study of animal substrate relationships and how animals reacted to environmental conditions, such as erosion, deposition, changes in energy regimes, abundance of nutrients, photic levels, salinity, temperature, pressure, oxygen levels, amounts of interstitial water, substrate cohesion and predators. How animals related to the substrate and environmental stimuli are expressed in the rock record in the form of their tracks, trails, burrows, borings and other traces. Unlike body fossils (which are the remains of actual animals, such as trilobites and dinosaurs), trace fossils are evidence of the organisms' behavior as they responded to environmental conditions that are (and sometimes are not) recorded in the rock record. Because organisms respond to more environmental conditions than do geologic materials, the record left by these "contemporaneous witnesses" can provide the creationist modeler with a new tool in understanding sedimentological paleoenvironments.

The purpose of this paper is to provide creationist modelers with a basic understanding of ichnology for use in reconstructing past geologic events in application of creationists' models. Additional information on the specifics of Ichnology and its use as an environmental indicator is found in the *References* and *Additional Resources* sections at the end of this work.

Basic Concepts of Ichnology

Trace fossils have four important characteristics: (1) they are found in numerous rocks devoid of body fossils, (2) they have a narrow facies range, (3) they are almost never transported, and (4) they span most, if

not all, of the sedimentary record. According to Crimes (1975, pp. 121-122), many trace fossils serve as geopetal structures in that they are useful in determining the vertical orientation during time of deposition. Additionally, trace fossils can indicate relative amounts of compaction and deformation.

Behavioral Trace Indicators

Three fundamental concepts of ichnology are: (1) behavioral implications, (2) the type of trace fossil preservation, and (3) the environment in which traces were made.

Behavior is the single most important aspect of ichnology. Animal behavior, as expressed in the traces left by organisms in sedimentary rock (Figure 1), is classified as follows (Seilacher, 1964a, pp. 298-299; 1964b, pp. 253-256, unless otherwise cited):

A. Cubichnia (resting trace). Shallow traces formed where vagile animals settled temporarily in the sediment. The behavior represented by the trace may include hiding as well as resting (Figure 1, number 2).

B. Domichnia (dwelling burrow). Three-dimensional, permanent or semi-permanent domiciles constructed by vagile or hemisessile animals. Such burrows may represent multiple discrete behaviors, e.g., protection, breeding, brooding and feeding (Figure 1, number 5).

C. Fodinichnia (feeding burrows). Vertical and horizontal shafts and tunnels made by vagile or hemisessile deposit feeders within the substrate. These traces generally reflect the search for food; some also fit the requirements for shelter (Figure 1, number 4).

D. Pascichnia (feeding trails). Trails or burrows of vagile deposit feeders made upon the substrate. Such structures are often systematically constructed and tightly wind or meander, reflecting a "grazing" search for food. An important characteristic of these traces is that they usually do not rework previously "mined" sediment (Figure 1, number 3).

E. Repichnia (crawling trails). Tracks, trails or burrows made by vagile animals upon the substrate

*Jack H. Cowart, MS., 3509 Benthollow Lane, Duluth, Georgia 30136; Carl R. Froede, Jr., BS., P.G., 2895 Emerson Lake Drive, Snellville, Georgia, 30278-6644.

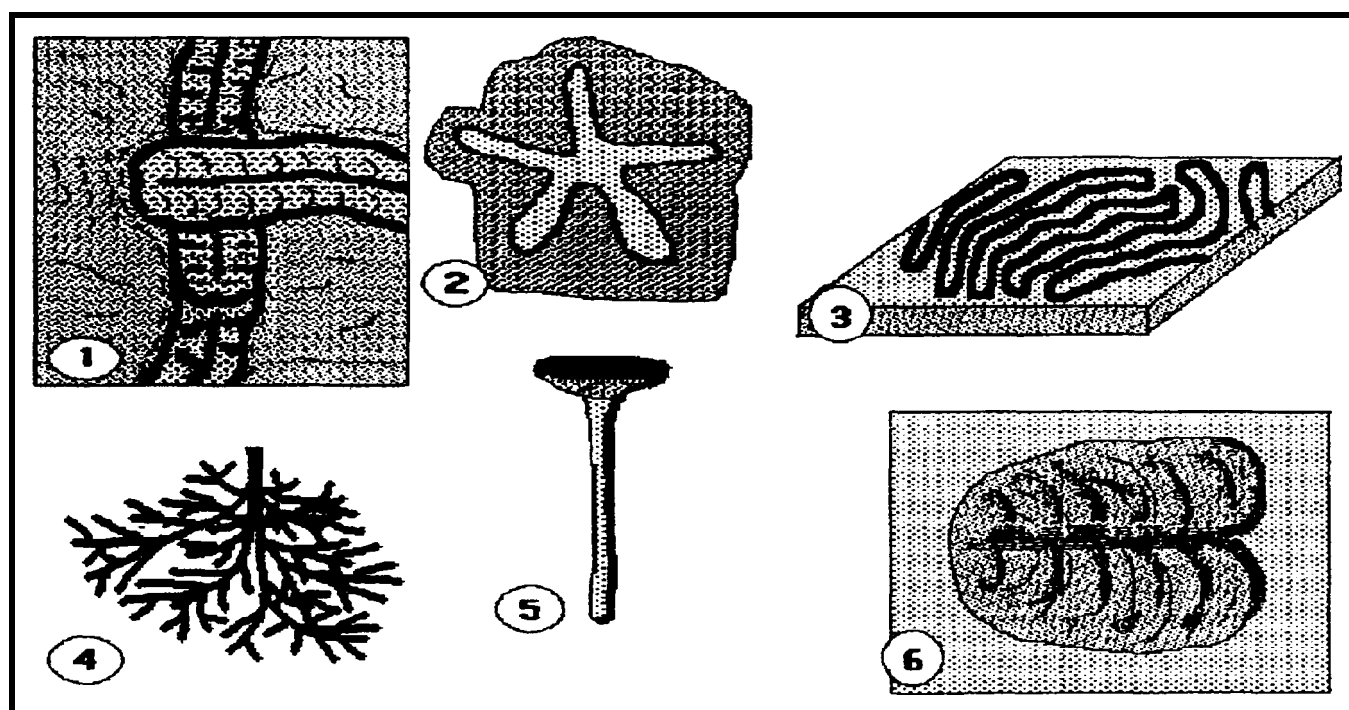


Figure 1. Examples of behavior represented by trace fossils. (1) planar view of crawling trace *Cruziana*, (2) planar view of resting trace *Asteriacites*, (3) planar view of grazing trace *Helminthoida*, (4) two dimensional representation of three dimensional feeding structure *Chondrities*, (5) two dimensional representation of three dimensional dwelling structure *Monocraterion*, (6) planar view of resting trace *Rusophycus*. Modified and combined from Frey (1978, p. 53) and Osgood (1975, p. 94).

surface or along sedimentary layers during directed locomotion [Figure 1, number 1).

F. Fugichnia (escape structures). Burrows made by an organism in an attempt to uncover itself after having been buried by an influx of sediment, or by borrowing deeper into the sediment to offset erosion at the substrate surface (Simpson, 1975, pp. 50-51).

C. Agrichnia (farming and/or trapping structures). Borrows which serve as both a permanent dwelling and provide a source of food, perhaps by means of farming or trapping within the borrow (Ekdale, A. A., R. G. Bromley, and S. G. Pemberton, 1984, p. 23). Also known as graphoglyptids (Seilacher, 1977, pp. 269-296). These structures are of uncertain behavioral significance.

Ichnofacies Classification

(Note to the reader: The ichnofacies classification is underlined and specific ichnogenera/species are italicized. Additionally, a glossary is included for selected terms.)

Within the behavioral classifications listed above are a wide variety of discrete trace fossil morphologies. These differing morphologies have been classified into ichnogenera and, where possible, to ichnospecies. Traces have been codified (see Häntzschel, 1975) just as body fossils have been.

Seilacher (1964a, pp. 307-314; 1967, pp. 414-416) introduced the concept of "ichnofacies," in which characteristic ichnogenera/species associations represent a diagnostic assemblage of traces. Eight ichnofacies are recognized in the literature and are summarized below.

The four most prominent are marine ichnofacies from soft substrate depositional environments. These are (in order of relative increasing depth): the *Skolithos*, *Cruziana*, *Zoophycos* and *Nereites* ichnofacies (Ekdale et al., 1984, p. 26). Firm substrates (i.e., stiff but uncemented such as mud) contain the *Glossifungites* ichnofacies, while hard substrates (i.e., fully indurated or rocky) are host to the *Trypanites* ichnofacies. Figure 2 presents an oceanic bathymetric profile upon which is superimposed the various ichnofacies associated with those bathymetric zones. Fresh water (lacustrine and fluvial) environments are typified by the *Scoyenia* ichnofacies, and wood substrates host the *Teredolites* ichnofacies. All of these ichnofacies have been summarized and described by Ekdale et al., (1984, pp. 26-28) as follows:

The *Skolithos* ichnofacies represents the high energy littoral (intertidal) zone in which are preserved primary sedimentary structures as well as abundant domichnia (e.g., agglutinated worm tubes, branching pellet-walled crustacean borrow systems and various Y- and U-shaped burrows). Also found are occasional repichnia (i.e., epichnial worm, gastropod and arthropod trails) and fugichnia. Due to the high energy associated with this zone most of the burrows are in the vertical plane as exemplified by such vertical domichnia as *Skolithos* and *Diplocraterion*.

The *Cruziana* ichnofacies occurs in the lower energy inner-sublittoral zone, just below low tide but within the wave base. Trace fossil diversity is generally high with virtually all the behavioral groups of trace fossils often being represented in this zone. The lower energy associated with this environment permits traces that are predominantly horizontal in nature, however verti-

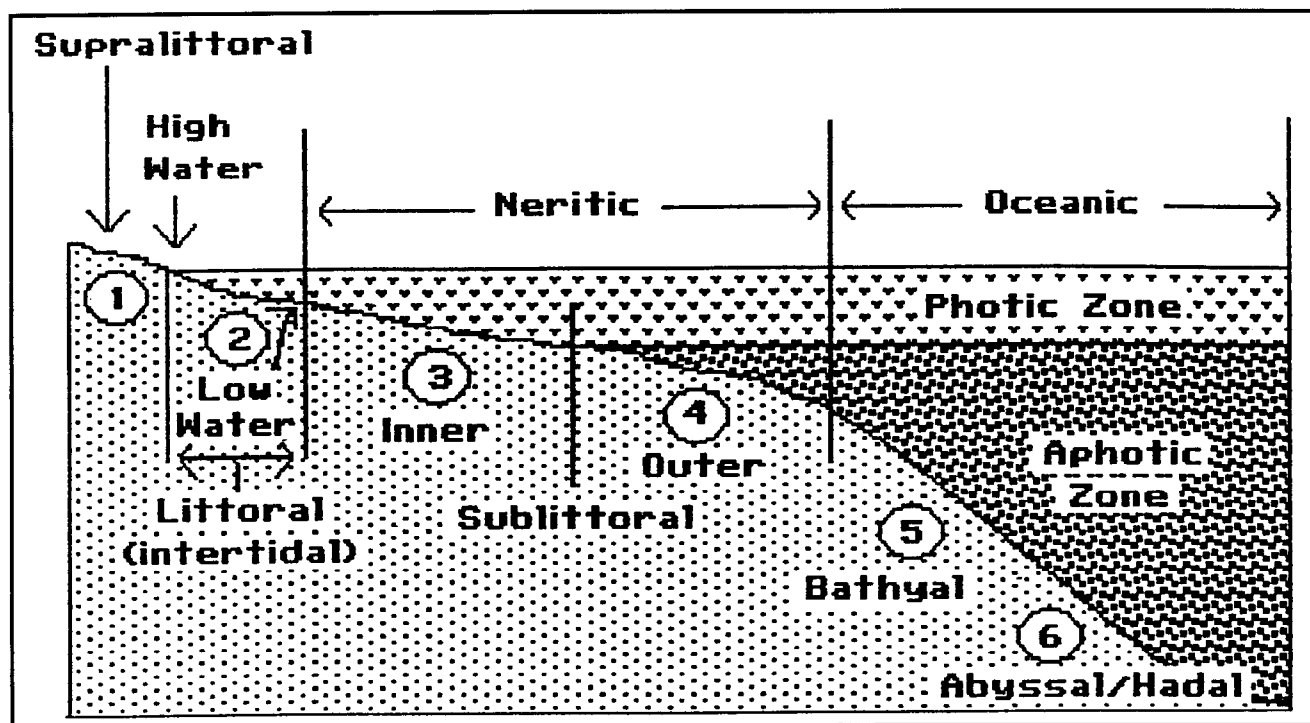


Figure 2. Classification of marine environments and the associated ichnofacies. 1) Supralittoral (Fluvial, Lacustrine — *Scoyenia*; 2) Littoral (Rock Shore — *Trypanites*), (Semiconsolidated Substrate — *Glossifungites*), (Sandy Shore — *Skolithos*); 3, 4) Inner/Outer Sublittoral — *Cruziana*; 5) Bathyal — *Zoophycos*; 6) Abyssal/Hadal — *Nereites*. Modified from Davis (1977, p. 241) and Ekdale et al., (1984, p. 187).

cal traces do exist in this zone. This is reflected in the horizontal repichnia (e.g., *Cruziana*, *Aulichnites*, etc.) and cubichnia (e.g., *Asteriacites*, *Lockeia*, etc.) which dominate this zone.

The *Zoophycos* ichnofacies, according to Seilacher (1967, p. 415), occupies the outer sublittoral and bathyal zones well below storm wave base. The environments are outer continental shelf and upper continental slope, and sediments may include proximal turbidites. However, this ichnofacies occurs in both shallower-water and deeper water zones as well. This is an example of how trace fossils cannot be used as strict indicators of bathymetry. According to Ekdale et al. (1984, p. 26), the *Zoophycos* ichnofacies may reflect low-oxygen conditions. Typically, this ichnofacies' trace fossil diversity is low, even monospecific, although burrows may be abundant. Complex fodinichnia of systematic, in-faunal deposit feeders (e.g., *Zoophycos*) are especially characteristic.

The *Nereites* ichnofacies, as defined by Seilacher (1967, p. 415), represents the abyssal and hadal zones. The sedimentary environments represented by these zones are hemipelagic muds and distal turbidite deposits. The ichnofacies is characterized by a high diversity of horizontal pascichnia (e.g., *Nereites*, *Helminthoida*, etc.) and agrichnia (e.g., *Paleodictyon*, *Cosmorhapha*, etc.), usually occurring on turbidite bedding planes. Vertical burrows are almost totally absent.

The *Glossifungites* ichnofacies is characterized by firm, compacted mud or silt substrates within the marine intertidal or shallow subtidal zones and thereby limits the type of creature that can live in this environment. This ichnofacies is represented by domichnia (e.g., *Glossifungites*, *Thalassinoides*, etc.) and plant

root penetration structures (rhizoliths); other behavioral types of traces are typically absent.

The *Trypanites* ichnofacies is typified by rocky and/or cemented substrates which extend from shorelines to bathyal depths. Such substrates are referred to as "rockgrounds" and "hardgrounds." This ichnofacies is characterized by a highly diverse assemblage of fauna, most commonly being represented by domichnial borings of worms (e.g., *Trypanites*), bivalves (e.g., *Gastrochaenolites*), barnacles (e.g., *Rogerella*) and sponges (e.g., *Entobia*). This ichnofacies, like *Glossifungites*, is different from most of those previously mentioned due to the fact that the substrate is the controlling factor.

The *Scoyenia* ichnofacies is characterized by fresh water (e.g., fluvial and lacustrine) environments in which ichnospecies diversity is lower than in marine environments, but higher than in terrestrial environments. It is typically characterized by simple horizontal fodinichnia (e.g., *Scoyenia*, *Muensteria*, etc.), which may be quite abundant locally, especially in sand and silt.

Terrestrial environments contain sparse trace fossils due to the decreased preservation potential for these deposits. Most trace fossils found in terrestrial environments consist mainly of domichnia and repichnia of insects and vertebrates. Terrestrial ichnofacies are currently unnamed. Much interest has been generated in the last 10 years over the large number of dinosaur footprints discovered and the information they have provided. This particular area of ichnology is referred to as vertebrate ichnology. It is not the intent of this paper to address vertebrate ichnology and the reader is referred to the following recent works: Gillette and Lockley, 1989; Lockley, 1991; Morris, 1980; and Baugh

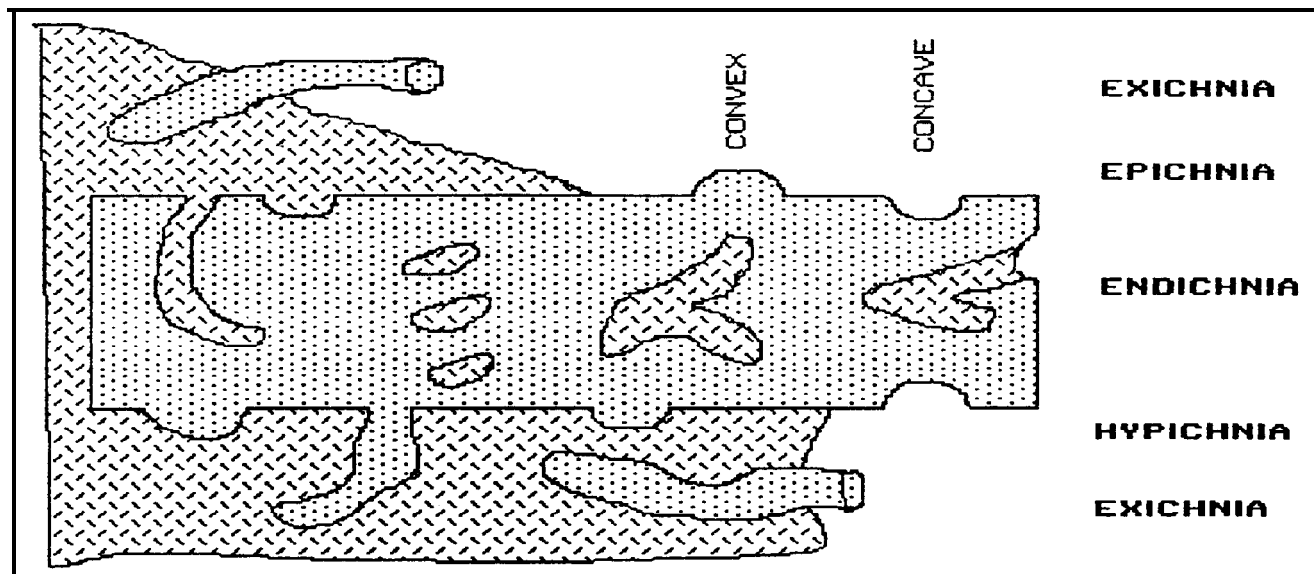


Figure 3. Preservational classification of trace fossils by Martinsson (1970, p. 327). Redrawn from Ekdale et al., 1984, p. 22.

and Wilson, 1987, as well as various *Creation Research Society Quarterly* articles dealing with this subject matter.

Some Principles in Ichnology

Any ichnogenus or ichnospecies which is the name bearer of an ichnofacies can appear in any other ichnofacies. For example, the *Skolithos* ichnofacies represents a high energy environment where the ichnogenus *Skolithos* may or may not be found. Conversely, any ichnogenus or ichnospecies that is the name bearer of an ichnofacies may be absent from its own ichnofacies classification. An example of this being the ichnogenus *Ophiomorpha* and *Diplocraterion* are characteristic of the *Skolithos* ichnofacies and might be the only representatives of that ichnofacies.

Different species of animals can and do leave identical traces (i.e., the same ichnospecies) in the geologic record. However, the same species of animal, or for that matter the same organism itself, can leave more than one type of trace (i.e., multiple ichnospecies). The reason for this change in behavior can be attributed to a change in environmental conditions. Anytime the behavior changes, the morphology of the trace changes, e.g., a resting trace changing to a crawling trace.

The behavioral aspects of a trace fossil are much more important than the identity of the tracemaker, since the traces represent an ecological niche. Identification of what made the trace is possible only if the creature is found in the trace or if the morphology of the trace so closely conforms to the morphology of the tracemaker that the organism can be recognized.

A sediment which has experienced a significant amount of reworking, but has not lost its original sedimentary features, is called an ichnofabric. Within the ichnofabric, traces can be classified to the ichnogenus, or if detailed enough, to the ichnospecies level. Ichnofabric differs from bioturbation, in that the latter is defined as the physical mixing of sediments to such a degree that the sediments, physically and chemically, are often blurred or destroyed in their original physical sedimentary structure(s).

Since the great bulk of trace fossils are found in the marine sedimentary rock record, trace fossils have typically been used for paleoenvironmental reconstruction in marine rocks. Many ichnofacies are found in the sedimentary record at sequence or unconformity boundary surfaces and as such are useful in determining sea levels.

Trace Fossil Preservation

Preservation of trace fossils is dependent upon a variety of factors, the two most important being (1) the type of sediment both in and surrounding the trace fossil(s), and (2) burial of the trace fossil by sufficient sediment to protect it from subsequent erosion. Trace fossil preservation classification is based on the relationship of the structure to a casting medium; the greater the contrast in sediments, the more obvious the trace (Bromley, 1990, p. 165). As preservational features, tracks, trails and burrows are classified into four groups (Martinsson, 1970, pp. 326-329; Frey and Chowns, 1972, p. 26) (Figure 3):

- A. **Epichnia** — Traces in primary contact with the upper surface of the casting medium; may appear as a ridge or a groove.
- B. **Endichnia** — Traces within the casting medium; i. e., not in contact with the upper surface.
- C. **Hypichnia** — Traces in primary contact with the lower surface (sole) of the casting medium; may appear as a ridge or a groove.
- D. **Exichnia** — Traces outside the casting medium and not in direct contact with it.

Since trace fossils are composed of the same materials as the sedimentological fabric (i.e., sand, silt and clay), transport of trace fossils is rare. The same forces that erode and transport sediments, shells, etc., usually destroy individual trace fossils in the same manner in which laminae, bedding features, etc., are destroyed. Exceptions to the rule of non-transport occur when trace fossils are lithified and retain their integrity during erosion and transport. In these cases, trace fossils may display any number of the same characteristics of any

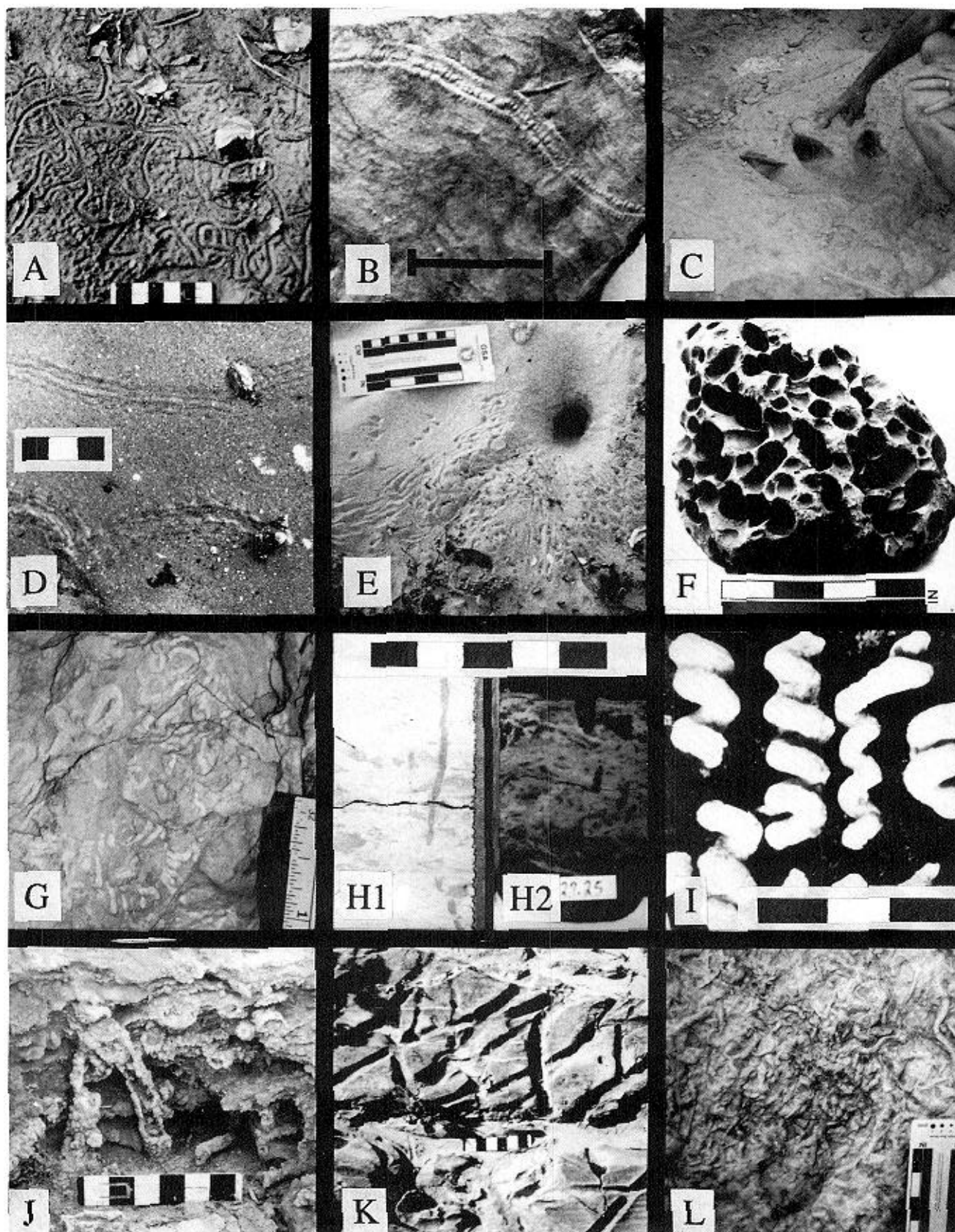


Figure 4. Examples of both ancient and modern trace fossils. (Scale bar unit equals 1 inch for all figures)
 A, Concave endichnion insect grazing trails (*Pascichnia*) in unconsolidated sediments, *Scoyenia* ichnofacies

(Figure caption continued, top of next page.)

Figure 4 caption (continued).

- B, Convex epichnion locomotion trail (Repichnia) in indurated sediments, possible *Cruziana* or *Nereites* ichnofacies (Used with permission of M. J. Hartnett).
- C, Concave epichnion bipedal vertebrate track (Repichnia) in indurated sediments, *Scoyenia* ichnofacies (photo courtesy of J. C. Meredith).
- D, Concave epichnion locomotion trails (Repichnia) of land hermit crabs (*Coenobita clypeatus*) in unconsolidated sediments, *Skolithos* ichnofacies.
- E, Unconsolidated trackway (Repichnion) and dwelling (Domichnia) of ghost crab (*Ocypode quadrata*).
- F, Indurated, highly bored (Endichnion) mudstone, *Trypanites* ichnofacies (specimen from Santa Monica Beach, California, USA. Used with permission of R. O. Howard, Jr.).
- G, Indurated endichnia of uncertain origin ("graphoglyptids" or Agrichnia). Possibly the *Cruziana*, *Zoophycos*, or *Nereites* ichnofacies.
- H, Interbedded mudstone and fine grained sand (Endichnion) with *Skolithos* vertical dwelling (Domichnia) burrow trace, possible *Skolithos* or *Cruziana* ichnofacies (Athabasca oil sand core—McMurray Formation, Alberta, Canada).
- H2, Interbedded bioturbated shale (light) and bitumen saturated sands (dark) with several distinct *Planolites* dwelling (Domichnia) burrow traces, possible *Skolithos* or *Cruziana* ichnofacies (Athabasca oil sand core—McMurray Formation, Alberta, Canada).
- I, Casts (Exichnia) of *Xenohelix* vertical dwelling (Domichnia) burrows possible *Skolithos* or *Cruziana* ichnofacies.
- J, Casts (Exichnia) of *Ophiomorpha nodosa*, vertical and horizontal dwelling (Domichnia) burrow tubes, possible *Skolithos* or *Cruziana* ichnofacies.
- K, Indurated sandstone casts (Exichnia) of *Thalassinoides suevicus*(?) horizontal dwelling (Domichnia) burrow tubes, possible *Skolithos* or *Cruziana* ichnofacies.
- L, Indurated hypichnion of a community of trace makers. Possibly the *Cruziana*, *Zoophycos*, or *Nereites* ichnofacies.

transported material, such as imbrication, abrasion, etc. Lithification of trace fossils may result from various chemical and/or physical conditions in the animal's environment or from the animal itself, such as secretions.

Additionally, trace fossils in driftwood (*Teredolites* ichnofacies) are an example of trace fossils that can be transported.

Figure 4 depicts some examples of different types of traces (modern and ancient) that have been found in the rock record. Additionally, these traces have been identified using both their preservational and ichnofacies classifications.

Not every feature resembling trace fossils is a result of biogenic activity. Pseudo-traces, which do not originate from animal behavior, can be confused with actual traces. These false or misleading traces are the result of physical and/or chemical processes such as tool marks, sedimentary overburden features (i.e., ball-and-pillow structures), convolute bedding structures, water escape structures, slump structures, turbidity current marks, gas bubbles, lightning strikes, faulting, shrinkage cracks, precipitation, diagenesis, and plant root casts (Boyd, 1975, pp. 6589).

Ichnology Related to the Creationist Model

The authors believe that trace fossil information in the rock record is another "arrow in the quiver" for creationist earth scientists to use in deciphering the geologic record left in God's Creation and in reconstructing the earth's history. The creationist model presented below is in a brief, generalized form. Only four major timeframes will be examined, those being the Antediluvian, the Flood event, the Post-Flood (including the Ice Age) and the Present Age.

The Antediluvian world existed from the "Creation" to the "Flood." This time period is not exact (Vis, 1950, p. 242) but could be estimated (using inexact biblical "generations") as being approximately 1,200 to 1,656 years in duration (Whitcomb and Morris, 1961, p. 26). The Antediluvian earth had mountains (Genesis 7:20), rivers (Genesis 2:10-14) and seas (Genesis 1:10 & 22), and so must have experienced geological activities similar to today with several exceptions, most notably that it did not rain (Genesis 2:5) [modified from Whitcomb and Morris, 1961, p. 215]. Created bodies of water existed in the antediluvian world with creatures designed and placed there by the Creator (Genesis 1:20-25). Antediluvian subaqueous surfaces (both fresh-water and marine) would provide the substrate for

contemporaneous ichnospecies. The amount of time postulated here is sufficient for all levels of ichnofacies development, including bioturbation and escape structures (fugichnia).

The authors believe that the beginning of the Flood resulted in the first occurrence of rain. However this point remains controversial among creationists today. Additionally the beginning of the Flood also marked the breaking up of the earth's surface resulting in the release of subterranean waters. This created an erosional environment on the continents and depositional environments in the lakes and seas and along the continental shelves and slopes in the oceans. These sedimentary deposits buried and filled (where possible) any traces during this event. Ichnofacies exposed to erosion associated with this event would have been destroyed.

Genesis 7:20 tells us that the Flood water covered the earth to a depth of at least 15 cubits (approximately 22 ft) within the first 46 days. This depth would not have prevented marine life from reestablishing itself on the substrata while the water covered the Earth. The earth, underwater at that time, did not have an underwater surface of equal depth and this uneven underwater surface would have promoted diverse environmental conditions and would have provided new opportunities for trace fossil development and diversity.

Then winds blew across the face of the earth as the waters receded (Genesis 8:1). Winds are recognized as a source of currents and this action may have resulted in the resuspension and/or winnowing of some subaqueous sediments. Trace fossil development during this time would result in the formation of escape structures or the burial of whole ichnofacies with a subsequent reestablishment of the same or perhaps different ichnofacies once deposition had ceased. This would have resulted in the generation of new niches for diverse trace makers to colonize.

During the latter stages of the Flood, tectonic forces, still incompletely understood, created basins into which waters flowed, thereby exposing earth's surface. Lowering of the water level would have created new opportunities for ichnofacies to develop. Sea level would continue to drop, possibly as a result of the continental plate's spreading with the cooling and the sinking of the oceanic basalt accommodating greater volumes of water (Schopf, 1980, p. 48). Sea levels would also continue to fluctuate due to the ensuing Ice Age. The time from maximum Flood water depth to Noah's

departure from the ark has been calculated as being 221 days (Whitcomb and Morris, 1961, p. 8).

The authors support the single "wet" ice age as outlined by Michael Oard (1990) and believe that the combination of tectonic forces coupled with climatic instability contributed to glacial disequilibrium resulting in the rapid rise and fall of sea level over the timeframe of the Post-Flood and Ice Age and subsequently thereafter (approximately 700 to 1000 years in duration). This change in sea level could create opportunities for the development of the various ichnofacies. The Post-Flood timeframe probably marked the time of greatest ichnofacies development. The earth was stabilizing to Post Flood conditions and the catastrophic processes which occurred during the Flood were no longer in operation. Changes in environmental conditions, such as changes in sea level, would subject the ichnofacies to tremendous stresses and change could occur from one ichnofacies to another very rapidly.

Modern traces, in many cases, are similar to those produced in the past (see Figure 2). However, there are many traces that do not have modern representatives. Today's sea level is estimated to reflect anywhere from 4,900 to 7,000 years of more nearly stable conditions (Dolan and Lins, 1986, p. 13; Curray, 1965, p. 733), which is consistent with the creationist's model (especially if the earth is no older than 10,000 years). This stability has allowed the reestablishment of ichnofacies at all levels of oceanic depth and has made possible the study and extrapolation of traces from the present back into earth's past.

Discussion

Trace fossils occur in almost all sedimentary rocks and have been found at all levels of the stratigraphic record as far back as the "Precambrian." According to Crimes (1975, p. 113):

The earliest recorded trace fossil is a burrow system considered to have been made by a worm-like organism, probably an annelid, found in the Grand Canyon Series (U.S.A.) and suggested to be more than a billion years old.

Additionally, many Cambrian-type fossils (i.e., trilobites, worms, etc.) were very well established and active, bioturbating the sedimentary package during this period. So we see that ichnofacies have developed from the earliest (deepest) rocks and are continuing to be developed today. In fact, the "remains" of soft-bodied animals in the form of trace fossils are probably much more common than the remains of animals with hard parts (Ager, 1993, p. 150).

As a tool, ichnology has helped determine depositional and environmental conditions. For example, an ichnofacies consisting of more vertical burrows than horizontal burrows covered and filled by overlying sand deposits, could reflect a high energy (near-shore) ichnofacies which was buried under migrating barrier/spit sands. Another example is a highly bioturbated substrate, which may indicate either a period of low sedimentation with time for the trace makers to work and rework the sediments, or a larger population of trace makers which rework more quickly deposited sediments. These are just a few examples of how ichnology can be used to further define the environment.

Ichnology, coupled with other geologic tools (i.e., stratigraphy, sedimentology, paleontology, paleoecology, etc.), offers the opportunity to better support the creationist model.

Conclusions

Ichnology is a tool that can, when properly integrated with other geologic disciplines, greatly aid in the determination of past deposition environments. The application of Ichnology toward the creationist model will help to determine the timeframe the ichnofacies, and the associated ichnogenera and ichnospecies in question, were produced, i.e., the Antediluvian, the Flood event and subsequent receding of waters, the Post-Flood (including the Ice Age), or the present. Once the timeframe is approximated, the creationist modeler should better be able to understand the environment and depositional setting in which the traces occurred. In many cases, Ichnology serves to reinforce the catastrophic nature of the Creation/Flood model. This ichnological information should serve as reinforcement to the premise of the Biblical interpretation of earth's historical events. In subsequent articles or notes, the authors will attempt to correlate ichnological evidence using specific sites where traces are present within a creationist young-earth model.

Glossary

- Abyssal zone — Oceanic zone of greatest depth, i.e., below 2000 m.
- Aphotic zone — Oceanic depths lacking light penetration.
- Bathyal zone — In marine ecology it is the region of the continental slope and rise.
- Distal turbidites — The turbidite sediments located furthest from the source of origin.
- Facies — Sum total of features that reflect the specific environmental conditions under which a given rock was formed or deposited. Can be singular or plural depending upon its usage.
- Geopetal structures — A sedimentary fabric which records the way up at the time of deposition.
- Hadal zone — The part of the ocean that lies in very deep trenches below the general level of the deep-ocean floor.
- Hemissessile — A sea creature which spends half its life floating and the other part attached to a substrate.
- Ichnofacies — A characteristic assemblage of trace fossils.
- Imbrication — Fabric resulting from the lateral stacking of rock fragments indicating the direction of flow (tilted/leaning against each other like roof shingles).
- Morphology — The form and structure of individual organisms.
- Littoral zone — In marine ecosystems the shore area or intertidal zone where periodic exposure and submersion by tides is normal.
- Neritic zone — The shallow-water or near-shore marine zone extending from low-tide level to a depth of 200 m.
- Photic — Relating to levels of light.
- Proximal turbidites — The turbidite sediments located close to the source of origin.
- Substrate — The base on which an organism lives.
- Turbidite — A sedimentary deposit laid down by a turbidity current.

Turbidity current — A variety of density current that flows as a result of a density difference created by dispersed sediment within the body of the current.
Vagile — A sea creature which is free to move about.

Dedication

This article is respectfully dedicated to the late Dr. Robert W. Frey, one the leading trace fossil experts in the world. Bob Frey was Mr. Cowart's major professor while Mr. Cowart worked on his trace fossil thesis for his Master of Science degree in Geology at the University of Georgia. Special appreciation is extended to Dr. S. George Pemberton, now with the Department of Geology, University of Alberta, Canada. While a Professor of Geology at the University of Georgia, Dr. Pemberton obtained a grant which permitted Mr. Cowart to work on his trace fossil thesis in Alberta, Canada.

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QUOTE

Thy righteousness is like the great mountains; thy judgements are a great deep: O Lord, thou preservest man and beast. How excellent is thy loving kindness, O God! therefore the children of men put their trust under the shadow of thy wings. They shall be abundantly satisfied with the fatness of thy house; and thou shalt make them drink of the river of thy pleasures. For with thee is the fountain of life: in thy light shall we see light. Psalms 36:5-9, KJV

PANORAMA NOTE

Virginia Triassic Basins, Dinosaur Footprints, and Catastrophism

In Virginia, Mesozoic rocks occur only east of the Blue Ridge of the Appalachian Mountains. Triassic rocks are found in areas which have been described as "Triassic basins." These basins which are found from Georgia to Nova Scotia (Olsen and Galton, 1977, Olsen, Remington, Comet, and Thomson, 1978, Olsen, 1986, Sues and Olsen, 1990), are often bounded by faults.

The Danville Triassic basin in Virginia and North Carolina (Figure 1) is bounded on the west side by the Chatham fault, which is an eastward-dipping normal fault or extension fault. Normal faults are found at a few places on the east side of the sediments, but at most places there is only a sedimentary overlap (Meyertons, 1963). Evidence indicates that Paleozoic sediments are missing under these Mesozoic rocks, the underlying rock being mostly metamorphic and granitic (Wilkes, 1988, Meyertons, 1963).

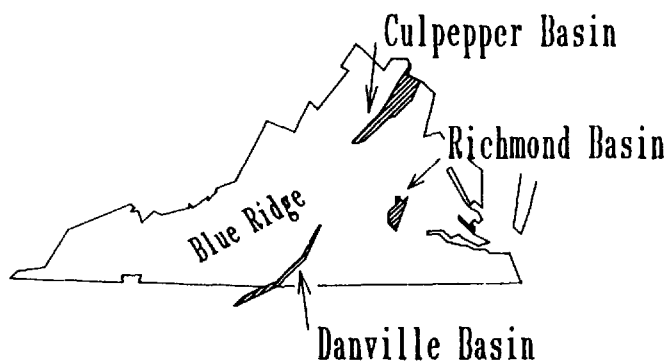


Figure 1. A map of Virginia showing the location of the Danville, Culpepper, and Richmond Triassic basins.

Reptile tracks have been found in quarries at Cascade, Virginia, which is southeast of Martinsville, on the North Carolina-Virginia border and at Culpepper Quarry, which is in northern Virginia.

The quarry at Cascade, which is a source of material for brick and ceramic ware, has been called "the Solnhofen of North America." Solnhofen, Germany is of course the type locality where the *Archeopteryx* fossils, which Darwinists have tried to label as a missing link between birds and reptiles, were first found. Fraser (1993a, b) has described the findings at Cascade. They include Triassic insects, a mass kill of a small (20-40 cm), long-necked, slender, lizard-like reptile called *Tanytrachelos* and Triassic plant life including cycadeoids, cycads, seed ferns, and conifers, and some limited angiosperm-like fossils. According to uniformitarian estimates, the Cascade quarry fossils indicate that angiosperms (flowering plants) existed some 100 million years earlier than previously accepted (but see Woodmorappe, 1983, p. 169 and Daghljan, 1981 for an even earlier controversy). According to Biblical creationists, these findings of flowering plants support the idea that ecological zonation did not lead to perfect exclusion of flowering plants in this area. In this view, the Triassic represents the preservation of an ecological zone not a timeframe.

Figures 2, 3 and 4 are photographs of the Cascade quarry. Figure 2 is a view looking south from the northern edge of one of the pits, showing that the pit is filled with water. The best place to collect fossils is along the east wall, since large plates of rock may be



Figure 2. A view of one of the pits at Cascade Quarry southeast of Martinsville, Virginia. The view is taken from the north side of the pit looking south.



Figure 3. A view of the pit at Cascade quarry looking east from a point on a mound of mine tailings at the south wall.

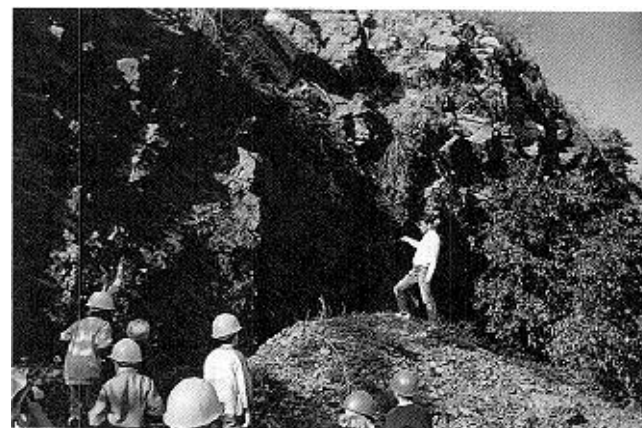


Figure 4. A segment of the south wall of the pit at Cascade Quarry, showing strata which are claimed to reflect "Van Houten cycles." Alternatively, the sandstone, siltstone, and shale could be flysch beds formed by turbidity currents.

easily broken off and split to reveal the fossils. On the south wall the strata are edge-on and are difficult to access. Figure 3 is a view looking east from a point on the south wall of the pit. One can see people who have climbed the east wall to collect fossils. Figure 4 shows the south wall, including layer after layer of fine grained clastic sediments ranging from thin layers of siltstone and shale containing organic debris to massive layers of sandstone. Fraser (1993a, b) and Olsen (1986) have interpreted the variation in terms of Van Houten cycles (Van Houten, 1962). These cycles are connected to the Milankovitch theory in which precession of the earth's equinoxes leads to a cyclic 20,000 year variation in lake levels, with a 41,000 year cycle superimposed which is related to the tilt of the earth's axis extrapolated to past times. Of course, the statistical evidence that this really occurred is rather meager, and provides only weak evidence against a young earth. An excellent summary addressing Milankovitch cycles is made by Oard (1984a, 1984b, 1985).

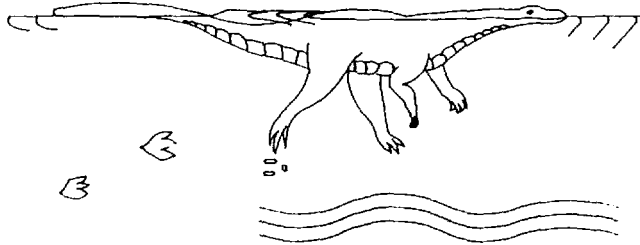


Figure 5. Representation of a swimming dinosaur, *Syntarsus* (meaning fused-tarsus), a Triassic dinosaur of about 10 feet length. Various impressions of the foot on the unconsolidated sediment would depend on the depth of the water at the point where the dinosaur steps. (Based on similar drawings in Coombs, 1980 and Bird, 1944).

In the mid 1986's the subject of Triassic Newark basin fossils was discussed in several letters to the editor of *Creation Research Society Quarterly* (Morton, 1982, 1983, 1987, Woodmorappe, 1982, Mehler, 1986). Morton suggested that the repeated occurrence of dinosaur footprints was evidence that these vertebrate trace fossil bearing formations could not be explained by the Noachian Flood, but rather were caused by a series of catastrophic events. Morton also cited a preservation of dinosaur eggs in Montana as evidence of catastrophe (Homer and Makela, 1979; Anon., 1981; Allman, 1993; Homer, 1984). Subsequently, Whitmore (1988, 1990), advocated the Noachian flood model, presenting evidence indicating that swimming dinosaurs, trying to escape the flood, could have been responsible for footprints at various depths of strata. For instance, at the Culpepper quarry in Stevensburg, northern Virginia, dinosaur footprints have been discovered at two different levels, separated by 100 feet of strata. Possibly these strata could be explained in terms of a Flood model if dinosaurs wading, perhaps like in Figure 5, could temporarily escape to high ground during the flood. Alternatively, dinosaurs starting from high ground could traverse sediments deposited on top of previous tracks thus leaving ichnofossils above those of a previous herd. In my opinion, there is ample evidence that wading or swimming

dinosaurs and other tetrapods could have produced footprints under rising Floodwater conditions (Coombs, 1980, Bird, 1944, Brand and Tang, 1991).

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Eugene F. Chaffin*

*Eugene F. Chaffin is the editor of CRSQ.

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