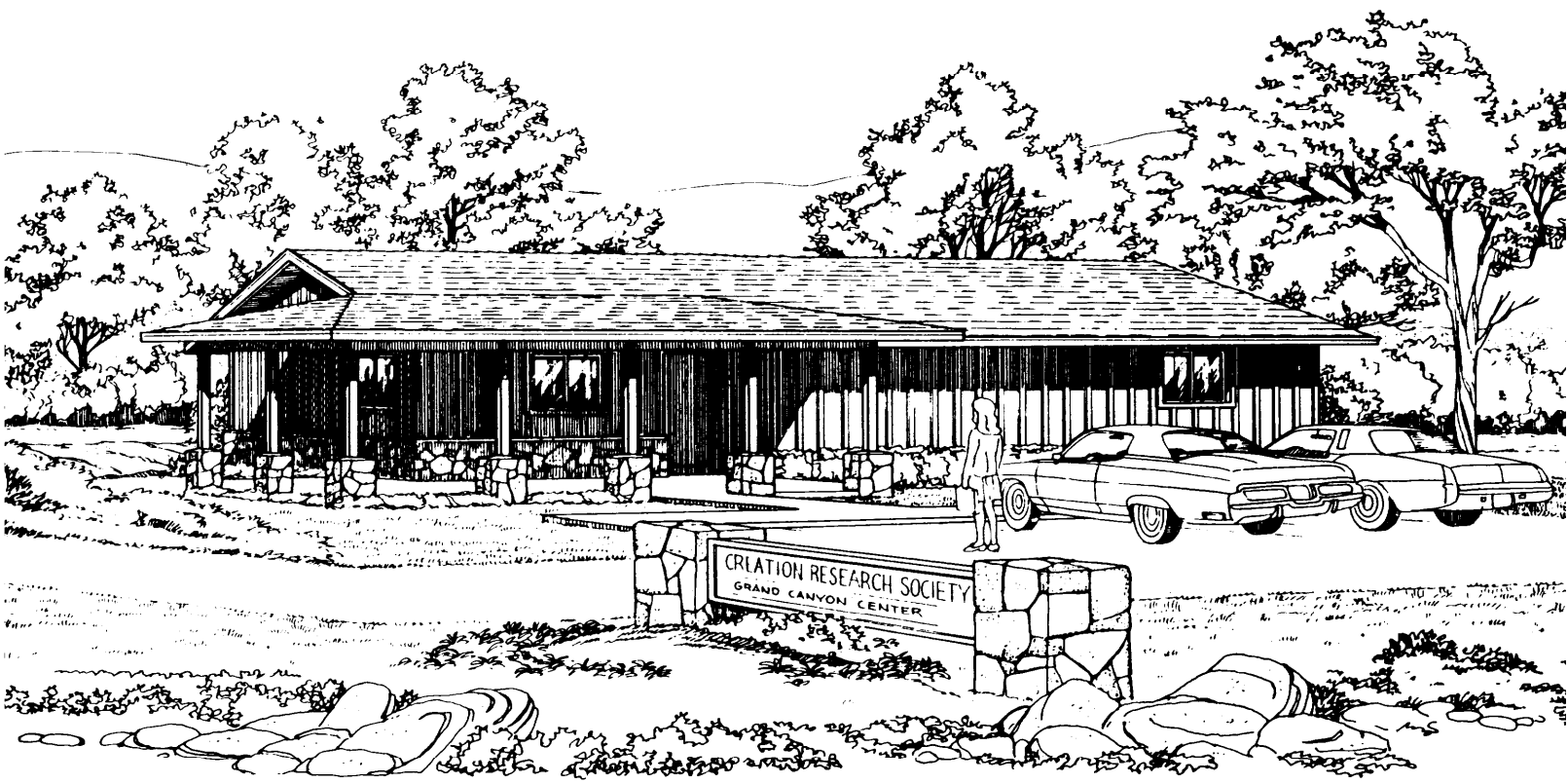
Creation Research Society Quarterly

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 28 **DECEMBER 1991** **NUMBER 3**



ARTIST'S RENDERING OF THE PROPOSED GRAND CANYON CENTER OF THE CREATION RESEARCH SOCIETY

CREATION RESEARCH SOCIETY QUARTERLY

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QUOTE

It is now well known that K-Ar ages obtained from different minerals in a single rock may be strikingly discordant.

Engels, Joan C. 1971. Effects of sample purity on discordant mineral ages found in K-Ar dating. *Journal of Geology* 79:609.

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CREATION RESEARCH SOCIETY

History The Creation Research Society was first 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 Paulden, Arizona and the Grasslands Experiment Station 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 $18.00 ($22.00 foreign) per year and may be sent to Glen W. Wolfrom, Membership Secretary, P.O. Box 14016, Terre Haute, IN 47803. 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 $18.00 ($22.00 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: $21.00 ($25.00 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.

CRS LABORATORY BUILDING PROGRAM MOVES FORWARD

The Creation Research Society is now involved in a major capital campaign to generate funds for the building of the first phase of our research laboratory a few miles north of Chino Valley, Arizona. For nearly a decade we have slowly developed this land. All that remains to be done now is to build and start operating this laboratory for origins research. All necessary permits and zoning requirements have been met and the time has come to launch out and place the laboratory into operation. As we do so, we immediately face two major obstacles.

The first is to generate funds for the building and the second is to acquire sufficient funds to begin operation of the research laboratory as soon as it is completed. Both must occur simultaneously. To this end the board of directors has established a new fund called the *Laboratory Fund.* In the past, the endowment for CRS research has been referred to as the Research Endowment Fund or the Lab Endowment Fund or just the Lab Fund.

From this point onward it is important that the old "Lab Fund" be consistently referred to as the "Research Endowment Fund." This fund, to which so many of our members have contributed over the last decade. Has been used to support research proposals which have been submitted to the research committee and approved. It will continue to serve as such a fund. It, as with all other endowment funds, represents money that will never be spent. All endowments are invested and only the proceeds generated from that investment will be spent. The new fund which will be used to build, equip, operate and staff the laboratory should be referred to as the "Laboratory Fund." This "Laboratory Fund" will not be an endowment fund. It is a building and operation fund and the principal will be spent.

I have recently spent some time re-reading the *Creation Research Society Quarterly* from the first few years of its existence. I note that Dr. Walter Lammerts, the world's foremost rose breeder and the first *CRSQ* Editor, clearly stated the goals of the Society in editorial comments. The following represents a collage of his thinking on this subject:

> Our aim is a rather audacious one, namely the complete re-evaluation of science from the theistic viewpoint . . . We cannot hope in one lifetime to complete the structure of a truly theistic science, but let us begin [*Creation Research Society Quarterly* l(l)]
>
> . . . our main thrust is toward the development of a new framework of reference in science, based on a whole-hearted conviction that the universe and the world in which we live is but the expression of God's creative wisdom and design constantly being maintained by His power . . . all research should be undertaken prayerfully with the objective of helping one's fellow man to better understand, enjoy, and thankfully appreciate the Glory of God as shown by the ever increasing evidence of the intricacy of His creations . . . As we move deeper into our re-evaluation of science, facts obscured by the prejudice of almost 100 years of evolutionary thinking will be discovered. This clearer understanding of natural phenomena will result in both a better appreciation of the glory of God's handiwork, and also an increased ability to use it wisely. We solicit your continued and dedicated support for the many tasks ahead. Our Lord and Saviour clearly prophesied that because of our inherent sinfulness we will never be able to build "The Great Society." But we as Christian men and women of science can at least reorient it so that our journey as pilgrims here on earth, though obscured by the work of Satan, will be guided by the light of God's power and glory as shown in His still marvelous creation *[Creation Research Society Quarterly* 2(2)]
>
> So let us not accept so easily the so called 'objectivity' of science. Let us have a fresh look. Let us see more clearly how the remains of a once perfect world still show so clearly the handiwork of our God, who daily is concerned over even the most humble sparrow that falls by the wayside, and who each spring causes the flowers (lilies) of the field to burst forth with such splendor that Solomon in all his glory was not arrayed like one of these *[Creation Research Society Quarterly* 3(1)].

The founding "Team of Ten" scientists brought into existence an organization which has had a profound influence on the modern creationist movement. For nearly 30 years the Creation Research Society has been true to its original purpose to reinterpret origins science from a theistic viewpoint. The anticipated research facility will take the Society another step closer to the fulfillment of this mandate.

Located in desert grasslands of North Central Arizona, this laboratory is strategically situated for studies of both desert and alpine biology. Its proximity to the Grand Canyon and southern Colorado Plateau place it near some of the most geologically important features in the world. Our goal is to make it the site of intense field and laboratory research for the establishment of the creationist model. We invite your generous support of the Laboratory Fund to bring this major research center into existence and productive operation.

John R. Meyer, Ph.D.
Chairman, Research Committee

When I would beget content and increase confidence in the power and wisdom and providence of Almighty God, I will walk the meadows by some gliding stream, and there contemplate the lilies that take no care, and those very many other little living creatures that are not only created, but fed (man knows not how) by the goodness of the God of Nature and therefore trust in Him. — Izaak Walton

Bachelder, Louise, editor. 1965. *Nature Thoughts: A Selection.* Peter Pauper Press. Mount Vernon, NY. p. 26.

Editorial Comments

The Symposium on Variation concludes with this issue. I hope you have enjoyed and profited from the 13 papers included in this series over a period of four Quarterlies. This issue also has articles covering geology, astronomy, thermodynamics, and biology. Danny Faulkner and I offer an introduction to a planned sequence of articles that will attempt to develop models for stellar evolution from a creationist perspective. Williams, Meyer and Wolfrom present Part I in a three-part series on the formation of the Grand Canyon. This series is appropriate to focus the attention of our membership on the proposed CRS Grand Canyon Center in Arizona. (See the front cover). Tracy Walters examines the constraints on a possible condensing pre-Flood vapor canopy. John Meyer and I discuss our reactions to a workshop on the biology of dinosaurs. Please contribute to the Quarterly effort by sending me manuscripts for articles, notes, book reviews and letters to the editor. It would be helpful if you increased the circulation of the Quarterly by making it available in public libraries in your area. I hope you have a joyful Holiday season and a successful New Year.

Don B. DeYoung, Editor

Erratum

March 1991 Quarterly, page 158, the zip code for Santee, CA should be 92072.

TOWARD A CREATIONIST ASTRONOMY

DANNY R. FAULKNER AND DON B. DEYOUNG*

Received 20 April 1991; Revised 23 June 1991

Abstract

It is noted that very little discussion of stellar evolution has been conducted from a creationist perspective. A brief summary of stellar structure and evolution is given with a few of the observational evidences usually presented. The question of how much fixity and change creationists should allow in stars is raised. It is argued that the theory of stellar structure appears to be founded on a good physical basis and that stellar evolution is intimately related to stellar structure. Stellar evolution, the name applied to the aging of stars, is a totally different case from biological evolution. The need of a complete creationist astronomy model is emphasized. Future discussion on these topics is encouraged.

Introduction

The modern creationist movement has made much progress over the past 30 years. This has coincided with the introduction of several periodicals and many books by numerous authors and various publishers. The general approach has been two-fold: first, to show that many observed properties of the world cannot adequately be explained by evolutionary or uniformitarian models, and two, to show that things can be explained better by the sudden creation of the world in the not so distant past. This second step has properly shied away from the response "that is the way God did it," in favor of the design and order that a benevolent Creator has ordained. When processes have been invoked, they have been ones of steady degeneration or of catastrophe.

The goal of all of this effort has been to produce a consistent and detailed alternate model that is Biblically correct and adequately describes what we observe. This work has progressed in the fields of biology and geology so that today we have a fairly well defined creationist model of each. The reviews of Gish (1975, 1989a, 1989b) show that these two fields have consumed the most attention of *Quarterly* authors since the inception of the Creation Research Society.

Astronomy is another science in which evolutionary and uniformitarian assumptions have had great sway, however a survey of creationist literature reveals that much less work has been done in this field as compared to biology and geology. Discussion has mainly involved five key topics:

Initial origin of the universe and solar system members
Age of things
Stellar evolution
Life in space
Anthropic principle of design

Of these, most of the work that has been done has fallen into two areas. One of these is the examination of the Moon, planets, comets, and other solar system objects to argue that they must have young ages (Humphreys, 1990). The other area leaps to the grand scale of the universe (cosmology) to argue against the standard, or Big Bang, model of the universe (DeYoung and Whitcomb, 1981). Since Big Bang cosmogony demands an ancient age for the universe, the purpose of this assault has obviously been to demonstrate that the universe does not necessarily have to be as old as currently thought.

We offer three criticisms of the present state of creationist thought in astronomy. First, as stated above, most attention has centered on the small scale (the solar system) and the large scale (cosmology), while leaving a rather large gap in scale between these. For example, the second Creation Research Society Monograph (Mulfinger, 1983) on design and origins in astronomy has only two sections of contributed papers, one on the universe and one on the solar system. Second, there has not yet emerged even a rough framework of an alternative creation model as we find in biology and geology. Third, except for teleological ramifications of the Earth's immediate environment, there does not seem to be any stress upon the purpose to the order and structure that we see in the universe. This last point seems to leave us with the uncomfortable position that the universe is as it is because God simply wanted it that way. As stated earlier, this has not been the general attitude prevalent in creationist studies of either biology or geology.

Actually, all three criticisms stem from the same root of a lack of a reasonably complete and consistent model, and the key seems to be the middle scale of criticism two. In general astronomical parlance this middle scale would be referred to as "stellar evolution" which purports to explain the structure of stars and to explain how and why they got to be in their present states. The use of the word "evolution" here carries a different connotation as it does in biology where an increase in complexity is implied. Instead, its astronomical use means change, whether the change is one of decay or perceived improvement. Furthermore, the evolution or change of stars is quite quantitative and is based upon well understood physical principles such as hydrostatic equilibrium, thermal equilibrium, equations of state of gases, and nuclear reactions. Still, the concept of stellar evolution is an attempt to explain the observed properties of the universe apart from the input of a creator. This, of course, should suggest caution to creationists. Indeed, Mulfinger (1973) has astutely warned

> . . . many professing Christians are being 'carried along with the tide.' Surely they fail to realize the consequences. There is no logical stopping point. The theory is a broad philosophical 'pathway' leading ultimately to atheism.

*Danny R. Faulkner is Associate Professor of Astronomy and Physics at the University of South Carolina—Lancaster, P.O. Box 889, Lancaster, SC 29720. His home address is 1402 University Drive, Lancaster, SC 29720; Don B. DeYoung, Ph. D., is editor of *CRSQ*.

Because of this danger, some creationists maintain the absolute or nearly absolute fixity of stars. The well observed occurrence of novae and supernovae should show that some change or evolution occurs. It is usually responded that these processes demonstrate that the evolution that we see is that of degeneration. But does not that conclusion stem from the general belief that such eruptions are from dying stars? And how do we know this? The study of stellar evolution tells us. Many creationists seem quite willing to accept certain conclusions of stellar evolution, while rejecting out of hand much of the theory leading to these same conclusions.

We feel that the whole topic of stellar evolution needs detailed examination from a creationist viewpoint, and it is hoped that this article and others to come will spark much interest and discussion in this journal and elsewhere. To be quite fair, there have been some attempts in the past, but they have not been of the scope that we feel is necessary. For instance, Wilt (1983) in his discussion of nucleosynthesis briefly described the major aspects of stellar evolution without offering many specific criticisms or alternatives. Mulfinger (1970) in a critique of stellar evolution identified a few problems in the theory current over 20 years ago; we are recommending that this work be updated and expanded.

As stressed earlier, one of the first issues that should be discussed is how much change in stars should we be willing to grant. It is not prudent to come to a hasty decision on this subject. Stellar evolution computer codes begin with models of stellar interior structure, which in turn rely upon well understood and very quantitative laws of physics. Complete rejection of stellar evolution would erode confidence in current understanding of stellar structure and would seem to repudiate much of physics as well. If creationists wish to scrap stellar evolution completely, then it is incumbent on us to rework stellar structure and/or physics in a convincing fashion. The present authors are not entirely certain about what, if any, should be kept, and we welcome discussion with other interested parties on this subject.

A Synopsis of Stellar Structure and Evolution

A brief summary of stellar structure and evolution would be appropriate at this point. For further study the reader is directed to the following recent review by Iben (1991) or to the standard texts in the field: Clayton (1968), Cox and Giuli (1968), Kippenhahn and Weigert (1990), Novotny (1973) and Schwarzchild (1958). We will not discuss here the birth and early development of stars, but instead start during the stable part of a star's lifetime. The fundamental problems with stellar birth have been discussed previously and perhaps we will return to this issue in a future paper.

The standard observational tool used in studying stellar structure and evolution is the Hertzsprung—Russell (H-R) diagram, so called because it was independently discovered by two astronomers by those names early in this century. It consists of a plot of stellar luminosities versus stellar temperatures, with luminosity increasing upward and temperature increasing to the left. Both quantities are plotted logarithmically. A schematic diagram is shown in Figure 1.

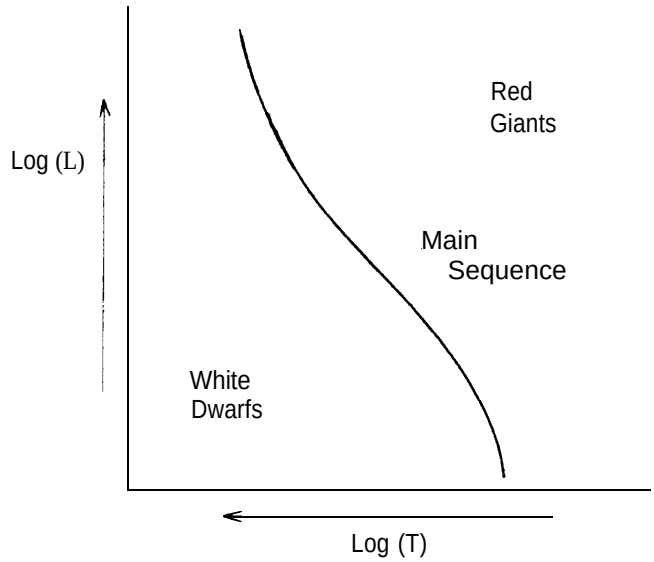

Figure 1. Schematic Hertzsprung-Russell Diagram. L is star luminosity; T is temperature.

Most stars are found on a roughly diagonal band called the main sequence (MS), while some stars are found in the upper right part of the diagram and a few are found to the lower left. The former are called red giants, while the latter are called white dwarfs. These names are appropriate because of the colors of these stars (reflecting temperature) and their sizes, which can be deduced with the following equation:

$$L = R^2T^4,$$

where L is a star's luminosity, R is the radius, and T is the surface temperature, and all variables are in solar units (L = R = T = 1, for sun). Notice that the above equation is very strongly dependent upon the temperature: a star to the right of the HR diagram has a low temperature and hence should have a low luminosity, while a star to the left has a high temperature and so should have a high luminosity. Stars to the upper right and lower left violate this trend, and this can only be if they are very large and very small respectively. White dwarfs are about the size of the earth, about 100 times smaller than the sun, while red giants may be hundreds of times larger than the sun.

A stellar interior model gives quantitative values of several physical quantities, such as temperature, density and pressure, at regularly spaced intervals inside a star. There are several assumptions, such as spherical symmetry, hydrostatic equilibrium, thermal equilibrium, an equation of state, nuclear energy generation processes, and radiative and convective energy transport. Each of these principles comes from well understood physics and finds applications in other fields. The equations can be expressed in differential form and must be solved simultaneously with boundary conditions that the star has the observed luminosity and temperature at its surface. Because the solution relies upon the use of a numerical integration scheme, much progress has been made since the invention of modern computers.

Early in the development of astrophysics the Russell-Vogt theorem was proved, which states that the struc-

ture of a star and hence its location on the H-R diagram is determined by the star's mass and composition. Further, it was shown that MS stars are consistent with models of stars having general cosmic abundances (mostly hydrogen and helium, with only a few percent by mass of everything else) and deriving their energy from hydrogen to helium conversion in their cores. Creationists have described possible gravitational contraction of the sun and other stars (DeYoung and Rush, 1989). This may indeed occur in certain stars, but the extreme temperature and pressure of stellar interiors assures that nuclear fusion is a major energy source. Even with only simple models this can be shown, as well as several predictions about the MS. First, the most massive stars are found to the upper left of the MS, while the masses gradually decrease toward the lower right. Furthermore, there should be a relationship between the mass and the radius (M-R relation) and a relationship between the mass and the luminosity (M-L relation). Stellar masses can be determined from studying binary stars, while radii and luminosities can be deduced from a couple of different methods each. Good observational data exist for a few score MS stars, to which the three model predictions above agree quite well.

This agreement is quite impressive and the physical assumptions that go into it are so well founded it is doubtful that many creationists would have much to argue with in MS stellar structure. However, what is generally called post MS evolution is not far removed from the brief outline of stellar structure given above. As thermonuclear reactions occur, the composition of a star will gradually change with time. A grid of stellar interior models for a given mass but reflecting the composition changes shows the gradual development or evolution that one would expect from the models. It would appear that acceptance of stellar structure involves a step or two down the slippery slope to which Mulfinger's quote referred. With that warning, let us turn to post MS development as suggested by stellar structure. We are not denying that stars were made on the fourth day of creation, complete with variety and maturity. This view of an instantaneous, fully functioning universe can readily be built into a creationist model of astronomy. The point that stars, in whatever initial stage of development, will naturally change due to energy considerations, if time permits. The rate of change, of course, is a critical variable of great interest to creationists.

Recall that the Russell-Vogt Theorem states that a star's mass and composition determine where a star is located on the H-R diagram. On the MS the compositions of stars are believed to be about the same (mostly hydrogen and very little of elements heavier than helium), so that mass is the only important determinant. Eventually all of the hydrogen in a star's core will be exhausted, and conversion to helium will commence in a shell surrounding the core. Without a nuclear energy source and accreting matter, the core will slowly contract, increasing the density and temperature of the helium core. Note that the composition has been radically changed from that of originally being nearly all hydrogen. The contraction and heating of the core will cause the outer layers to expand and cool, so that the star will move to the upper right in the HR diagram and become a red giant.

How far a star progresses past the red giant phase depends upon how much mass it has. Most stars have enough mass so that the temperature and density of the core increases until helium begins to fuse in the triple alpha process, called such because three helium nuclei (alpha particles) come together to form a carbon nucleus. With a renewed nuclear energy source, the contraction of the core is reversed for a while and the outer layers are restructured so that the star moves back down toward the left in the H-R diagram to a horizontal branch above the MS. Eventually the helium in the core is exhausted, and hydrogen to helium and helium to carbon fusion occurs in shells concentric with the carbon core. The process of core contraction is repeated and the star once again swells to a red giant along a path called the asymptotic giant branch. The most massive stars may pass through successive steps of fusing helium nuclei with increasingly more massive nuclei up to iron. Beyond iron, fusion reactions are generally endothermic (requiring energy) and so cannot be tapped as a fuel source for stars. Note that these transitions have not actually been observed. However, they are based on physics principles and will naturally occur. The lifetimes and rates of change of star stages might be a fruitful area for creationists to challenge current models.

About 35 years ago it was realized from the models that the cores of some of the giant stars should be electron degenerate, which suggested that these stars may be progenitors of white dwarfs. Degeneracy arises with great density, when electrons move freely in the stellar core. The atomic nuclei themselves are tightly spaced in a regular crystalline lattice-like arrangement. Twenty years earlier it had been demonstrated that electron degeneracy pressure could account for the very compact structure of white dwarfs (Chandrasekhar, 1939). It was felt that if the outer layer could somehow be ejected, then the core left behind would be a white dwarf and we would have a plausible explanation of their origin. Observations of red giants reveal that they experience large outward "winds" that can cause large mass loss over some time. Furthermore the relatively small surface gravity of red giants would allow for any instabilities to remove mass at a great rate. The exact mechanism is not quite known, but most astronomers agree that a red giant can eject a large amount of mass at some point, leaving behind a white dwarf that is surrounded by the ejected gas that we would see as a planetary nebula. In the past 25 years a picture has emerged for the most massive stars: their electron degenerate cores exceed the upper limit (1.4 solar masses) that electron degeneracy can support, and the resultant collapse to a neutron star or black hole gives rise to the explosion of a type II supernova.

Observational Predictions of Stellar Evolution

The theory of stellar evolution only briefly summarized above can be used to make some predictions that can be tested by observations. A back of envelope calculation can be done to determine how long a star will remain on the MS if the assumptions above are correct. It is generally assumed that about 10 percent of a star's mass is in the core and hence available for nuclear processing. Most of that material (more than

70 percent) will be hydrogen, and we know that 0.007 of the mass will be converted to energy when hydrogen is fused into helium. Using the mass and luminosity of the sun yields a MS lifetime of 10 billion years. More massive stars are higher on the MS, and though they have more mass available for fuel, their luminosities are so much greater that their lifetimes are significantly less. Less massive stars have somewhat less fuel, but their luminosities are much less, so that their MS lifetimes are much longer. The upshot is that the most massive stars have MS lifetimes of only a few hundred thousand years (of course, still much longer than young-age creationists would allow), while the lowest mass stars have MS lifetimes approaching 100 billion years.

Suppose that we consider a group of stars that form from a cloud of gas at about the same time, but having different masses. Because the cloud would be expected to be thoroughly mixed, the stars should have about the same composition. Exactly where the MS for such a group of stars occurs on the H-R diagram depends on the composition: a high metal abundance (elements heavier than helium in astronomy parlance) shifts it slightly to the upper right, while a low metal abundance shifts it slightly to the lower left. For a given composition, the locus of all masses where stars first appear on the MS is called the zero age main sequence (ZAMS). As stars "age" on the MS they will hook slightly upward to the right from the ZAMS, as shown in Figure 2. This is caused by the change in composition from the thermonuclear reactions occurring in the core. Upon the exhaustion of hydrogen in the core the star will move into the red giant region. Because of the greatly increased energy requirements of a giant star and the diminishing efficiency of post MS nuclear reactions, the lifetime of the giant phase is only a small fraction of the MS lifetime.

Notice that because the upper MS stars have the shortest lifetimes, they will be the first to turn off from the main sequence. The point at which this occurs is called the turn off point (TOP), and it will be located at progressively lower levels on the HR diagram

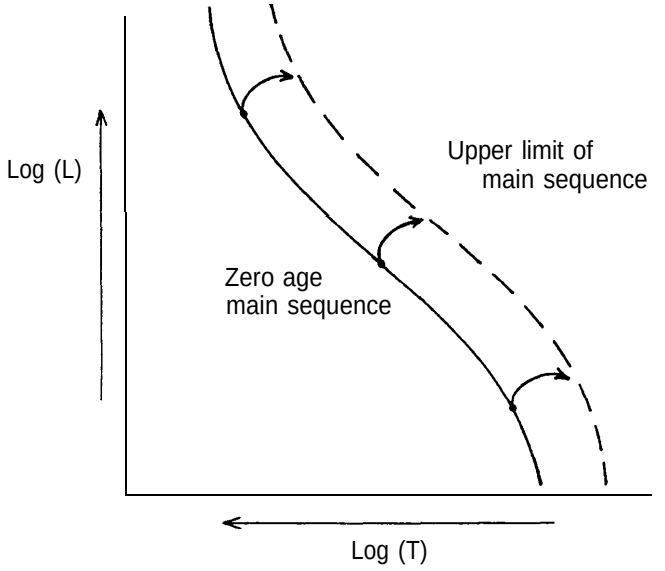

Figure 2. Theoretical path of stars from the Zero Age Main Sequence through the Main Sequence band.

with the passage of time. Therefore if a collection of stars having the same age and composition is compared to a different collection of stars having another common age and composition, the theoretical prediction can be compared to reality. If one is convinced of the basic correctness of the theory, then this method can be used to probe the ages of star clusters.

Where do we find stars of the same age and composition? An evolutionary assumption concludes that the stars in a star cluster should form from a single cloud so that the members represent such a homogeneous group. Different clusters should have different ages, and though they technically have different compositions, even large differences in composition do not seriously affect the overall appearance of an H-R diagram. Generally, the observations of stars in a cluster consist of colors and magnitudes, which must be converted to luminosities and temperatures. This process involves steps such as estimating the distance to the cluster, correcting for interstellar absorption and reddening from dust, and considering the effects of stellar atmospheres. This process has been done for a number of clusters, and the agreement of the theory is quite impressive, though one wonders how much the theory has been guided along by knowledge of the data to be fitted. Figure 3 shows schematic diagrams for a "very young" (100 million years) open cluster and a "very old" (15 billion years old) globular cluster. Note that the globular cluster has well defined red giant and horizontal branches. This is because globular clusters contain larger numbers of stars than open clusters and have TOP's in a region that show these features well.

Globular clusters are generally believed to be of about the same age (15 billion years) while open clusters are believed to have a much wider dispersion of ages up to 6 or 7 billion years. Additional arguments for the relative ages of the two types of clusters stem from kinematic and abundance studies, which spring from a general scenario of galaxy formation and history, which is an evolutionary model in itself. Stars that are now old formed early when gas was not confined to the galactic plane, while younger stars formed after gas collapsed to form the disk. Thus open clusters are found in the galactic disk and globulars are found in the halo of the galaxy. Because of the chemical enrichment of the interstellar medium that occurs when stars expel processed material when ejecting a planetary nebula or during the eruption of a supernova, stars that formed early would be expected to have low metal abundance, while later stars should have higher metal abundances. Such a trend between globular and open clusters is observed.

Evidence that the formation of planetary nebulae and the evolution of white dwarfs are related is usually given in the correlation of the estimated ages of those two types of objects. The structure of white dwarfs show that they cool over time, rapidly at first and more slowly as time progresses, and the rate is very similar for all white dwarfs so that the temperature roughly reveals the age. Spectroscopic measurements of a planetary nebula reveal how rapidly the gases in the nebula are expanding. If the size of the nebula can be measured, then the expansion can be extrapolated into the past to roughly reveal the age. These two ages have a very good correlation, that is, the

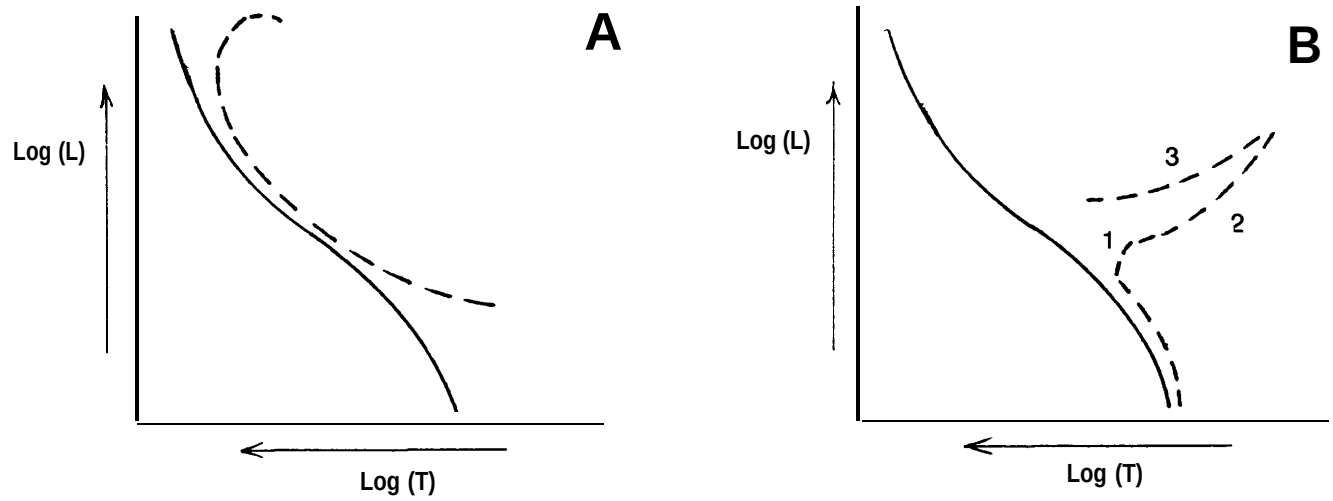

Figure 3. Schematic Hertzsprung-Russell diagram for a very "young" open cluster (A) and an "old" globular cluster (B). On each graph the zero age main sequence is indicated by a solid line and the turn off point by the number 1. On the globular cluster plot the Red Giant branch is indicated by the number 2 and the horizontal branch by the number 3. Note that the turn off point for the open cluster is much higher, and that its stars at the lower end lie above the main sequence.

younger planetary nebulae are associated with the younger white dwarfs, and the older planetary nebulae are associated with somewhat older white dwarfs. All planetary nebulae seem to have a white dwarf at the center, but not all white dwarfs are surrounded by a planetary nebula. How can this be? Planetary nebulae exist for only a brief time before the gases of which they consist are dispersed into the interstellar medium. The oldest planetary nebulae have estimated ages of only a few tens of thousands of years. On the other hand, white dwarfs last a very long time, virtually forever. So the white dwarfs that do not have an associated planetary nebula are simply old enough to have lost the nebula.

A similar relationship holds for neutron stars and supernova remnants. As with planetary nebula, the expansion velocity and observed size of the remnant can be used to estimate the time since the explosion. For example, the Crab Nebula has an age of about 950 years. and it has the same position of a supernova observed in the year 1054. The explosion of a supernova is believed to usually result in a neutron star, which is too small to be ordinarily observed. However, neutron stars generally emit beams of light from their magnetic poles, and the very rapid rotation of the tiny star causes a sort of search light of radiation to sweep out a conical shape. If we happen to lie near that cone, we can observe the periodic flashes of light, and the star is called a pulsar. Even with the seeming improbability of being situated near the cone, more than 300 pulsars are known, with periods on the order of a millisecond to a few seconds. The rotational kinetic energy is the source of energy for the beam, and so the period must increase with time. The rate of change in the period normalized to the period, or $\dot{P}/P$, is directly related to the pulsar's age. Where a pulsar can be identified in a supernova remnant, the ages of the remnant and the pulsar are well correlated.

Conclusion

Very brief discussions of stellar structure and evolution have been presented. Though it would seem that creationists would not have much with which to quarrel in the former, most would largely dismiss the latter. However, the two are intimately related, and one cannot be rejected without seriously calling into question the other. We are appealing to readers to give much attention to the study of stellar evolution, and we hope that much lively discussion follows.

A number of issues must be addressed. One of the most important is the question of how much change in stars should a creationist be willing to grant. Absolutely no change does not seem to agree with obvious observations. On the other hand, acceptance of most of the stellar evolution with its required vast ages is not acceptable. A related issue involves the time scales and rates of change which result from stellar models. These figures are certainly open to question, but the task is not simple. If competing creation models are to be presented, then sophisticated, original computer work lies ahead. Finally, the question arises upon what physical grounds will rejection of any part of stellar structure or evolution be done. This requires that an alternative be offered for each part, the sum of which should provide some guidance toward a creationist astronomy.

This is indeed a daunting task, one not to be taken lightly. We plan to publish further papers, but we certainly welcome correspondence from interested parties in the meantime.

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EROSION OF THE GRAND CANYON OF THE COLORADO RIVER PART I — Review of Antecedent River Hypothesis and the Postulation of Large Quantities of Rapidly Flowing Water as the Primary Agent of Erosion

EMMETT L. WILLIAMS, JOHN R. MEYER AND GLEN W. WOLFROM*

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Abstract

One interpretation of the erosion of the Grand Canyon is reviewed—the antecedent view of the Colorado River cutting through the rising landscape. It is postulated that rapidly flowing water laden with abrasive particles moving from higher regions into lower areas was the main erosive agent in the formation of the Grand Canyon and that this erosion occurred rapidly within recent times.

Introduction

The Grand Canyon defies description because of its immensity and barren beauty. Even more so its history and the origin of the Colorado River that runs through it have led to considerable speculation and many differences of opinion. When one sees different portions of the Canyon, one can understand why there is so much variation of interpretation. If one has seen only the eastern end of the Canyon at the visitor centers, he is in for a shock when he visits the western portions of the Canyon. (See Figures 1-4.) Such was the authors' reaction. In many aspects it is similar to viewing two different canyons. It takes hours of walking to reach the Colorado River in the eastern Canyon. Likewise trying to reach the Shiva Saddle from the North Rim with a limited supply of water in extremely hot weather is very difficult (Meyer, 1987; Meyer and Howe, 1988). By contrast, you can drive down into the western Grand Canyon through Peach Springs Canyon. One feels as if not enough energy has been expended to achieve the goal or he has not placed himself at sufficient risk!

Because of the barrenness of the region, (Figure 5) the geology of the various formations can be examined in detail if one can reach the area of study. This differs from so many areas in the eastern United States when only an occasional window (fenster) can be found to study the arrangement of the geological formations. Thus the Colorado Plateau has attracted many people to do geological work because of the abundance of opportunities for observation. Uniformitarian scientists as well as catastrophist scientists have studied the area. We review one of the interpretations as to how the Grand Canyon formed and postulate the major causative agent for erosion—rapidly flowing water. Later papers will discuss other interpretations of formation as well as other processes involved in the formation of the Canyon. In mentioning time estimates, the authors are quoting the opinions of various workers involved. We do not subscribe to the geologic timetable.

*Emmett L. Williams, Ph.D., 5093 Williamsport Drive, Norcross, GA 30092, John R. Meyer, Ph.D., 1300 Fairview Road, Clarks Summit, PA 18411, Glen W. Wolfrom, Ph.D., 5300 NW 84th Terrace, Kansas City, MO 64154.

John Wesley Powell's Views

The first widely accepted explanation of how the Grand Canyon originated was elucidated by Major Powell, a one-armed Civil War veteran who led an expedition by boat down the Colorado River in 1869. As Collier (1980, p. 34) claimed:

> Powell advanced the notion that the Kaibab Plateau rose against an already established Colorado River. The River would have cut through the Plateau like a stationary saw cuts through a rising log.

Or in Powell's own words (1961, pp. 89,90),

> . . . Over the entire region limestones, shales, and sandstones were deposited through long periods of geologic time to the thickness of many thousands of feet; then the country was uplifted and tilted toward the north; but the Colorado River was flowing when the tilting commenced and the upheaval was very slow, so that the river cleared away the obstruction to its channel as fast as it was presented, and this is the Grand Canyon.

Thus Powell believed that the Colorado River existed prior to the uplift [antecedent to the structures in the Grand Canyon area] (McKee, et al., 1967, p. v) originating as far back as Tertiary times (Blackwelder, 1934, p. 554). As Nations and Stump (1981, p. 88) state, ". . . Powell the first to run the Colorado River through the Grand Canyon . . . claimed that the river was there first and merely maintained its course as the Kaibab Uplift rose beneath it." Also this antecedent view was held by Dutton (1882). Likewise Usinger (1967, p. 187) seemed to support this view:

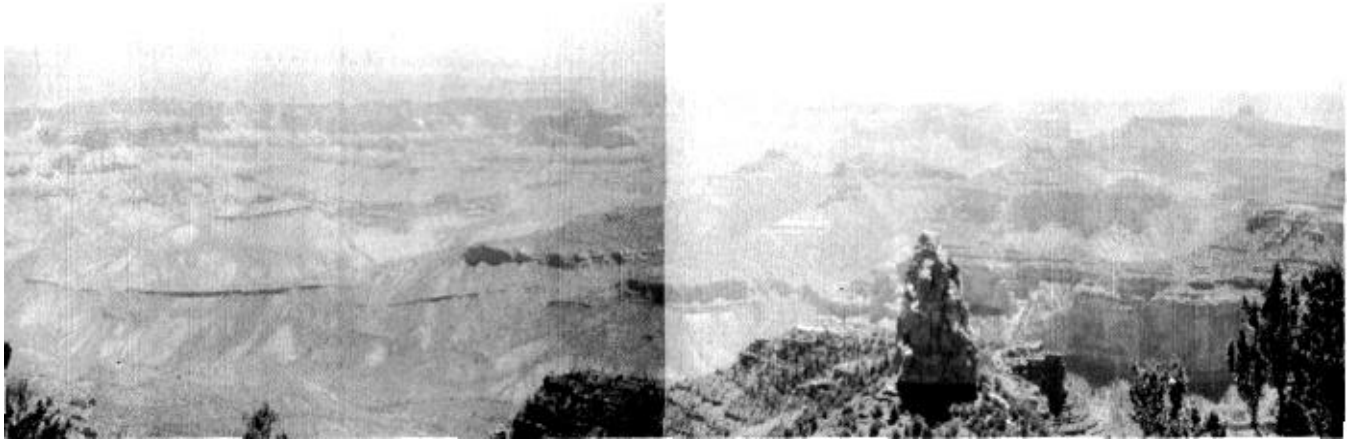


Figure 1. Panoramic view from Point Imperial Vista, North Rim, eastern Grand Canyon. Photographs by Glen Wolfrom

> . . . the site now occupied by the canyon (Grand Canyon) was a wide level plain traversed by a river that probably looked relatively placid. But then, as a result of a shifting of the earth's crust, the plain began to arch upward into a dome. As the land gradually rose higher and higher, the river cut constantly downward, carving a narrow ever-deepening scar in the earth.

Inherent in this view of the formation of the canyons of the Colorado River is the assumption that rapidly moving water when laden with abrasive substances can extensively erode consolidated sediments. This view needs to be explored and will be considered at this point.

Flowing Water, Erosion and the Grand Canyon

Powell, having risked his life exploring the various canyons through which the Colorado flowed, likely was impressed by the power of moving water as are all who have taken a boat trip upon the rapidly flowing stream. He (1961, pp. 390, 393) graphically stated:

> The carving of the Grand Canyon is the work of rains and rivers. The vast labyrinth of canyon by which the plateau region drained by the Colorado is dissected is also the work of waters. Every river has excavated its own gorge and every creek has excavated its gorge. When a shower comes in the land, the rills carve canyons—but a little at each storm and though storms are far apart and the heavens above are cloudless for most of the days of the year, still, years are plenty in the ages, and an intermittent rill called to life by a shower can do much work in centuries of centuries.

Powell discussed the erosive power of rapidly moving large quantities of water available from melting snows and infrequent rain storms in the arid climate of the Colorado Plateau in other places in his treatise (1961, pp. 28, 29, 46, 221, 223). Basically, given *enough time* the erosion caused by the flowing water containing silt and other abrasive material could carve the Grand Canyon. As Stokes (1989, p. 28) noted:

> It is not uncommon to hear a tourist give expression to the thought that the Grand Canyon is a fault or giant crack, opened by a great upheaval. But most persons with a little reflection can be convinced that everyday erosion, given enough time, could do the job.

Interestingly, Longwell, Knopf and Flint (1946, p. 68) mentioned as Stokes did that ". . . those who first speculated on its (Grand Canyon) history thought that the river had found a low-level course already prepared for it by a great gash or rift earlier opened by some cataclysm in the Earth's crust." However they attributed the erosive power of the vast amount of sediment carried by the Colorado River as the key to the formation of the Canyon (p. 68). They stated that the River carried 11,000 tons/hour of material past a given point as it drained an area of 230,000 mi^2. ". . . we find that the whole surface of this 230,000 mi^2 of country is being lowered at the average rate of one inch every 440 years" (p. 68). Stokes (1966, p. 42) estimated that the area of drainage by the Colorado River was 244,000 mi^2. Because of the large amount of sediment carried by the River, he conjectured that an estimated 142 million tons of sediment settled in Lake Mead every year until 1964 (p. 42). Since the construction of Glen Canyon Dam near Page, Arizona, the flow of the Colorado through the Grand Canyon has been reduced (Hamblin and Rigby, 1982, p. 8).

McKee (1985, p. 36), after noting that the average person often cannot comprehend the erosive power of running water, explained that:

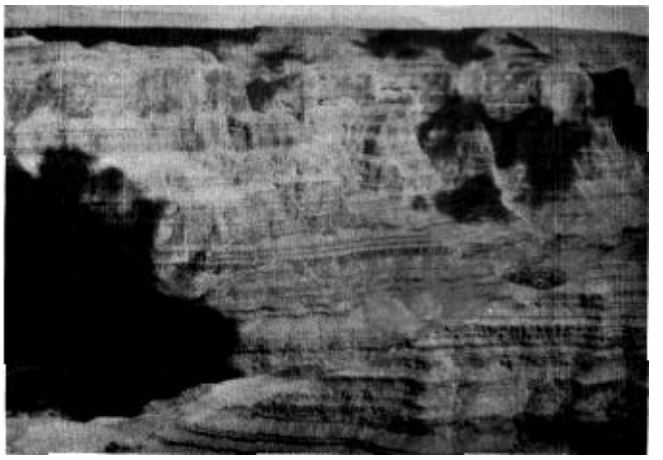
> The vast Grand Canyon, however, an extreme example of erosion, seems a bit too large—too wide and deep—to be attributed alone to the power of any river such as exists today. But the Grand Canyon—the greatest of chasms—is nothing more than the result of the work of running water over a long period of history.

McKee, who spent much of his professional career studying the geology of the Canyon region, felt that the arid climate and the very rapid down-cutting of the river had caused the development of the Canyon profile (1985, p. 37).

Rapid Erosion Possible

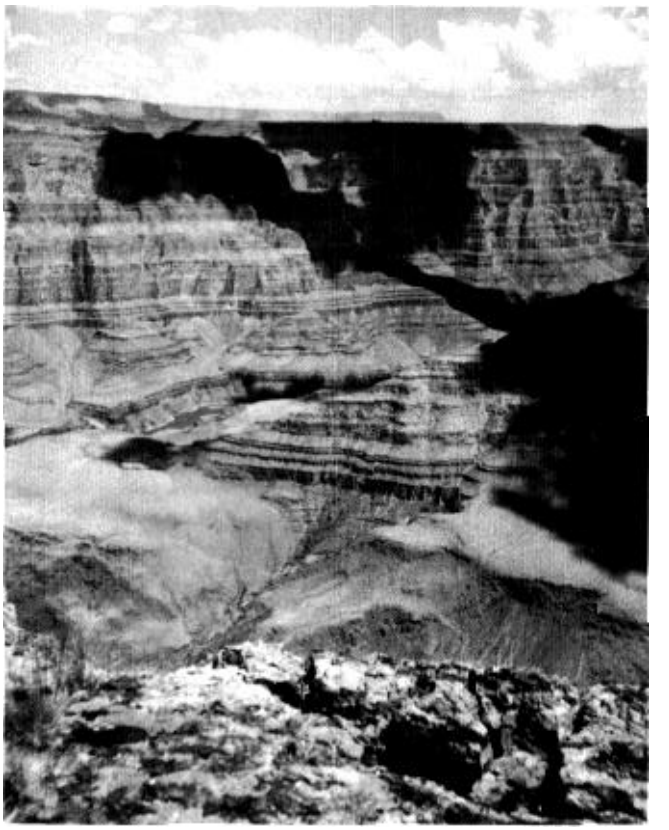
Morris, a hydraulic engineer, presented many examples of the destructive power of river water, particularly in flood conditions, including an instance observed

Figure 2. a. View from Quartermaster Viewpoint, western Grand Canyon, looking north. Colorado River can be seen in lower center of photograph. Photograph by Glen Wolfrom



b. Another view from Quartermaster Viewpoint, western Grand Canyon, Colorado River is in lower left of photograph in shadow. Photograph by Glen Wolfrom

in the Colorado River (Whitcomb and Morris, 1963, pp. 259-261). Also Austin (1984, pp. 179-180) discussed the formation of two extensive gorges in a Colorado River flood of 1905. Particular examples of rapid erosion and the catastrophic results have been noted in the Quarterly. Morris (1966, p. 53) mentioned the amount of sediment transported by the Mississippi River per year which relates to the erosive power of moving water. The "antecedent bed" of the Mississippi River, the transportation of gravel and the significance of deltaic subsidence in relation to the movement of large quantities of water was considered by Allen (1972, pp. 96-114). Also see Mehlert, 1988, pp. 121-123 for another discussion of the erosion and deposition capabilities of a large river. Burdick discussed (1970, pp. 143-144) the effects of flooding in the scablands of eastern Washington. Also see Allen, Burns and Sargent, 1986. The alteration of a cave during the flooding associated with hurricane Camille in 1969 in Virginia was noted briefly by Armstrong (1972, pp. 135-136). Also see Austin, 1984, p. 178. The unbelievable damage caused by 30 to 40 inches of rain in Nelson County, Virginia (a county of many narrow valleys surrounded by steep ridges) within a six-hour period was related by eyewitnesses (Williams, 1986, pp. 62-63). A team of geologists recorded the damage and stated:



c. Same view as b except reduced to illustrate distance between Viewpoint and Colorado River. Photograph by Emmett Williams

> Erosion resulted mainly from debris avalanches down the mountain-sides and channel scour along streams and headwater tributaries. Total amounts of sediment yield from certain mountainous areas in Nelson County were about 2-4.6 million cubic feet per square mile, probably the equivalent of several thousand years of normal denudation. . . . For drainage basins ranging up to about 1.5 square miles, the estimated storm-average sediment-transportation rates varied from practically nothing to as much as 172,000 pounds per second (7.4 million tons per day) [Williams and Guy, 1973, p. 1].

Compton, in discussing the James River system, also mentioned this remarkable flood damage in 1969 in Virginia (1977, pp. 23-46). This catastrophe could possibly be compared to what might have happened in the Grand Canyon area during its early erosion cycle when copious quantities of water cascaded down higher elevations into lower regions.

Lammerts (1974, pp. 101-103) conducted some field studies on the rapid formation of beaches and rounded stones by wave action at San Luis reservoir. Such erosional processes do not require long periods of time to grind and smooth even hard stones. See Austin (1984, pp. 180, 182, 184) for the erosion and other damage caused by catastrophic wave action. The horrible erosive action in Tsunamis (seismic sea waves), particularly in shallow water, was vividly described by D'Armond (1980, pp. 95-98). He conjectured on the possible erosion effects in the emerging stages of continents in the late stages of the Flood (or possibly

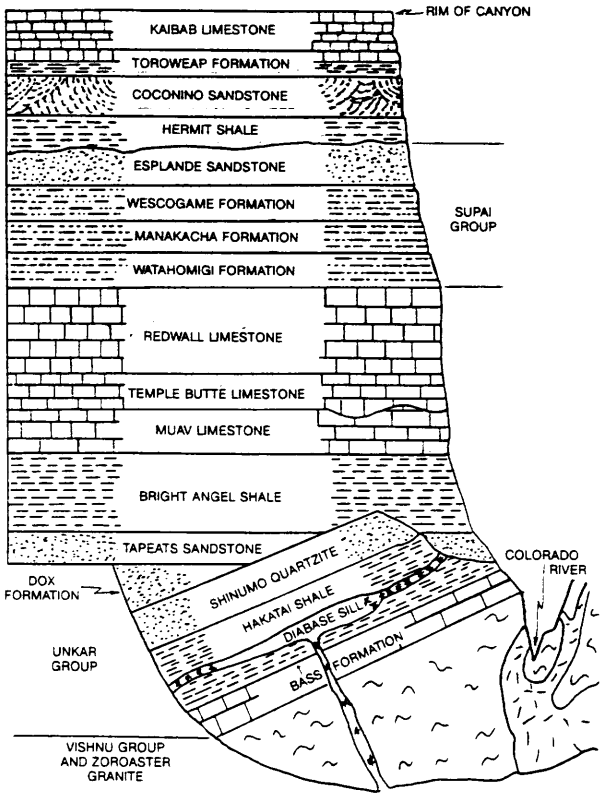


Figure 3. Idealized geologic cross section of the eastern Grand Canyon (after Breed, 1975).

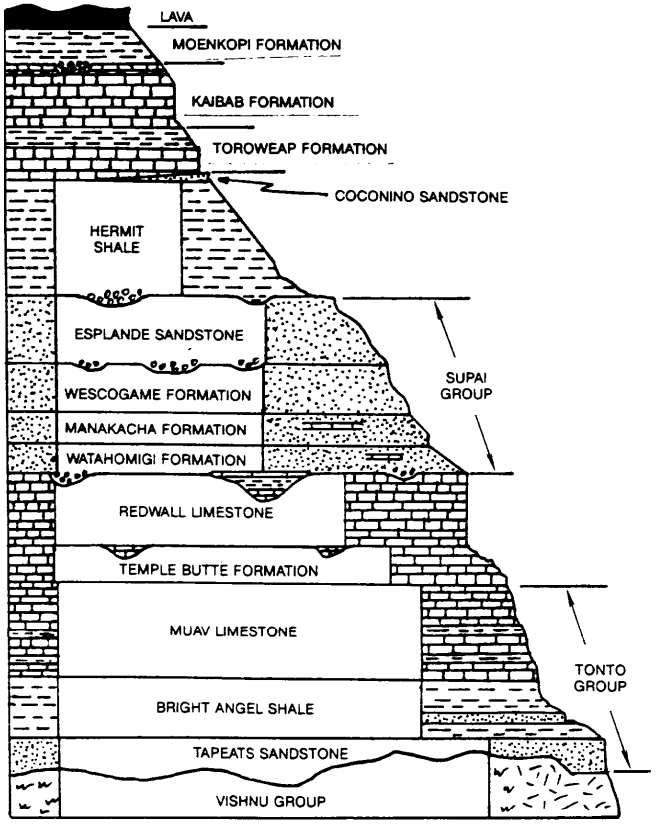


Figure 4. Idealized geologic cross section of the western Grand Canyon (after Billingsley and Breed, 1980).

as aftereffects of the Flood). For damage done by some tsunamis, see Austin (1984, pp. 181-185, 189).

The effect of floods on the filling of Yosemite Valley, including the erosion damage, was presented by Lammerts (1975, pp. 3-4). Water-action erosion of the Sierra Nevada mountain chain was discussed in a reprinted article (1978, pp. 164-165) by J. D. Whitney, California State Geologist from 1865-1882. Ur of the Chaldees was a seaport before rivers brought in considerable delta deposits "and left Ur high and dry in the desert" (Heinze, 1977, p. 87). Erosion by rivers was necessary to bring in such an enormous amount of sediment. Cox (1979, pp. 26-27) briefly elucidated the erosion of the Great Lakes basins, the Niagara Escarpment and the Finger Lakes of New York by the possible action of rapid currents of water. The rapid erosion of the Niagara Falls escarpment and St. Davids Gorge was carefully discussed by Daly (1974, pp. 177-181). Likewise Daly noted that Columbia Canyon probably was formed recently (pp. 181-182). It would be instructive to refer to Corliss' discussion (1988, pp. 136-138) on erosion of the Columbia River Plateau. Cox (1979, pp. 154-162) felt that the erosive action of rapid currents formed drumlins and was responsible for the shaping of recently deposited sediments. Also see Corliss (1988, pp. 132-136) for a discussion of drumlin anomalies.

In an important series, Holroyd (1990a, b) discussed the actual damage to reinforced concrete structures by rapidly moving water due to the process of cavitation. Large volumes of water rushing through tunnels to a lower level caused considerable damage to the concrete and adjacent sandstone. Such a phenomenon can develop in any rapidly moving water system. The author, in postulating damage potential for a Grand Canyon simulation made the following observation (1990b, p. 54):

> However, the harnesses of the rocks during the carving of the Grand Canyon might have been similar to those observed today and reflected in the present erosion profile. A catastrophic flow of water, such as might result during the capture of the Colorado River through the Kaibab uplift, might encounter similar profiles. The computer simulation shows that there are indeed locations for cavitation processes to greatly accelerate the removal of rock.

In a brief note Williams (1990, p. 96) mentioned two examples of rapid erosion. The Duna River excavated 2250 cubic meters of material in 24 hours and the granite pavement in a tunnel had to be replaced within a year because of erosion. Austin (1984) cataloged some other rapid erosional effects resulting from water catastrophes:

> The geological effects of hurricane Donna in south Florida, 1961 (pp. 175-176, 187)
> The geological effects of hurricane Cindy in Texas, 1963 (pp. 176-178)
> Erosion on Surtsey Island, 1967/68 (pp. 193-194)

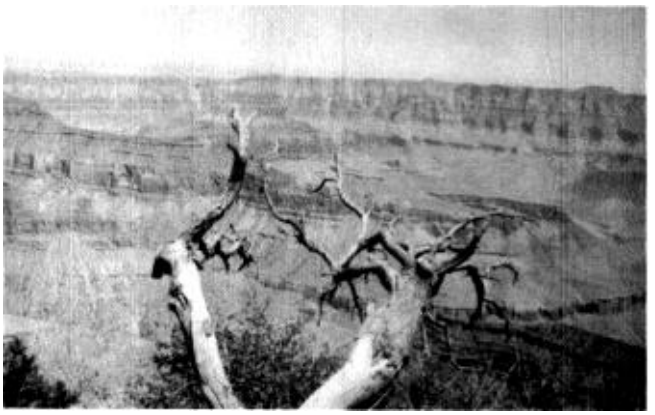


Figure 5. Barrenness of the region allows geologists to study the various formations in detail. View from Cape Royal Vista, North Rim, eastern Grand Canyon. Photograph by Glen Wolfrom

Erosion along Waiho River, New Zealand, 1965 (p. 194)
Overnight valley formation, San Nicolau, Brazil, 1974 (p. 195)
Rapid gulley erosion, Mount St. Helens, 1980 (pp. 196-197)

Frederick Dellenbaugh was a member of the team that accompanied Powell down the Colorado River on the second expedition (1871-1872). Acting as artist and assistant topographer, Dellenbaugh did quite a bit of exploring throughout the canyon country. He recorded (1988, p. 180) an example of rapid erosion near Kanab, Utah:

> While camped below Kanab, Clem and I in walking one day saw a place where the creek which flowed on a level with the surroundings suddenly plunged into a deep mud canyon. This canyon had been cut back from below by the undermining action of the falling water, and it was plain to see that it would continue its retrogression till it eventually reached the mouth of the great canyon several miles above, but I did not dream that it could accomplish this work as rapidly as it actually did years after. During a great flood it washed a canyon not only to Kanab but for miles up the gorge, sweeping away at one master stroke hundreds of acres of arable land and leaving a mud chasm forty feet deep.

Emmett Williams, George Howe and Norbert Smith, while doing some field work near the Grasslands Experiment Station in Oklahoma, observed a similar situation. A field of grain at Crowder Lake had been planted near a creek; however the edge of the field dropped abruptly approximately 30 feet to the creek bed. The grain was only about a few inches tall but an enormous gulley had been cut through the field about 25 feet deep by water draining across the field from a slightly higher elevation (Figure 6). The steep-sided gulley was quite wide and had destroyed about one-third of the grain field. This erosion developed by a drainage flow diversion when State Route 270 West was repaved. Any unconsolidated material is easily washed away by excessive water flowing over and through it when such a height gradient exists that increases the erosive power of the moving fluid.

Unless one has witnessed a rain storm in an arid climate, it is difficult to realize the potential damage capability of a "cloudburst." In July of 1990, Emmett Williams, George Howe and William Waisgerber were caught in a thunderstorm in the northwestern part of Big Bend National Park in the Chihuahua Desert. Deep streams developed rapidly in dry gullies actually

Figure 6. a. Looking down into steep-sided gulley near Crowder Lake, Oklahoma

b. Looking up from the base of steep-sided gulley. Photographs by George F. Howe

becoming raging torrents carrying abrasive materials from eroded deposits making roads immediately impassable. Considerable erosion is possible in a brief time span in such a situation. Thus in the Grand Canyon area in the past, large quantities of water moving over consolidated strata could have formed the various canyons *rapidly*. The literature cited in this section illustrates several possible mechanisms for quick erosion of both hardened and unconsolidated material. Powell was correct in his observations of the power of moving water but the time necessary to perform the canyon-cutting task was overestimated. Rapid erosion is possible as long as there is ample moving water available for the task. As in the formation of caverns in limestone (Williams and Herdklotz, 1977, pp. 197-198; 1978, p. 88), the critical factor is *large quantities* of water.

Austin, et al. (1992), in the finest creationist monograph in print on the subject of the Grand Canyon, devoted a chapter to the erosion of the area (pp. 69-91). Steve Austin who wrote this chapter pointed out the enormous amount of erosion that has occurred (pp. 69-70). Not only the canyon itself, but possibly 1000 feet of material on a vast plain that once was above the Canyon also may have been removed by erosion! He (pp. 79-81, 87-88) noted other catastrophic occurrences that illustrate the erosive power of large quantities of moving water—the failure of Teton Dam in 1976, the prehistoric Spokane flood and canyon formation in the Mount St. Helens area in 1980-1982. Austin (pp. 80-85) offered evidence for accelerated drainage in the past compared to the present water flow upstream from the Grand Canyon:

1. The present streams and rivers are "underfit."
2. Incised river meanders cut into hundreds of feet of sedimentary strata.

Austin (pp. 88-89) mentioned also cavitation, hydraulic plucking and hydraulic vortex action as possible mechanisms of rapid erosion in bedrock.

Although the erosive power of sediment-laden water probably is considered the most important factor in the formation of the Grand Canyon by uniformitarian geologists, other agents such as weathering, collapse, etc. will be discussed in a later article.

Geological evidence discovered in the first half of this century disproved Powell's antecedent view of the Colorado River on the Colorado Plateau. This evidence will be discussed in Part II.

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SYMPOSIUM ON VARIATION-XI**

VARIATION AND FIXITY AS SEEN IN CLIMATOLOGY

TED AUFDEMBERGE *

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Abstract

The climate involves many interlocking feedback mechanisms. Their complexity raises questions about current forecasts of climate change. The case is presented that built-in design limits any major climate change.

Introduction

There has been considerable interest lately in the subject of global warming and the greenhouse theory of climatic change. Computer models called general circulation models have been written to predict the effect that an increasing concentration of carbon dioxide in the atmosphere will have on the future climate of the earth. These without exception predict that the earth's average temperature will increase, anywhere from 1 to 5°C. Climatologists are puzzled when they compare these predictions to reality. The greenhouse theory of climatic change is so believable and predictions based on it are so straightforward that scientists are hard pressed to see where the models based on it are failing. Yet a study of the weather records for the last century from all over the world suggests that most of the predictions are on the high side.

A search of the literature indicates that explanations given by climatologists as to why the predictions are high fall into five groups. One of the five groups of climatologists is, I believe, of special interest to creationists. This group believes that feedback mechanisms are built into nature so that the earth's climatic environment will not change drastically, if at all. They conclude that for every positive feedback there is also a negative feedback or set of negative feedbacks that keep the earths temperature in its present equilibrium. Therefore there will be little, if any, global warming. These climatologists do not publicly state that they are creationists nor should it be construed from this paper that they are creationists, but their research does fit into the creationist model of limited variations in a created environment that is approximated by the average conditions found on the earth today.

There are three kinds of feedbacks in the earth's atmospheric system: positive, negative, and thermostatic feedbacks. What follows is a brief description of each with an example or two taken from the study of climatology.

Feedback

Feedbacks are changes that may cause a spiraling or "vicious circle" effect. A positive temperature feedback causes the temperature to become hotter and hotter. A negative temperature feedback would cause the temperature to become colder and colder. For example, a doubling of the carbon dioxide concentration in the atmosphere increases the amount of energy incident on the earth's surface by 5 watt/meter! If it were not for two positive feedbacks, this 2% increase in energy at the earth's surface would not by itself raise the earth's temperature very much. The feedback processes which double the warming effect of the increased carbon dioxide are: (1) the ice-albedo feedback and (2) the water vapor feedback.

The first case follows: A snow and/or ice surface has a higher albedo or reflectivity than a ground or vegetation surface; thus the latter surfaces heat more than an ice or snow surface. This in turn heats the air. The snow/ground and ice/water boundary is an equilibrium position whose location depends on the mean global air temperature. If the earth experiences greenhouse warming; the snow/ground, ice/water boundary will move poleward, exposing more land and water. This will absorb more insolation, thus causing the earth to warm, causing the snow/land boundary to move further poleward causing more warming, etc. At first glance this appears to be a positive feedback mechanism which will continue to escalate until the earth warms to the point that there is no permanent snow or ice on the earth. This is, in fact, how this feedback is treated by most climatologists.

Ellsaesser (1984), however, believes the ice-albedo feedback is overestimated, if not actually of the wrong sign. In other words, he thinks the feedback may be negative rather than positive because ice and snow have a strong insulating effect. Therefore he reasons that an ice or snow cover reduces the wintertime loss of latent and sensible heat. This represents a warming for the earth. Thus global warming which would reduce the snow and ice cover would in the long run cool rather than warm the earth and be a negative feedback rather than a positive feedback.

There is a second feedback which is thought to double the warming effect of increased carbon dioxide. Water vapor in most instances is part of a positive feedback loop. The warmer the air, the more water will evaporate, This water vapor then absorbs terrestrial radiation which, through a chain of events, heats the air, which in turn causes more water to evaporate. When this positive feedback is built into general circulation models the estimated global warming is approxi-

*Ted Aufdemberge, Ph.D., 9020 Gross Road, Dexter, MI 48130.
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mately double the warming predicted when only the carbon dioxide concentration is increased and this feedback eliminated.

Water vapor under the right conditions condenses to form clouds. Thus it is also involved in a negative feedback loop. When this is taken into account along with the positive water vapor feedback mentioned above, the combination creates a thermostatic feedback chain which causes the temperature to go back and forth around an equilibrium temperature. The warmer the air, the more vapor it can hold and the more vapor the air can hold, the more cloud droplets can form. The more cloud droplets there are, the more insolation is reflected. This cools the earth, which reduces the evaporation, which reduces the cloud cover, which allows more radiant energy from the sun to warm the earth, and round and round it goes. This thermostatic feedback is complicated by the fact that clouds also reflect infrared radiation back to earth where it is reabsorbed by the earth's surface, which warms the earth. It should also be noted that instead of warming the earth this back radiation can be stored in plant material through photosynthesis or it can be stored as latent heat of vaporization, if and when it evaporates water. In these two instances the energy is taken out of the system for a longer or shorter time. In the first case the greenhouse gas carbon dioxide as well as energy is removed from the system.

Until recently it was thought that the positive and negative feedback of clouds balanced out and thus could be ignored in the climatic models. Or if the positive feedback won out, clouds could be treated as a greenhouse gas. Recent satellite radiation measurements taken as part of the Earth Radiation Budget Experiment (ERBE) now indicate that it is the negative feedback that dominates (Ramanathan, et al., 1989). This net cooling effect is greatest over the mid and high latitude oceans. This is just where the standard general circulation models predict the greatest warming. They therefore conclude that clouds have a net cooling effect on the earth and that small changes in cloud-radiative forcing fields can play a significant role as climate feedback mechanisms. It will be interesting to see if this conclusion can stand the test of time.

There is another thermostatic feedback chain. Because carbon dioxide dissolves more easily in cold water, global warming should cause more carbon dioxide to be released. This should warm the earth through the "greenhouse" process, which should release more carbon dioxide from the oceans, which should cause the temperature to spiral upwards. There is, however, some research that indicates that the starting premise is not true. Taro Takahasi (Anon., 1987) of the Lamont-Doherty Observatory of Columbia University tested samples of water taken from the North Pacific and found that most carbon dioxide is absorbed during the summer months. Present wisdom expects just the opposite to occur. Takahasi suggests two reasons for this unexpected turn of events: (1) Photosynthesis by plankton is greater in the summer consuming more carbon dioxide, and (2) during the summer months when the surface layers of the ocean warm, convection currents, which normally bring carbon dioxide to the surface are suppressed. If this explanation is verified, the assumed positive feedback will have to be treated as a thermostatic feedback which would work as follows: The warmer the earth gets, the more carbon dioxide will be consumed, which will cool the earth, which will increase carbon dioxide, which will warm the earth and will cause carbon dioxide to decrease, which causes the temperature to go up and down around some equilibrium temperature.

Certain phytoplankton excrete dimethylsulfide (DMS) into sea water. Part of this DMS enters the atmosphere and oxidizes to form sulfate aerosols which serve as condensation nuclei for cloud droplets. The clouds thus formed reflect isolation. In addition cloud droplets formed on DMS condensation nuclei are more reflective than droplets formed on other condensation nuclei. The thermostatic feedback occurs as follows. Global warming increases phytoplankton growth, which increases DMS. This increases the number of cloud droplets which increases the albedo. Warming decreases, which decreases phytoplankton growth. DMS decreases, which decreases the number of cloud droplets and decreases the albedo, which warms the earth and the temperature again goes up and down (Gribbin, 1987; Andreae, 1989).

Lindzen (1990. pp. 292-297) contends that as carbon dioxide increases it acts as a greenhouse gas warming the atmosphere. This increases convection, creating cumulo-nimbus clouds which carry warm moist air from the lower to upper troposphere. During this process the air cools to below the dew point. This removes its moisture which eventually precipitates. This combination of processes fills the upper atmosphere with dry air which allows the latent heat removed from the earth and released above most of the greenhouse gas to radiate to space, cooling the earth. This set of processes represents another thermostatic feedback.

There are other feedback loops involved in global warming which involve the atmosphere/ocean system and the atmosphere/vegetation system. One is described by Bakun (1990): Global warming takes place, which increases coastal ocean upwelling. Fogs increase near desert coastal areas, which increases aridity inland and may promote sedimentation of unoxidized organic matter. This would decrease the atmospheric carbon dioxide concentration causing cooling because the greenhouse effect would be reduced.

The presence of these thermostatic feedback loops in nature lend broad support to the creationist view that the environmental variability found today in nature is limited. That this limit to variability lies within a range that is suitable for human existence supports the view that the earth was created as the home environment for man.

Conclusion

One ought not draw the conclusion that, since the world has these self-regulatory cycles, we need not be concerned about the increasing concentrations of greenhouse gases in the atmosphere. One should indeed be concerned about this and make every effort to decrease the level of greenhouse gases or at least keep the level from rising. This is especially true of those greenhouse gases that are not part of the created, natural order. There are much more pressing reasons than

the possibility of global warming to limit the production of carbon dioxide. The foremost is that fossil fuels, the primary source of carbon dioxide, are non-renewable resources which are vital to modern Western civilization.

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SYMPOSIUM ON VARIATION—XII

THE LIMITS TO VARIATION

J. B. JONES*

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Abstract

Variation can be readily observed within species and can be shown to be involved in speciation through mechanisms such as random change occurring in the genome, and selection pressure acting on populations. However, there is no evidence that "missing links" occur and punctuated equilibrium theory, while providing an explanation for this, does not provide proof that "evolution" has caused the changes required to create new phyla.

Variation

There can be no doubt that considerable variation occurs within species. Variation in morphology is apparent in man (e.g., color, fingerprints, eyeshape) and selective breeding of pets and livestock has been practiced since before records began. Perhaps the most obvious example is provided by the many varieties of domestic dog which are all one species (whether Great Dane or Chihuahua) and which can often interbreed now only with the intervention of man. Yet from the time of Aristotle western scientists have generally perceived that the living world is highly ordered in a hierarchical system despite the variation. Nearly all the great biologists who founded comparative anatomy, taxonomy and paleontology, such as C. Lyell, R. Owen, G. Cuvier, C. Linnaeus and L. Agassiz, adhered strictly to a discontinuous topological model of nature. However, from the 1860's evolutionary biologists, building on Darwin's ideas, have been claiming that the same pattern provides support for organic evolution. This is the concept of species change by the natural selection of heritable differences which arise at random in each generation.

With the development of genetics and more recently molecular biology, the complex changes in genes and DNA sequences that drive genetic and thus phenotypic variation have been revealed. This has provided the mechanism upon which the concept of gradualistic non-random evolution has become firmly established. The theory, perhaps better described as a metaphysical dogma is now known to its followers as "Neo-Darwinism" or the "Synthetic theory."

*J. B. Jones, Ph.D., 11 Seine Street, Wellington, New Zealand.

Although there has been much debate about Darwinism as a philosophy, even within the scientific community (e.g. Halstead, 1980, p. 215; 1981, p. 403; Eldridge, 1986, p. 54; Perutz, 1986, p. 36)), there is no doubt that at the species level at least "micro-evolution," in the sense of change, has occurred. Clear and unambiguous sequential arrangements of DNA can be reconstructed to show the process by which new genes arise. Because of their much faster generation times, change is best seen in micro-organisms and in smaller invertebrates such as copepods where, for example, studies of the segmentation and setation of the limbs has enabled extensive lineages of species to be traced to taxonomic levels above that of Order. Comparison of genera and species of fish and their parasitic Copepoda from New Zealand and Australia led Jones (1988) to strongly suggest that the New Zealand copepod parasite fauna was derived from the Australian with subsequent speciation. Among vertebrate groups, an example of species formation among birds is provided by the phenomenon known as circular overlap. The following example is provided by Denton (1986, p. 81). In Europe there are two species of gull, *Larus argentatus* (the herring gull) and *L. fuscus* (the black backed gull). These distinct species co-occur but do not interbreed. Further to the east, in Russia, the herring gull does not occur. The black backed gull becomes increasingly unlike the European type but resembles the herring gull until in the United States the herring gull only is found.

Mechanism of Variation

Given that variation does occur and can lead to differentiation at the species level, what is the mech-

anism by which it happens? Neo-Darwinian theory proposes the concept of "natural selection" or the gradualistic selection of advantageous mutants by environmental selection pressures. However, the development of the Neutral Theory by Kimura in 1968 (see Kimura 1985, p. 41) proposed that the majority of evolutionary changes at the molecular level are caused, not by Darwinian selection but by the random fixation of selectively neutral, or nearly neutral, mutants. The most important evidence for this theory was the discovery of "pseudogenes" or genes that had lost their function. In these "dead" genes it has been estimated that the "evolutionary" rate (the change in DNA sequence) is much faster, by about a factor of 10, than in the normal genes. If change is caused by natural selection of the fittest, it is difficult to see why the functionless genes should be evolving so fast. But neutral theory maintains that in a pseudogene all mutations are neutral, occurring at random and accumulating over time. Change is slower in normal genes because many mutations are deleterious to function. We also know that the cells can incorporate bacterial and viral DNA. For example McKenzie (1990, p. 14) explains that schistosomes can incorporate genes from retrovirus, while Chesnick and Cox (1986, p. 291) provide a review of bacterial symbiosis in cells. There is now strong evidence from RNA comparisons that plant chloroplasts and cell mitochondria were once symbiotic bacterial cells (see Gray, 1984, p. 693).

It should also be noted that the inheritance of acquired characteristics, proposed by Lamarck and vigorously attacked by evolutionists, has not yet been disproved. The evidence that animal populations can change their phenotype in response to the environment is well established. A good example is provided by Lindsey (1981, p. 1497). Until we understand the mechanism we are in no position to dogmatize about the effects of the environment on the genome. Lamarckism has always been an anathema to Darwinists (Maddox, 1981). The apparent ability of the bacteria *Escherichia coli* to generate beneficial mutations in response to the environment, reported by Lewin (1990, p. 15), has again fueled this debate.

Are There Limits to Variation?

There is no evidence that the major divisions in nature can be crossed by the processes just discussed. There is obviously an enormous difference between the speciation in fruit flies and the hypothesized development of birds from reptiles. Agassiz, for example held that all variation was merely variation on an underlying theme or design that was fundamentally immutable: all birds are equirepresentative of Aves; hair is unique to mammals. These limits have also been recognized by Neo-Darwinists. The problem of the "missing links" is as real today as it was in the 1860's. Even 130 years of searching have not produced one convincing example, despite the requirement for a graduation of intermediate forms between phyla which gradualistic evolutionary theory would require. Moreover, many of the sequences of fossils that have been assembled seem to have started simultaneously or in groups of sequences that suddenly "jump" to new series (e.g., the Cenozoic mollusc sequences reported by Williamson, 1981, p. 437) from the Turkana Basin. These jumps, or "Punctuated Equilibrium Theory," which does away with the need for missing links, are a direct contradiction of Darwin's assertion that nature does not make jumps. The theory was vigorously attacked by Darwinists. More recently with the development of the idea of genes switching on and off, and of mathematical models that show that bursts of rapid change following long stable periods are consistent with classical Neo-Darwinist mechanisms, including selection, the theory has been absorbed into the dogma of Darwinian evolution as explained by Lewin (1986, p. 672). Though punctuated evolution theory explains how the observed changes in the fossil sequences might have occurred, it provides no evidence that they actually occurred through Darwinian selection mechanisms. Indeed the magnitude of the sudden changes required to put into place new organ systems strain credibility. Crawley (1985, p. 1463) cites an excellent example. The development of complex structures such as the eyes of the Australian female net casting spider which work at an aperture of f/0.58 with perfect chromatic and spherical aberration correction cannot be explained by evolutionary theory which would have gradual change from a simple to a complex eye while maintaining perfect vision throughout the series.

A Personal View

A basic problem is the lack of any coherent alternative theory. Any such theory must not only fit the observed facts but must also have a predictive capability such that it fits new facts as they emerge. This creationists have failed to do. It is easy to pick holes in other theories, but evolution, with all its faults, offers a comprehensive (if incomplete) explanation of observed variation and a framework in which new discoveries in genetics and molecular biology can be tested. However, I recognize that evolution fails to provide answers on a microbiological scale. What I believe to be happening is the occurrence of a form of classical typology. Fixed "kinds" (corresponding more or less to phyla) occur within which variation occurs by random mutation, genetic recombination, gene switching and environmental selection pressures (in a sense, a fall from the original genome). Within "kinds," change in species can be monitored and phylogenetic 'trees' constructed. In this way the complex and highly modified parasite fauna, especially the parasitic Copepoda with which I am familiar, such as *Sphyrion* or *Mugilicola)* can be traced back to free-living ancestral forms. Reptiles never have, and never will "evolve" into birds nor will fish become apes. There are no missing links. Where the "kinds" came from can be explained by several theories, such as polyphyletic evolution, but I prefer to ascribe their origin to an act of Original Creation.

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SYMPOSIUM ON VARIATION—XIII

THE LIMITATIONS OF VARIATION

G. RICHARD CULP*

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Abstract

Variation is a normal characteristic of living organisms, and the operation of the laws of chance under natural conditions maintains the stability of these respective kinds. It is necessary to prevent natural conditions in order to produce and maintain new strains of livestock and vegetables, and the new varietal characteristics would usually hinder survival in the wild state. The effect of the gene pool is noted in variations in color, including albinism and melanism. Unusual Australasian forms are discussed in the light of the fossil record. Other variables include bird life and isolation, and human disease resistance. The relationships of environment to variation are discussed in reference to animal size, climate, elevation, degrees latitude, high temperature, salinity, moisture, aridity, and geographic distribution, along with the limits that can be endured by living organisms.

Introduction

Variation refers to a deviation in the structure or character of an organism from that of the majority of others of the same species or group. Variation is one of the features in the plant and animal world which magnify the beauty and intricacy of the handiwork of God. *Speciation* is more difficult to define, inasmuch as this term implies an assumed development of one species into another. The distinction of whether one organism's deviation from another is sufficient to constitute a new species is a subjective and controversial one with scientists, even with evolutionists who disagree where to draw the line to indicate a different species. Thus the term *kind* may be more significant than that of *species*, and is frequently used in the vocabulary of creationist biologists. The extent of variation among plants and animals, and the factors that limit variation, constitute a vast subject. This study is therefore limited to comments on the gene pool and some important environmental factors.

The Gene Pool

Variation according to traditional evolution depends on the "laws of chance." For example, for every random gene for longer legs, one for shorter legs should appear also. The result is that the overall effects of these are cancelled and the status quo tends to be preserved. These extremes usually cannot survive without other genes being present to compensate the effect of the new character. Shorter legs will result in slower running, and longer legs may compromise balance on difficult terrain, so larger animals with deviant characteristics will be more easily captured by predators and smaller ones by birds of prey. There are some animal kinds in which the population has always been short-legged as indicated by the fossil record. Thus alpine species are relatively short-legged, and those which dwell in subterranean burrows are *quite* short-legged. Animals which have been long-legged as far back as geological evidence can be found are equipped to inhabit plains, steppes, and particularly the African savannas, and are well equipped to avoid their predators by their sheer speed.

Some evolutionists have conjectured that the huge Irish elk, which had an antler spread of up to 11 feet, developed its size and large antlers by evolution, to the point where it suffered extinction by having its antlers caught in the foliage of trees (Figure 1). Not only is there no evidence for this, but such thinking is inconsistent. According to the teaching of the survival of the fittest, it could not gradually evolve an antler larger than that which would be optimal for survival. In contrast, extinction by a *sudden* environmental change would give evidence for catastrophism.

Variations which provide more significant differences, or *sports*, are sometimes claimed as evidence for organic evolution. Examples include sweet Concord grapes, hornless cattle, short-legged sheep, "double" flowers, and new varieties of seeds (Fenton, 1972, p. 332). A second look at this list, however, indicates that these characteristics would not last in the wild, as all of them compromise the species' chance of survival. For example, the Concord grape, while serving mankind as a superior grape (particularly when used fresh), is much less insect- and disease-resistant

*G. Richard Culp, D.O., P.O. Box 1187, Middlebury, IN 46540.

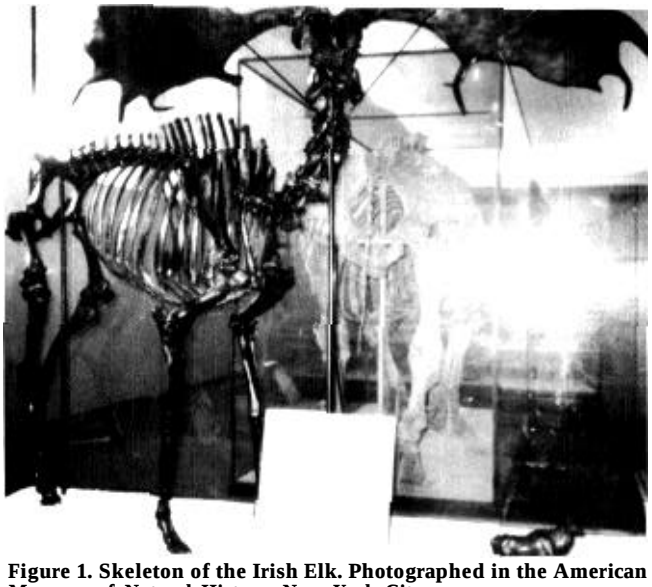

Figure 1. Skeleton of the Irish Elk. Photographed in the American Museum of Natural History, New York City.

than the northern fox grape *(Vitis labursca)* from which it stems. Obviously, a hornless strain of cattle would be at a distinct disadvantage in warding off predators in the wild state.

The fine tomatoes we have developed have been selected for characteristics which decrease their survival in the wild. Large size, tender skin, few seeds, juiciness, and flavor all make them more susceptible to the ravages of insects and disease. We need to go back to the wild tomato for breeding in disease resistance. The same is true of domestic animals such as dairy cows. Further, the only way that the new varieties can be maintained is by artificially *preventing* natural selection. That is why the dairymen must carefully maintain the blood lines in sire and dam, and the tomato breeder must cover his blossoms to prevent random pollination. Otherwise the cows revert to scrub cows, and tomatoes revert to small, less desirable tomatoes with more wild characteristics.

Variation in Color

Variation in color contributes much to our enjoyment of wildflowers and bird study. Some examples of these are the swamp rose-mallow *(Hibiscus palustris)* which is usually white with a crimson center, pure light pink, or pink with a crimson center, although pure white and pure dark pink can be found (Figure 2). Occasionally a dark red with smoother petals can be found, but the petals are more strap-like and somewhat defective. Likewise the alien chicory *(Cichorium intybus),* although usually blue, can often be found with white and lavender variants growing among them.

Striking examples of color variation are found in pure albino animals and birds with pink eyes and pure white fur or feathers. These are usually rare and are at a disadvantage to survive, because the absence of pigment in the retina causes poor vision and makes one stand out from its environment. Also, other animals or birds tend to pick at it and threaten it by assault. In the arctic some animals that are not true albinos are white all year; others only in winter. The arctic wolves on Ellesmere Island, at the very northern tip of Canada, are white but do not have pink eyes. However, they are the same species *(Canus lupis)* as the black and gray wolves found in Alaska, Siberia, and the lower United States. Polar bears also have uniformly white fur with a tinge of yellow, and dark eyes and nose. White squirrels are resident in Olney, Illinois where complete protection perpetuates inheritance of the trait. Many arctic species are white only in winter, becoming brown in the spring and summer.

Similarly, the Cuni Indians, inhabiting the San Bias Islands off the east coast of Panama, have the highest proportion of human albino births in the world, 7%. This percentage is maintained somewhat artificially by favoring the albinos in family and tribal relations, and also by tribal law which prohibits intermarriage with whites. Albinism is caused by the presence of *inhibitor* genes which prevent the formation of the pigment called melanin.

Many degrees of partial albinism, with large white areas mingled with darker areas, can be found in animals such as blue-eyed white bison, white-tailed robins, and mule deer with large white areas in the hide. In the same family one mule deer may be approximately one-half white and the other one-fourth white (Figure 3). Albinism in plants, such as corn, is lethal because of the absence of chlorophyll, except where the plant is saprophytic as in the Indian pipe *(Monotropa uniflora)* or parasitic as in some fungi.

On the opposite end of the spectrum, melanism denotes an excessive deposit of melanin in hide or feathers. Rudyard Kipling's "black panthers" in the *Jungle Book* are examples of melanism in leopards of India, a trait found also in the jaguar in the Western Hemisphere. The black silver fox illustrates this also. Usually black leopards and foxes have normal-colored

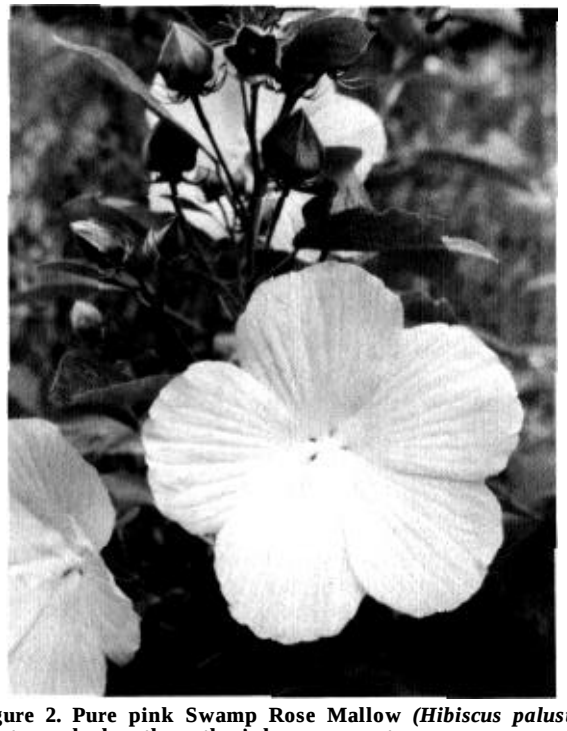

Figure 2. Pure pink Swamp Rose Mallow *(Hibiscus palustris).* Photographed on the author's home property.

Figure 3. Partial albinism in mule deer *(Odocoileus hemionus)* which invaded the author's camp in Olympic National Park. WA.

siblings. In the black leopard, spots can still be seen although largely masked by the melanism. In animals melanism is a minority or recessive trait, and ordinarily would seem to decrease the likelihood of survival. Partial melanism is found in the dark phase of hawks such as the rough-legged *(Buteo lagopus),* ferruginous *(B. regalis),* red-tailed *(B. jamaicensis),* Swainson's *(B. swansoni),* Harlan's *(B. harlani),* and short-tailed *(B. brachyurus).*

Melanism in man is more complex. Scheinfelt feels it may be determined by two pairs of genes, with two black and two dark melanoid genes in Caucasians, with intermediate forms in between and many other genes possibly involved (Scheinfelt, 1965, pp. 88-89). These chromosome locations govern principally the extent of melanin deposition in the skin in granular form, and "melanoid" in diffuse form. Thus the offspring from two mulatto parents may vary from quite dark to quite light, but this can be true to a lesser degree when both parents are white. Other factors that seem to alter skin color are hemoglobin, and a tinge (not pigment) of color imparted to skin by deep opaque underlying layers of skin which scatter the light and give the bluish end of the spectrum. It is thought that the darkest skin, eyes, and hair are caused by an intensifier gene. Yellowness of the skin may be increased by carotene, a yellowish pigment related to that in carrots, and also melanin in finely dispersed form. Some have theorized that races of Mongoloid origin may possess an intensifier gene for carotene. In African negroes and blacks in Australia and South Pacific Islands, melanism is associated with other facial and body features, whereas in India it is present with the typical European phenotype. In tropical climates it would appear to favor survival, whereas the blond, blue-eyed Nordic type survives well in northern areas. Melanism in man is expressed by an additive effect of the number of genes governing it, and thus the latter have intermediate degrees of melanism in contrast with that in lower animals, which is a recessive trait in the examples given.

The dark form of the peppered moth *(Biston betularia)* seems to have increased in smoky districts of England subject to heavy industrialization. Its color camouflages it better there against predation by birds such as the native tits. Some contend that this is an example of evolution, but this is rather an example of simple variation.* Both dark and light forms are the same species, the dark variant having been in existence long before the industrial era.

Australasia-Structural Variation

Theoretically, the gene pool would seem to be affected by the size of the breeding population, and isolation would favor increased variation. The evolutionist would claim then that speciation would likewise be a natural result in Australasia. The number of living marsupials in South America and the large number of marsupial fossils in both North and South America (Fenton and Fenton, 1958, p. 379) indicate that this theory is not correct. In addition, the fossils of marsupials in Australia itself are all in surface deposits with no underlying fossils indicating gradual change in their direction. One must also consider that isolation actually limits the size of the gene pool.

An enthusiastic Audubon lecturer in our area, showing pictures of Australia and New Guinea, became carried away by this subject and began to use superlatives such as, "This is an ideal place to study the evolution of animals and plants, as new species are forming all the time." He attempted to fortify this statement by trying to show differences between the echidna, an egg-laying mammal *(Tachyglossus aculeatus)* in New Guinea and Australia (Figure 4); (Serventy, 1972, pp. 16-18). Actually these differences are minor, and one can identify them as the same animals at a glance. The Tasmanian echidna is also structurally and externally essentially identical but having more hair than the other two, and they are all classified as the same species (Norwalk and Paradise, 1983, pp. 4-5). These differences are obviously less than those manifested between the races of man, all of which are recognized as *Homo sapiens.*

Bird Life and Isolation

Isolation is particularly difficult to maintain among bird life. North America is visited by many species from abroad, some accidentally, some regularly. Among the European birds that find their way to our shores are the lapwing, ruff, European woodcock, European teal, barnacle goose, European widgeon, Baikal teal, black-capped petrel, and Harcourt's petrel. From Mexico, South America and the West Indies come the jacana, masked duck, red-billed tropic bird, blue-footed booby, brown booby, Mexican duck, thick-billed parrot, elegant tern and bridled tern. Asiatic visitors are the blue throat, wheat ear, arctic warbler, Harcourt's petrel, New Zealand shearwater, slender-billed shearwater, pale-footed shearwater, scaled petrel, and white-tailed tropic bird. When our sandhill cranes *(Grus canadensis)* migrate to Canada and Alaska, a number of the latter fly to Siberia to be with the same Siberian species nesting there.

*Editor's Note: See Williams, E. L. 1986. A reevaluation of the English Peppered Moth's use as an example of evolution in progress. *CRSQ* 23:27-28.

Figure 4. Tasmanian echidna *(Tachyglossus aculeutus)* of the same species as that found in Australia and New Guinea.

Variation in Bird Migrations and Calls

Some scientists are not satisfied with the separation of eastern and western meadowlarks entirely on the basis of differences in song, as they cannot be distinguished by field marks. As Mumford had indicated, ". . . one difficulty with records of singing birds [is that] some individuals sing both the western and eastern meadowlark song." This was discovered by Samuel W. Witmer who watched and listened to one singing both songs in 1937 near Goshen, IN (Mumford, 1984, p. 332).

Especially interesting are the "regularly scheduled" migration flights of birds and fishes. The arctic tern flies 22,000 miles from the Arctic just after the sun is beginning to sink below the horizon at midnight, after six months of continuous light, and arrives in the Antarctic about the time the midnight sun can be seen, and continues there for six months. It spends most of its life in nightless splendor. If it had tried simply to find a cool region far to the South, it would have been persuaded to turn back in the region of the equatorial calms, where the air is traveling vertically upward in hot blasts to the upper atmosphere. This argues for a migratory instinct placed within it by its Creator.

Similarly, the eels from North America and Europe congregate to spawn near the Bermuda Islands in the Sargasso Sea. They then die and the fingerlings that develop from the eggs begin their long migrations back to North America and Europe without their parents or chart or compass. It takes a year for the American eels and three years for the European ones to find their way to the same ancestral waters from which their parents came. The American species never become confused and migrate eastward to Europe, nor do the European ones migrate westward. This seems to offer powerful evidence for a created instinct placed within them in centuries past.

Variation in Inheritance of Human Disease Immunity

When the white man came to this country, he brought with him not only valuable foreign plants and animals such as the potato and horse, but also his diseases. The Indians had not been exposed to these illnesses, and had not developed immunity against them. Consequently, the death rate among them was high when they were exposed to such diseases as smallpox, with entire villages being wiped out.

Two groups of whites in America have lived for several generations in semi-isolation: the Amish and the Hutterites. Both stem from the Anabaptists, originally the most evangelistic groups of the Reformation period. Persecuted relentlessly by both Catholic and Protestant state churches, the second generation withdrew to forested mountains and any refuge where they could survive and raise their children in peace. They were somewhat forced to intermarry under these circumstances, and consequently they have been studied extensively by the Ford Foundation, Johns Hopkins University and other similar institutions. The Amish have demonstrated a high incidence of congenital and inherited diseases, including mongolism (Down's Syndrome), polydactyly, muscular dystrophy, various anemias and chondroplastic dwarfism, to name some of the most prominent of these disorders. On the other hand, the Hutterites, beginning with few ancestral families have almost none of these maladies. This is presumably because the Hutterites have taken special precautions such as forbidding marriage between cousins. *Disease resistance* is related to the immune system, and does not affect structural change. *Inherited* diseases, until very recently, caused early death, and in older societies those diseased were not considered marriageable and thus could not compete with their siblings.

Environmental Factors Causing Variation

It has been observed that large size can be a detriment to survival. Most of the largest birds, such as the moa, have already become extinct. Further, those that survive but are on the verge of extinction are the largest in their respective groups. This is particularly outstanding among the largest birds, e.g. the trumpeter swan *(Olor baccinator),* the California condor *(Gymnogyps calilfornianus),* the whooping crane *(Grus americana),* and the ivory-billed woodpecker *(Campephilus principals).*

The farther we travel northward from the equator the larger the animals are *within their respective group.* The largest specimens among timber wolves, moose, brown bears and song sparrows are all found in Alaska. Likewise the smallest race of Virginia deer *(Odocoilius arrginianus)* is the Key deer in the Florida keys, which is the size of a dog. The northernmost tiger *(Panthera tigris)* is the Siberian race which is the largest, whereas that found in the South Sea Islands is the smallest.

We find a few exceptions to this, however, the gaur *(Bos gaurus),* a wild cattle found from India to Malaya, is comparable to the largest of the wild cattle with a weight of up to 1000 kg, the maximal size obtained by other large wild oxen, including the more northern yak *(Bos grunniens)* (Norwak and Paradise, 1983, pp. 1250-1253).

Traveling northward into arctic regions, animals become more scarce, but the waters, especially the ocean, are teeming with fish. Many animals become white in winter and replace the fur with dark hair or feathers in the spring, including the short-tailed weasel, the arctic *(Lepus arcticus)* and snowshoe *(L. americanus)* hares, and the ptarmigans *(Lagopus lagopa* and *Lagopus mutus.).* As we have noted, some are white all year, such as the arctic wolf *(Canis lupis)* and the polar bear *(Thalarctos maritimus).* Notable exceptions however are the darker musk ox *(Ovibos moschatus),* woodland caribou *(Rangifer caribou)* and black and gray phases of the wolf *(Canis lupus).* Animal life can be found as far north as land continues. Plant life on land becomes stunted in the far north until finally the last trees, often aspen *(Populus tremuloides)* and tamarack *(Larix laricina)* disappear. Herbaceous plants likewise are shorter and are able to endure freezing weather partly because of increased osmotic pressure in the protoplasm, and the fact that water molecules are adsorbed on the surfaces of colloids within the protoplasm and are not free to freeze. Despite these variations which enable survival in the far north, when the snow line is reached all surface vegetation disappears on land although the snow line may vary on the same mountain from one year to another.

Alpine plants must similarly withstand extremes of cold and high wind velocity. Small plants, thicker leaves, brighter floral coloration all favor survival. The apparent isolation and climatic rigors would seem, to some scientists, to favor change as expressed by organic evolution, but the high altitude and wind velocity favor widespread dissemination of seed and pollen. Alpine plants are thus unusually stable and enjoy *freedom* from isolation in comparison with those at lower altitudes. The snow-lotus *(L. himalaya)* is covered with white hairs and white flowers, and its roots can penetrate stony alpine soils to a depth of more than three feet, enabling it to blossom and bear fruit even when the ground is snowy. The ability to withstand high wind velocity and cold has its limitations, however, and these factors can ultimately overcome any tenacity to survive, as evidenced by the appearance of "balds," even on top of southern mountains such as the Great Smoky Mountains in Tennessee and North Carolina, and barren heights on southwestern mountains.

The ability to withstand high temperature also has its limitations. Emerald Pool in Yellowstone National Park appears to have emerald-green hot water. This is due to the presence of three blue-green algae in the water, a unicellular alga *(Gloeothece yellowstonense),* and two filamentous algae *(Phormidium rubrum* Tilden and *Phormidium faveolarum* [Montagne] Gomon). These, combined with the natural deep blue in the hot pools, produce the clear deep green for which this pool is famous. Dr. Arthur Nash, former ranger naturalist, recorded the water temperatures at 69.5° C. (Haynes, 1949, p. 86). It is amazing that these algae can withstand such high temperatures. There is a limit to this, however, as the protoplasmic proteins undergo chemical change and the cells die if the temperature is much higher. Nearby Morning Glory Pool has a higher temperature, and no algae can survive in it. Therefore it is a deep blue due to reflected blue of the sky and the blue imparted to the waters of the area by the presence of colloidal silica.

Cold waters also discourage plant growth, as evidenced by the dearth of aquatic flora on the shores of cold lakes in the high Cascades in Oregon in contrast with the abundance of wild flowers on the shores around the warmer lakes of the middle West such as in Indiana and Southern Michigan.

Soil pH—acidity and alkalinity—can be observed in the Western States such as Western Nebraska and the Great Basin where the rate of evaporation exceeds the rate of precipitation; under these conditions alkali soils and alkali lakes form. Alkali lakes may support good fishing and ducks, geese, muskrats and beaver. The dry alkali soils will support a few tolerant grasses and sedges, but where the alkalinity is excessive, we find only white alkali flats that are essentially bare.

Neutral soils and lakes support a wide variety of flora and fauna, including the climax maple-beech forest. Acid soils support a good but lesser growth of vegetation. They are caused by the leaching of bases (e.g., calcium, magnesium, sodium, potassium) from the aluminum silicate exchange particles in the soil. These are replaced by hydrogen ions which produce acids in the soil complex. In addition to rainfall, other factors tending to increase soil acidity are temperature, age of soil, and type of vegetation. Pines and other evergreen trees do well on acid soil.

Sphagnum bogs produce an environment for acid-loving trees and herbaceous plants. Tamaracks *(Larix laricina),* blueberries and cranberries do well, as also certain species of rare wildflowers such as pink lady's slipper *(Cypripedium acaule).* However, many plants will grow best only within narrow limits of pH. Thus the white lady's slipper *(C. candidum)* and the yellow lady's slipper *(C. parviflorum)* are found more likely in neutral soils in what are sometimes incorrectly called bogs, but are actually fens.

As to salinity, some plants do well along the ocean shores, such as the mangrove trees growing right in the salt water along shores in Florida and the Caribbean Islands. Brackish waters support many plants in bayous and saline estuaries. Many birds such as shorebirds, black brant, and some ducks do especially well. However, living protoplasm can endure only a certain concentration of salt in the aqueous environment before shrinking of the cell membranes and protoplasmic contents which, if not interrupted, causes the death of the cells. The two saltiest bodies of water are the Dead Sea in Palestine and Great Salt Lake in Utah. The latter is so salty that no life can live in it except the brine shrimp and the larval stage of a fly. The Dead Sea water has 24% solid matter, mostly sodium chloride, but it also supports a small crustacean and a few plants (Harris, 1972, pp. 48-49).

Moisture made available when rainfall is heavy develops luxuriant forests in eastern United States and the western edge of Pacific Coast states. Jungles and tropical forests develop where precipitation is great in areas near the equator. Farther away from the western coast of the continents rainfall may be scanty and deserts are found. This climate is very healthful, despite low food production in the area. Dunes may form inward from the shore near the ocean as well as

near the Great Lakes in Canada and the United States. Because of high winds coming off the lakes from the west, "blow-outs" may occur, removing tons of sand and depositing it elsewhere. The most successful tree grown in the dunes is the Carolina poplar *(Populus deltoids).* When sand is removed from around the roots by wind, the root growth downward keeps ahead of the sand removal, taking in much needed soil water. When wind piles sand up around the trunk, new adventitious roots form to stabilize the tree and grow outward to absorb soil moisture. Sometimes shifting sands are excessive and the poplar tree succumbs in spite of its capacity to adjust to rising and falling levels of sand, which is largely silicon dioxide. The striking white sands in New Mexico are actually gypsum (calcium sulphate).

Conclusion

We have reviewed briefly examples of variation in the gene pool, and the fact that these do not account for evolutionary change because of the limitations of the effects that they may have. We have also indicated many variations in the environment, and indicated how these are met by living organisms which in themselves demonstrate variation which can enable them to survive under adverse conditions. We have observed also how their ability to endure environmental extremes is limited and can affect significantly their ability to survive in a particular environment.

For most of the period since Darwin, interpretation of these variations has been left largely to speculation by scientists of a humanistic persuasion who have argued that, given enough time, these variations can account for development into other species by gradual organic evolution, ultimately from amoeba to man. It is my conviction that variation must be interpreted in the light of sound scientific evidence. The fossil record argues decisively that they have not led to significant change, but have remained much the same as they appeared in fossil remains. The lowest fossiliferous strata in the Grand Canyon in Arizona bear fossils essentially the same as living counterparts today. We have a sizeable number of "living fossils" today which argue that they have not changed since the days they were laid down in fossil form (Culp, 1990, pp. 85-87). The striking example, of course, is the Coelacanth, which was known only in fossils until the mid-20th century (Figure 5). Because of the peculiar fleshy portion of its fins, it was given a prominent place in evolutionist charts, allegedly demonstrating a transition stage from fish to amphibians over a period of 90 million (some said 300 million) years. In 1952 a fisherman in the Indian Ocean pulled up a lively five foot specimen and the fleshy appendages had not changed since its fossil counterpart was laid down under flood waters! Similarly, fossil redwood remains called "dawn redwood" (because they were supposed to be the primitive ancestors of our California redwoods) were said by "experts" to have become extinct millions of years ago, but were found growing in the mountains of China in the 1940's. I have a prize specimen of it growing in my lawn for demonstration purposes. Such evidences have caused even many evolutionist scientists to abandon Darwin's theory of gradual change, and adopt another equally speculative-theory

Figure 5. Coelacanth, photographed in the Science Museum in London.

of the "hopeful monster," progressing by great leaps (Gould, 1977, p. 22).

Another critical line of evidence is that of geographical distribution of plants and animals. Evidence is accumulating that the great majority of the large animals in North America have counterparts in Eurasia which are now recognized as the same species with no significant change in the many centuries which have passed since they came to this continent, presumably over a land bridge in the Bering Strait area (Culp, 1988, pp. 24-27). We are accumulating even larger lists of plants and birds which corroborate this conclusion. I challenge our evolutionist friends to seriously consider these evidences, and join us in helping our generation emerge from a position of science fiction to one of solid factual evidence.

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PANORAMA OF SCIENCE

Gaia and Lynn Margulis

It had to happen sometime. The rise of the new age movement, in particular with its emphasis on pantheism, eventually had to marry science. The result is the gaia hypothesis. In this note I emphasize a recent magazine dedicated to the analysis of the gaia hypothesis, the *Spiritual Counterfeits Projects Journal (SCPJ),* and why Lynn Margulis, a respected botanist, has embraced gaia (Mann, 1991).

The gaia hypothesis, taken after the Greek goddess of the earth, postulates that the earth is alive. The earth itself shapes and regulates the biota and the environment. The earth possesses self-regulating mechanisms ". . . to maintain the climate and the chemical composition at a steady state favorable for life" (Lovelock, 1986, p. 393).

The *SCPJ* (1991) has five excellent articles dedicated to the gaia hypothesis. The articles describe gaia as a religion of the earth, thus gaia is the mother earth goddess. The gaia hypothesis has spawned several sects the most radical being the "Earth First!" group and the animal rights movement. These groups wish to dethrone man from his preeminent place in nature and bring him down to the level of the rest of nature. This is consistent with the theory of evolution in which man is just a risen animal. Earth goddess worship has come of age within some segments of the feminist movement.

Respected scientist James Lovelock invented the gaia hypothesis. He believes in evolution but reasons that the delicate balances of life and the environment could not have evolved by random, purposeless processes. Gaia causes evolution over an almost infinite amount of time. Lovelock has personally researched the fine-tuned balance of the biota and the environment. Besides his books dedicated to the gaia hypothesis, he publishes his research in respected scientific journals (Lovelock, 1986; Charlson et al., 1987). Lovelock clothes the gaia hypothesis in scientific garb; the hypothesis is becoming a powerful and influential scientific theory.

The new age and pantheistic underpinnings of the gaia hypothesis are evident. Stuart Chevre (1991, pp. 29-30) states:

> What is the root cause of our current predicament: moral degradation, narcissistic alienation, environmental destruction, the threat of nuclear holocaust and possible extinction of humanity? According to Lovelock, it is because we no longer practice the rites of the ancients by whom "the Earth was worshiped as a goddess and believed to be alive."

Lovelock as well as others blame the Judeo-Christian worldview for the present environmental woes and for destroying the peaceful goddess-orientated culture of old Europe. To answer the former charge, the *SCPJ* (1991, pp. 33-34) gives excerpts from Francis Schaeffer's ecological defense of Christianity (Schaeffer, 1970). A proper understanding of creation is the answer to the ecological mess.

A recent article in *Science* (Mann, 1991) describes Lynn Margulis's belief in the gaia hypothesis and the reaction of her peers. She is dedicated to the scientific aspects of the hypothesis and rejects anything that suggests the spiritual. She is branded as a respected maverick, who has been correct previously. Lynn Margulis widely promulgates gaia through the copious attention the media pays to her. Of special interest to creationists are the reasons she accepts the gaia hypothesis and the challenges she presents to her colleagues.

Specifically, she does not believe in neo-Darwinism, which she describes as a complete funk and ". . . a minor 20th-century religious sect within the sprawling religious persuasion of Anglo-Saxon biology" (Mann, 1991, p. 380). She further describes neo-Darwinism as:

> . . . a "quaint, but potentially dangerous aberration that needs to be tossed out in order for science to answer "basic questions" like why stasis is so prevalent in the fossil record, and how one species can evolve from another (Mann, 1991, p. 378).

She admits that scientists really do not know how evolution supposedly worked. This is also indicated by a remark made by Niles Eldridge in his response to Margulis's gaian belief: "Understanding speciation is indeed difficult . . ." (Mann, 1991, p. 379).

Lynn Margulis does believe in natural selection, but redefines it as the reciprocal actions between organisms and the environment. She does not believe the slow buildup of chance mutations could result in the fantastic array of living forms. In her scientific addresses, she challenges biologists in the audience to name a single, unambiguous example of the evolution of a new species by the increase of chance mutations. Although biologists can suggest disputed possibilities, so far they have apparently failed to offer one unambiguous example. Instead, Lynn Margulis believes the source of evolutionary novelty is the acquisition of symbionts, in which two organisms co-exist together for mutual benefit. After awhile they somehow become melded together into a new organism.

In one of her talks an engineer challenged her belief that the earth is conscious. She threw the challenge back by saying: "Look if you accept the standard definition of consciousness, it's very easy to prove that most people, biologists included, are totally unconscious their whole lives" (Mann, 1991, p. 381).

It is too bad that few evolutionists take her challenges seriously. She is exposing glaring weaknesses. But instead of embracing creationism, scientists that reject the postulated mechanisms of evolution embrace a new age caricature of creation.

The gaian scientists are discovering environmental processes that further show the unique balance of nature. It points more naturally toward a purposeful Creator. Creationists may also find the discoveries helpful for creation research. For instance, oceanic phytoplankton probably increase the reflectivity of clouds (Charlson et al., 1987). Lovelock assumes this is another self-regulating mechanism, and for the current earth he is probably correct. However after the Flood, increased phytoplankton, especially coccolithophorids, and the lack of sea ice would substantially increase the amount of sulphur in the atmosphere. This sulphur oxidizes to form an aerosol that increases the cloud condensation nuclei (CCN). More CCN result in a greater number of water drops that reflect more sunlight back to space. This unique process would be another cooling mechanism that would contribute to an ice age after the Flood (Oard, 1990).

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Michael J. Oard*

*3600 7th Avenue South, Great Falls, MT 59405.

Genesis Kinds

I have pleasant memories of the CRS organizational meetings. As I recall, at that time we engaged in no discussion of the nature of Genesis types or kinds. I could wish that since then there had been a little more sharing of our respective views. The Bible tells us that the Genesis kinds were created by the Word (the Son, Christ, John 1:1-3).

I would like to make known a few items of my philosophical science. It is important to recall that by the time of Creation Week Lucifer, an angel who had been formed the highest of all created beings, full of wisdom (Ezekiel 28:12), had given himself over to a strong desire for self-exaltation and deep jealousy toward his Creator, and as a result had been excluded from heaven. With his angels he took his abode on our earth as soon as it was brought into existence.

One of the attributes of our Creator is foreknowledge. He could see the coming fall of man and the eventual takeover by Satan of our natural world. He knew Satan would search the secrets of the laboratories of nature and learn how he could most effectively mar nature's face. Certainly Satan would attempt a confusion of the kinds of organisms through crossbreeding and thereby a horrible condition would rapidly develop around the world. Therefore the Creator isolated each kind of organism in such a way that Satan would be foiled. Even the highest created being could not solve the problem of how to cross two Genesis kinds.

What is the scientific support of such a view? Just this: never in the history of organisms has it been possible to solve how to cross two Genesis kinds. Lester and Bohlin in their book, *The Natural Limits to Biological Change* (1984, p. 156), suggest my theory of gametic union is "rather simplistic" because it offers no rationale for why kinds cannot cross. How could I explain what I still assume to be a secret of the Creator, a secret which has proved to be an untold blessing to mankind and all nature?

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Frank L. Marsh*

*8254 North Hillcrest Drive, Berrien Springs, MI 49103.

Catastrophism and Rapid Erosion—III

Introduction

Earlier notes (Williams, 1986; Williams, 1991) discussed rapid erosion, primarily within a catastrophic framework. Austin (1984) has noted many instances where catastrophic geological forces have shaped the earth's surface. Creationists who believe in a worldwide Flood generally suggest that catastrophic conditions are much more important than so-called slow, gradual uniformitarian processes. Creationists often use present-day catastrophic floods, storms, winds, etc. as small-scale models of what could have taken place during and after the Genesis Flood to rework the surface of the earth.

A Cloudburst and Rapid Erosion

Uniformitarian geologists have recorded the results of violent storms and have suggested to their colleagues that possibly they should consider catastrophic processes more seriously. Moneymaker (1938) recorded the erosional effects of a storm in the Tennessee mountains.

> On August 5, 1938, a cloudburst of proportions very unusual for the Southern Appalachians occurred on Webb Mountain, located in the southeastern portion of Sevier County in the immediate vicinity of Pitman Center, about fifteen miles southeast of Sevierville. According to the most reliable information available, the downpour commenced at 2:00AM and lasted about four hours. The amount of rain that fell in the four-hour period cannot be precisely determined, but unofficial records indicate that the maximum was in excess of twelve inches. Nearly all of the streams draining the mountain were heavily swollen and even within a few hundred feet of the crest the water was as much as fifteen feet deep in gullies having gradients steeper than thirty degrees. On some of the more uniform slopes the water was not concentrated in channels but moved down the mountain in sheets (Moneymaker, 1938, p. 190).

Webb Mountain is a steep east-west trending ridge about five miles in length. It is 2800 feet above sea-level and stands approximately 1400 feet above the larger streams in the area. As Moneymaker (p. 190) noted:

> The unusually heavy rainfall on Webb Mountain resulted in a stupendous amount of erosion in a very short time. Numerous large scars, which are conspicuous for many miles and which no doubt will remain evident for many years, developed on the steeper slopes within a few hours. The channel of nearly every stream in the area was enlarged, even in bedrock, wherever the gradient was steep . . .

Moneymaker (p. 190) categorized the erosional effects as gullies, landslides and channel erosion.

Channel Erosion and Deposition

Erosion into bedrock was discussed (p. 194).

> In the upper courses of some streams, where the gradient is steep and where the rocks dip downstream, the channels have been deepened as much as four or five feet in bed-rock by the ripping off of the much weathered phyllite and thin-bedded quartzite along cleavage and bedding planes and dip joints.

He then noted examples of deposition and postulated that much of the "bottom" land below Webb Mountain could have been brought into existence as a result of a single flood (p. 195). Moneymaker concluded that:

> A study of the erosional effects of the Webb Mountain cloudburst brings to light some facts bearing on erosion and transportation not always fully appreciated by geologists (p. 195).

He observed that a stream can suddenly deepen its channel and that small "bottoms" along mountain streams in the Southern Appalachians may be quickly formed and quickly destroyed by catastrophic floods (p. 196).

Suggested Applications

The erosional effects of this local flood are similar to the effects recorded in Nelson County, Virginia when hurricane Camille dumped 30 to 40 inches of rain in portions of the county in a six-hour period (Williams and Guy, 1973; Williams, 1986; Williams, Meyer and Wolfrom, 1991). The damage in Nelson County was more severe but both of the areas, Webb Mountain and Nelson County, have similar topographies, i.e., steep mountains with narrow valleys. Williams and Guy (1973, p. 1) speculated the erosion from this one flood in Nelson County was likely the equivalent of several thousand years of normal denudation.

Extremely heavy precipitation producing large quantities of water that move rapidly down steep slopes carrying enormous quantities of abrasive material can cause unbelievable erosional damage. As the water moves from a high altitude to a lower level, its potential energy can be converted into kinetic energy and the resulting raging torrents and moving sheets of debris and water are capable of removing massive quantities of consolidated and unconsolidated material.

Consider the formation of canyons, particularly the Grand Canyon of the Colorado River. Sometime after the Flood, large quantities of rapidly-moving water from the higher uplifted elevations flowing into the lower basin and range regions could have scoured out massive areas of sediment, especially if they were not in a fully-consolidated state. See Austin, et al., 1992, pp. 69-91; Brown, 1989, pp. 74-75, 83; Burdick, 1974, pp. 26-27; Cunningham, 1977, p. 2; Williams, Meyer and Wolfrom, 1991. Other catastrophic mechanisms such as cavitation could have developed to further accentuate the damage (Holyroyd, 1990a, b). Under such conditions, large canyons may have developed in a relatively short time.

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Emmett L. Williams*

*5093 Williamsport Drive, Norcross, GA 30092.

Who Can You Believe?

Science and Scripture

The positions we hold with regard to "creation science" and evolution are closely connected with our views on scientific research and the Bible. Both our confidence in the integrity of the scientific community and our degree of confidence in the inspiration, veracity in scientific matters, and infallibility of the Scriptures play a large role in shaping our opinions. A high view of scientific integrity would tilt us in the direction of the uncritical acceptance of data published in establishment journals in the area of evolution and its chronology. A high and literal view of Genesis on the other hand leads us to question and distrust the scientific literature when it touches these matters. For example, the authors of *Science Held Hostage,* each of whom is "wholly committed to the Christian faith, firmly believing that God and the physical universe are related in a way that is profoundly portrayed by the Creator-Creation metaphor" (Van Till et al., 1988, pp. 42-43) urge caution on the application of Biblical truth to scientific concern:

> A question of direct concern to many Christians is, Does the Bible provide any data relevant to the construction or evaluation of theories in the natural sciences? Persons equally committed to

> the Christian faith differ widely in their judgment in this matter. Some persons, for example, judge that the Bible provides data relevant to theories concerning the events, processes and chronology of the formative history of the universe. Others are convinced that it was never intended to address such concerns. Resolution of these differences is not a simple matter. The Bible contains a rich diversity of forms of historical literature—forms often very different from what we are accustomed to. Furthermore, the agenda of the Bible's historical literature is authentic to its ancient Near Eastern cultural and religious context—a setting quite different from our modern Western world. Thus all persons, whether committed to the Christian faith or not, must exercise great care and caution in making statements about biblical data and its relevance to contemporary scientific theorizing.

In speaking of the "Creator-Creation metaphor" we have terminology at odds with the literal six day creation described by Exodus 20:11.

But not only is this view of Scripture lower but the view of the current scientific literature higher. Consider this quotation from the chapter, "The Legend of the Shrinking Sun": ". . . both geological and radiometric evidence indicate a terrestrial age of billions of years" (Van Till et al., 1988, p. 60) or this one:

> In our judgment, however, Steidl paid far too little attention to a vast array of empirical and theoretical considerations which have led the professional scientific community to the well-founded *conclusion* (not assumption) that the solar system formed about 4.6 million years ago." (Van Till et al., 1988, p. 62).

We can observe here and throughout this book a willingness to accept the basic integrity of the established scientific community even when its findings cast doubt on the Biblical chronology given in Genesis 1. Perhaps those that hold to similar views as these authors would think that I exhibit a hopeless naivete when approaching the Scriptures but we do not have to be naive about scientific research as it is currently practiced at least in some academic circles.

Human Nature

The scientific community has been rocked by the allegations of Margot O'Toole about the lack of validity of data published by Nobel Laureate David Baltimore, Tufts University immunologist Thereza Imanishi-Kari, and four others. Furthermore, forensic analysis of Imanishi-Kari's laboratory notebooks showed that she had fudged them. In O'Toole's opinion it was not important to Baltimore to correct the lies. She even mentioned the contempt the authors of this bogus paper had for the labor of people trying to repeat the work (Zurer, 1991, pp. 35-40). Perhaps this is an isolated case, but we should be alert to the danger signals since most published data is never replicated, some of it never even read. Simply put, there is no money in it; research grants are given to produce new findings, not rehash old ones.

All sorts of pressures are developing on the $10 billion academic research enterprise. The system is bedeviled by questions concerning research ethics, questionable accounting and inconsistent funding. Universities today function not only as knowledge centers but increasingly as financial conglomerates. Historian Page Smith gives a harsh indictment of big-time research:

> Is not the atmosphere hopelessly polluted when professors are forced to do research in order to make a living, in order to avoid being humiliated—and terminated. What kind of research can possibly come out of such a system? The whole nature of intellectual activity is hopelessly distorted, the nature of knowing the roots of life (Lepkowski, 1991, pp. 40-42).

Summary

Let us inquire as to the funds available to a scientist with the temerity to question the scientific establishment and their firm "conclusion" of an old earth and even older universe. Even if the "god of this world" had not blinded their understanding, normal economic and social forces would. A new world order is arrayed against the Bible believer. It offers to us neither money, prestige, position or respect, but we are still better situated outside of the camp, bearing His reproach.

It behooves us, therefore, to be certain that our research is of the highest quality and integrity. We cannot expect that researchers who play fast and loose with government grants (Stanford University will serve as an example of this practice) will suddenly be honest in the laboratory. But we do have a right to expect that creationists will be rigorously honest in all of their communications. Otherwise, the rising tide of mediocrity will sweep all of us away.

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George Matzko, Ph.D.*

*2902 Edwards Road, Taylors, SC 29667.

A Classical Case of Mimicry Runs Afoul

A "subparadigm" of evolutionary theory states that many species of butterflies and moths evolved similar wing-color patterns. One mechanism for this transformation is called Batesian mimicry in which a tasty butterfly evolves the wing color pattern of a foul tasting species. For more than 100 years the classic example has been the luscious viceroy butterfly evolving a very similar wing pattern as the nasty monarch butterfly.

Would you believe this classic example has never been tested and now is considered false? Tim Walker (1991, p. 348) in *Science News* states: "New research indicates, however, that the viceroy has successfully deceived scientists, not birds." The basis for this conclusion is a recent taste test reported in *Nature.* Using just the abdomens of viceroy, monarch, and queen butterflies, Ritland and Brewer (1991) discovered that viceroys are just as unpalatable to birds as monarchs.

Have scientists given up on viceroy mimicry as a result of the new test of their hypothesis? No, Ritland and Brewer have just switched from one mimicry mechanism to another. The new mechanism, called Mullerian mimicry, goes something like this: If two noxious butterflies have different wing patterns, birds would have to eat many of each to learn to avoid them. But if one species evolved its wing pattern to mimic the other, the birds would eat about half as many butterflies.

The notion of mimicry has always seemed irrational to me—one of those seemingly endless subsidiary hypothesis to patch a leaky foundation. Both mechanisms come close to attributing conscious planning on the part of the butterflies. Many logical conundrums arise concerning the mechanisms of mimicry. For instance, in Mullerian mimicry, why would not both species try to evolve towards the other, resulting in a chaos of variant wing patterns, or a third wing pattern after much trial and error?

The most significant point of this research for creationists is the reason why the viceroy's avian palatability had never been tested. Walker (1991, p. 348) states:

> One reason, says entomologist Austin P. Platt of the University of Maryland-Baltimore County in Catonsville, is that the viceroy evolved from a group of tasty admiral butterflies. "So it was just widely held that the viceroy itself was also palatable," he explains.

Investigators just assumed evolution and never tested their hypothesis! How many other *testable* evolutionary/uniformitarian conclusions have never been tested before and just assumed true based on the truth of evolution?

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Michael J. Oard*

*3600 Seventh Ave. South, Great Falls, MT 59405.

The Origin of Euglena

Plant or Animal

Euglena is a unicellular organism with both plant and animal features. Many workers classify it as an animal in phylum while botanists put it into a plant division of its own called Euglenophyta. On the plant side the organism possesses chloroplasts in which photosynthesis occurs. There are also pyrenoids which are embedded in the chloroplasts, where starch accumulates. During the palmella stage, when growth occurs, numbers of cells are enclosed within a gelatinous matrix.

Did it Arise by Endosymbiosis?

There are a number of possibilities for the origin of *Euglena.* One supported by many evolutionists is the symbiotic origin of the green chloroplasts. This view assumes the chloroplasts arose when independent algae entered the cytoplasm and took up residency. The chloroplasts have a three-membraned envelope (Leedale, 1982, p. 13). It was initially thought that the two inner membranes were the chloroplast envelope proper, and the outer membrane was that of the plasmalemma of the original host cell which the algae invaded. It was found that the outer membrane does not bear ribosomes, nor does the membrane connect to the nuclear envelope. Leedale suggested that green chloroplasts of *Euglena* were taken from algae, just as the genus of algae called Peranema supposedly cut their way into another cell to produce *Cladophora* of today (Leedale, 1982, p. 1). In this way the chloroplasts could have been engulfed by *Euglena,* but failed to be digested and thus become a part of the make-up of what we now call *Euglena.* The two inner membranes would be the original algae chloroplast and the third, outer membrane would be the *Euglena* cytoplasmic membrane picked up by the invading algae. It is believed this also explains the presence of chlorophyll B in *Euglena,* a pigment normally limited to algae of other taxonomic divisions. The ancestors of *Euglena* would therefore have been colorless because of a lack of the algal symbiont. While this may be the means the Designer used to originate *Euglena,* it seems unlikely. There are many problems facing endosymbiosis as an origin theory applied to other organisms.

Let us examine this idea of endosymbiosis as it might apply to *Euglena.* There are no algae with three-membraned chloroplasts that would serve as possible progenitors of Euglena. It would be an odd state of affairs if all the algae with three membranes had later disappeared simply because a few colorless *Euglena* had taken some of them on board as part of their anatomy. It also is unlikely that the invading algae would have acquired and retained the host cell's plasmalemma as part of its own equipment. Thus the concept of endosymbiosis falls short as an explanation of the three-membraned chloroplasts of *Euglena.*

Did the Origin of Euglena Involve the Gene Theme Approach?

The Creator may have used a procedure that I call the gene-theme model (Brown, 1987). Here, God has taken certain design patterns and used them throughout creation. This could have involved either the use of the same or similar genes, or different genes altogether to produce a similar phenotypic result, remembering that genes can have more than one function. In the case of *Euglena* the Designer may have originally given it the option of a number of lifestyles. All these modes of life were of a non-predator-prey relationship. Indeed, this is true of most of the genus *Euglena* at present. In the gene-theme perspective, the three-membraned chloroplasts of *Euglena* would be unique, for some reason yet unknown.

Reproduction in *Euglena* is asexual. This rules out direct descent from many algae of the genus Chlamydomonas, as a number of these have sexual reproduction. Because of this, and because the chloroplasts of *Euglena* are unique, it appears clear that *Euglena* in no way arose from any other green algal ancestors. Under the Designer's control, *Euglena* may have been produced by an act of endosymbiosis. However, it was more likely produced in its present form as a separate kind, possessing unusual three-membraned chloroplasts as a tribute to the Creator's versatility.

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Colin Brown*

*61 Derby Road Golborne, Warrington WA3-3LE, England.

Reprinted CRSQ Volume 6

Introduction

The *Creation Research Society Quarterly* has been published since 1964 (27 complete volumes). Many of the early Quarterlies are out-of-print, yet these past issues contain articles of continuing interest and value. In an effort to make these volumes available, the Board of Directors has incurred considerable expense to reprint them. In order that those interested in good scientific creationist articles, sound criticisms of the evolutionary hypothesis, along with the needed literature citations accompanying the treatises will have a general idea of the contents of each volume, brief synopses will be written to appear in this and future Quarterlies. See Williams, 1990a pp. 57-58; 1990b, pp. 93-94; 1991a, pp. 136-138; 1991b, pp. 27-29; 1991c, pp. 67-69.

Genetics

In the lead article of the first Quarterly of this volume, Dr. Walter E. Lammerts, founder of the Society, answered the bold assertion of some geneticists that modern developments invariably support the organic evolution concept (Lammerts, 1969, pp. 5-12, 26). Using data on beans, roses and corn, he showed that variation is *limited,* not unlimited. His discussion on mutations was very enlightening and he pointed out that these mistakes could not be used as mechanisms for molecules-to-man evolution. Other topics discussed were the research on fruit flies, natural selection, chromosome doubling and recombination. John Klotz (1969, pp. 45-48) examined each type of chromosome aberration. Since gene mutation is thought to be the source of variability in evolution, then polyploidy and chromosome change in general are often pictured as the source of new genes. Klotz concluded that these aberrations are not of the type that would be required for any major evolutionary upward step.

Embryology

"Ontogeny recapitulates phylogeny''—it was Ernst Haeckel who popularized the idea that an embryo of a complex animal retraces the stages of evolutionary development as the fetus grows. Wilbert Rusch (1969, pp. 27-34) not only enumerated the scientific shortcomings of this "biogenetic law," but he discussed translations of original German papers which clearly showed the fraudulent nature of Haeckel's drawings and arguments. Mennega (1969, pp. 121-126), employing both science and philosophy, investigated comparative morphology. He carefully noted that the creationist position provided coherent explanations of such phenomena as homology, embryology, pharyngeal pouches, kidneys and even the so-called "human tail."

Comparative Anatomy and Homology

Many science instructors glibly assert that "similarity means kinship." In "The Form and Structure of Living Things," Frank Marsh (1969, pp. 13-25) showed such particulars as homology and convergence find ready explanation within the creationist framework. Other topics presented were the creation of plants and animals, classification systems, origin of human beings, the fossil record, variation and fixity within the kind framework, microevolution and macroevolution. Dr. Russell Artist (1969, pp. 55-64) elaborated how that similarities can be viewed as a product of creation according to a common plan. As well as emphasizing design, the author gave evidence of evolutionary dogmatism in textbooks. Homology is not a key evidence for the "fact" of evolution.

Botany

William Tinkle, in one of his notes on wildflowers (1969, pp. 65-66), illustrated how "Jack-in-the-Pulpit" *(Arisaema triphyllum)* could not have evolved but must have been designed. George Howe, editor of the Quarterly, presented a history of creationist botany (1969, pp. 85-95). In this very interesting article, Dr. Howe discussed plant physiology, plant design, paleobotany, morphology, homology, analogy and plant genetics. This article is an excellent introduction for anyone wishing to do an in-depth study of plants from a creationist perspective.

Biochemical Evolution

"Missing links" are often used to show the deficiencies in macroevolutionary philosophy. Larry Butler (1969, pp. 127-128) noted two biochemical missing links (intermediate forms of two alleles). The author mentioned the lack of predictive value of the naturalistic hypothesis based on this evidence.

Anthropology

In "Fossil Man: Ancestor or Descendant of Adam?" Daniel Shaw (1970, pp. 172-181) examined the topic from a creationist viewpoint. Briefly discussing the evolutionary concept of the origin of the genus *Homo,* he then outlined the Australopithecine, Pithecanthropine and Neanderthal stages, the region of the origin of man, genetic action on small populations and morphology. He provided a creationist model for the data. The late Harold Armstrong developed an interesting creationist nomograph for use in human population statistics (1970, pp. 183-184).

Overthrusts

The so-called geologic column was developed to "show" evolutionary sequences preserved in a particular inviolable sequence of sedimentary strata. In some areas of the earth's surface these strata are found in a supposed "wrong order." The concept of overthrusting of an "older" stratum over a "younger'' one is employed to explain this wrong order. Burdick and Slusher (1969, pp. 49-54) investigated one such overthrust in the Empire Mountains of Arizona. They concluded that there was no physical evidence for an overthrust at this location. The authors suggested the overlying Permian layer was actually younger (deposited later) than the Cretaceous layer beneath it. Burdick (1969, pp. 96-108)

also reported on his field work concerning the Lewis Overthrust in Montana and Alberta. He found no evidence of overthrusting. The contact line in several locations was studied and photographed.

Other Geological Studies

The excellent research on the classic Joggins petrified trees by Harold Coffin (1969, pp. 35-44, 70) was presented in this volume. Dr. Coffin concluded that the evidence available from his investigation indicated that petrified trees and coal deposits are allochthonous in origin. This careful field and laboratory work deserves serious study. Bernard Northrup examined the Sisquoc diatomite fossil beds in California (1969, pp. 129-135). He postulated that the formation of the diatoms occurred after the Flood and a redeposition of the organisms in a post-Flood catastrophe. In an extensive book review, Northrup (1970, pp. 161-171) suggested that the formation of the Franciscan assemblage of rocks could best be explained with a catastrophic rather than a uniformitarian framework.

Miscellaneous Articles and Notes

Robert Whitelaw (1969, pp. 71-73) published another paper on radiocarbon and potassium-argon dating. Using the evidence available, he formulated a model for a young earth. Employing a book review as a vehicle, Norbert Smith (1969, pp. 73-74) discussed population control without predation. Mosher and Tinkle (1970, pp. 182, 184) noted the inadequacies of the natural selection concept. Henry Morris (1970, pp. 199-200) explained how the second law of thermodynamics prohibited any molecules-to-man development. Many varied topics were covered by technical notes in the Comments on Scientific News and Views format in each issue. A considerable number of significant book reviews also appeared in this volume. Thus readers can find much of interest in another early volume of Quarterly writings.

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Emmett L. Williams*

*5093 Williamsport Drive, Norcross, GA 30092.

KEYWORD INDEX TO VOLUME 27

GLEN W. WOLFROM*

*Glen W. Wolfrom, Ph.D., is Membership Secretary of the Society. For multi-page items, the reference is to the first page only. Letters following numbers indicate: a = article; L = letter; p = panorama; r = reviews.

MINUTES OF 1991 CREATION RESEARCH SOCIETY BOARD OF DIRECTORS MEETING

On Thursday, 11 April 1991, a meeting of the Executive Committee was held at the Wolverine Best Western Motel, Ann Arbor, Michigan, from 2000 to 2250 hours to set agendas for the committee meetings on Friday. On Friday, 12 April 1991 between the hours of 0800 and 1700, the Constitution/Bylaws, Financial, Publications, Quarterly Editorial, Research and Temporary Meeting Committees held meetings each of approximately two hours. The chairman of each committee recorded the business in preparation for the Saturday business meeting.

The official annual meeting of the Society was opened at 1900 hours by President Frair in Room 102 of the Science Building at Concordia College, Ann Arbor, Michigan. Present: D. Boylan, E. Chaffin, D. DeYoung, W. Frair, D. Gish, G. Howe, D. Kaufmann, J. Klotz, L. Lester, J. Meyer, D. Rodabaugh, W. Rusch, E. Williams, G. Wolfrom. Also present were 136 visitors. The President welcomed everyone to this meeting of the 28th year of the Creation Research Society. This was followed by silent prayer.

Dr. Ted Aufdemberge, Professor of Science, Concordia College, welcomed CRS members and guests to the College. President Frair expressed gratitude from the CRS to Mr. David Golisch, President of the Creation Science Association of Detroit, for providing refreshments. Mr. Golisch spoke briefly on the programs of his group.

Meyer gave a report on the CRS Research Station in North Central Arizona. Editor DeYoung gave a report on the status of the CRS Quarterly. Williams gave a report on the status of CRS publications. Frair summarized the latest developments of creation in the news.

Rodabaugh introduced the speakers of the mini-symposium. Boylan spoke on “Creation Science: Is It Really Science?” Chaffin spoke on "Geology of Southwest Virginia." Meyer spoke on "Creationist Challenges in Ecuador." Williams spoke on “Big Bend and Grand Canyon Expeditions: Howe spoke on “Vestigial Organs in Flowering Plants.” Rusch spoke on "Baked Rocks or Things Are Not What They Seem." Gish spoke on “Recent Proofs for Evolution.” The meeting was adjourned at 2215 hours for refreshments and social discourse.

On Saturday, 12 April 1991, the closed business sessions of the Board were called to order at 0830 hours. Present: D. Boylan, E. Chaffin, D. DeYoung, W. Frair, D. Gish, G. Howe, D. Kaufmann, J. Klotz, L. Lester, J. Meyer, D. Rodabaugh, W. Rusch, E. Williams, G. Wolfrom.

The minutes of the 1990 meeting were read and accepted. Secretary Kaufmann reported the following were elected to the Board for a three-year term: Chaffin, Klotz, Lester, Rodabaugh and Wolfrom.

The financial report by Meyer was given as follows: for the 1991 fiscal year the income was $89,624.93; expenses were $88,930.26. The report of the independent auditor was accepted.

The membership report by Wolfrom was given as follows: total membership for 1990-91 was 1873 (673 voting, 779 sustaining, 379 subscribers and 42 students). This is an increase of 83 over 1989-90.

The editor’s report by DeYoung was given as follows covering the period from 11/88 through 3/91: 131 articles were received; 61 (46%) were published; 70 (54%) were rejected. Also published were: 37 book reviews, 44 panorama of science items (technical notes) and 54 letters.

The constitution/bylaws report was given by Boylan as follows: the removal of the Editor position as an officer in Bylaw Article 1, Section 1 was approved. The Board proposed a Bylaw addition of Article 1, Section 2 as follows: Position descriptions for offices shall be formulated and reviewed by the Constitution/Bylaws Committee and approved by the Board.

The research report by Meyer was given as follows: it was passed that the Research Committee provide total expense information for the construction and maintenance of our Research Center in Arizona for our next Board meeting. The President appointed a special Fund Raising Committee (Chaffin, chair; Klotz; Meyer; Wolfrom; Zimmerman) to raise money for the Research Center and increase the Endowment for the purpose of sustaining fiscal support for the Research Center Director. It was passed that all undesignated funds be turned over to the Research Endowment Fund.

The publications report by Howe was given as follows: CRS books will sell *Natural Limits to Biological Change* by Lester and Bohlin, *Genesis and the Dinosaur* by von Fange. It was decided that correspondence by Frair with Accelerated Christian Education and Zondervan be continued to secure all “rights” to the CRS high school textbook, *Biology: A Search for Order in Complexity*. No decision was made at this time to republish the book.

It was passed that a catalogue and brochure be developed by Williams and be disseminated to advertise our books. It was passed that permission be granted to videotape the CRS Friday evening meeting under the following provisions: prior permission to videotape

be approved by the Chairman of the Friday evening session, the tapes not be copied for sale and one complete copy be sent at CRS expense to the Chairman of the Friday evening session.

The financial report by Klotz was given as follows: it was passed that the Treasurer consult with the auditor on a voucher system of payments to be shared with the Financial Committee for possible implementation in the future.

It was passed that we enlarge the Board to 16 members. It was passed that the six incumbents (Boylan, DeYoung, Gish, Kaufmann, Williams, Zimmerman) along with Russell Humphreys and Robert Gentet be nominated for the 92/93-94/95 Board. The top six vote-getters will be elected for a three-year term while the last two vote-getters be nominated for a one-year term with eligibility to be nominated again the next year for a three-year term.

The following were elected as officers: President—W. Frair, Vice President—E. Chaffin, Secretary—D. Kaufmann, Treasurer—J. Meyer, Financial Secretary—P. Zimmerman, Membership Secretary—G. Wolfrom.

It was passed that anyone requesting access to our archives at the Concordia Historical Institute at St. Louis be required to get written permission from the President of CRS.

It was passed that our 1992 Board Meeting be 9-11 April at Ann Arbor, Michigan.

It was passed that Wolfrom be authorized to purchase an IBM compatible computer system for $5830.

The Board acknowledged the 28 years of service of Bill Rusch to the Society. The Board on behalf of the CRS recognized Dr. Rusch's retirement from the Board as the end of an era during which he provided exceptional leadership to the formation and development of CRS. His influence on the cause of creationism is reflected by hundreds of students who are now dedicated to creationism.

It was passed that the President write a letter to the Editor of the *Scientific American* protesting the disqualification of Forrest Mims for a position because of his creationist views.

The meeting was adjourned at 1520 hours.

David A. Kaufmann, Secretary

DINOSAUR UPDATE

DON B. DEYOUNG* AND JOHN R. MEYER**

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Abstract

The authors summarize a National Science Foundation-sponsored workshop on the Biology of Dinosaurs, conducted by J. Michael Parrish. a leading paleontologist. Current ideas and uncertainties about dinosaurs are discussed. Possible creationist research areas are noted.

Introduction

During March, 1991 we attended a workshop on the Biology of Dinosaurs at Northern Illinois University, DeKalb. The meeting was sponsored by the National Science Foundation and was designed especially for college professors. There was no acknowledgement of an awareness of non-evolution views of dinosaur origins, existence, and demise. However we were surprised and encouraged by the openness of the group to question much of the traditional evolutionary dinosaur "doctrine," and especially to question many of the new claims published in the last decade. Not that the concept of evolution was in question, just its mechanism and evidence! The following report gives our impressions of the workshop and related literature.

Technical Literature Resources

The primary suggested text for the course was *The Age of Dinosaurs* by Kevin Padian (1989). This work is the product of 13 contributing experts in dinosaur biology and covers in considerable detail the current data and speculation on such subjects as taxonomy, behavior, physiology, anatomy, ecology, extinction, tracks and trackways. The stated goal of this publication is to form ". . . the basis of an increased number of dinosaur courses in college and university curricula" (Preface). Thus, the text, and indeed the entire conference was geared toward giving undergraduate college teachers the background necessary to teach a rigorous course in biology, using dinosaurs as the integrating theme. A reasonably detailed, technical bibliography makes the text a valuable resource not only for teachers, but also for researchers who may want access to the most recent, significant literature in the field.

Current Controversies

Dinosaurs are being studied by more experts than ever before; graduate schools of paleontology are crowded. There is fundamental, emotional debate in a large number of areas. We see this as a healthy sign that dogmatism regarding dinosaur fossil interpretation within the professional community is in decline. The reader should not assume, however, that this openness necessarily extends in all cases to actual skepticism of evolution itself. The following are some of the controversial areas where diversity of opinion reigns:

Classification The details of the supposed dinosaur family tree are interpreted differently by nearly every researcher. Phylogenetic systematics or cladistics now often involve extensive data sets and sophisticated statistical analysis by high-speed computers. The new taxonomies have largely replaced older classifications, and show great variation depending on who does the study.

At the base level, the group of Thecodonts are no longer thought of as dinosaurs, but as the ancestors of

*Don B. DeYoung, Ph.D., Editor of *CRSQ*, Grace College, 200 Seminary Drive. Winona Lake. IN 46590.
**John R. Meyer, Ph.D, Treasurer of CRS, 1306 Fairview Road, Clarks Summit, PA 18411.

dinosaurs, crocodiles, and birds. In fact, this term which was part of the standard evolutionary tree a quarter century ago is now declared off limits by some (see Padian, 1989, p. 18). Rowe (1989, p. 100) notes, "We have yet to discover anything that might reasonably be thought of as the ancestral theropod . . ." Major gaps still appear today in dinosaur taxonomy, just as in the past.

South America, especially Brazil and Argentina, is now looked at as the "cradle" of dinosaur origin. However, do not look any time soon for consensus among evolutionists regarding the fine details of dinosaur evolution! As Parrish noted in the course, "As we find more specimens, things are not necessarily getting clearer, but they are certainly getting more interesting!"

Metabolism Were particular dinosaurs endothermic (warm-blooded) or ectothermic (cold-blooded)? That is, did they have internal thermostats; and if so, what was the set-point? There are multiple arguments for both sides (see for example, Bakker, 1975.) One suspects that some advocates for endothermism are seeking an evolutionary dinosaur link with birds which have a high and precise internal thermostat setting. From the fossil evidence, it appears that a number of thermal strategies may have been used, including those which are primarily behavioral (i.e., basking in the sun to warm up and seeking shade to cool.)

Diet Were particular dinosaurs carnivores, herbivores or omnivores? Paleontologists now recognize that teeth and claws are not always definitive diagnostics of diet. Such implements might be needed for eating tough vegetation as well as flesh. *Tyrannosaurus rex (T. rex)* is still pictured as the ultimate carnivore, and is commonly called a "land shark." *T. rex* is interpreted as a vicious predator that rammed into the side of its prey with gnashing teeth. With a behavior similar to that of the present day Komodo Dragon, it may have then backed away from its large, potentially-dangerous prey and waited for it to weaken or to die due to blood loss or infection.

Anatomy Did various dinosaurs move with a sprawling gait like lizards with legs spread out to the sides? Or were the legs erect, perhaps like horses? Museum models can be found of identical dinosaur species exhibiting either stance. The correct posture for many groups is unclear.

Some of the Hadrosaurs (duck-billed dinosaurs) had a large single curved horn-like structure above their heads. Analysis shows this crest *may* have been a resonance chamber connected with the animal's air passage. The calculated frequency of this "singing" dinosaur is 85 Hz, a bass sound that would carry over large distances. Some have suggested a bassoon-like tone! It is thought that other very peculiar, enlarged nasal and cranial cavities may have contained poison sacks, but the precise function of many is still a mystery.

Did dinosaur tails drag, or were they held out straight and horizontal? The recent variety in published dinosaur illustrations shows the need for more careful biomechanical analysis of these creatures. Tail-drag prints and ossified tail tendons are being studied to better understand actual dinosaur appearance.

The conference revealed many other uncertainties in current dinosaur illustrations. Speaker Parrish, an expert on fossil skulls, acknowledged that dinosaur skull reconstruction is often based on "wishful thinking." Apparently in dinosaur cranial preservation, as in the preservation of the skulls of supposed pre-human ancestors, the pressure of the overlying sediments may cause distortion and render precise measurements of cranial dimensions and capacities *speculative* at best. In recent dinosaur reconstructions, the line between research and artistic license has clearly become blurred.

Birds, Feathers, and Dinosaurs Creationists have written many articles on *Archaeopteryx*, the supposed dinosaur-bird transition. Papers in the *Creation Research Society Quarterly* include those by Akridge (1979), Brown (1980), Lubenow (1980), and Trop (1983). Some evolutionists continue to claim that particular dinosaurs had feathers and this has been promoted in reconstructions of *Iguanodon.* This is clearly a biased attempt to establish an evolutionary dinosaur-bird relationship. Leading scientist J. H. Ostrom (1976) believes that birds are actually small, carnivorous dinosaurs of theropod origins. There has been a significant attempt to press this dogma in the popular media. For example, Bakker (1986, p. 462) in his book *Dinosaur Heresies* makes the following evangelistic appeal to the evolutionary faithful:

> Let dinosaurs be dinosaurs. Let the Dinsosauria stand proudly alone, a Class by itself. They merit it. And let us squarely face the dinosaurness of birds and the birdness of the Donosauria. When the Canada geese honk their way northward, we can say: 'The dinosaurs are migrating, it must be spring!'

Gauthier and Padian (1989, p. 121) assert, ". . . the origin of birds, once the most problematic of evolutionary 'missing links,' is now probably the best resolved major evolutionary transition known in all of paleontology." They also note (p. 125) that this concept can be effectively indoctrinated into students using the following technique:

> The conclusion reached by these studies is that birds *are* dinosaurs, not just descended from them . . . This realization is an especially effective one to bring to students, who delight in knowing that they eat dinosaur at Thanksgiving, have dinosaur baths in their backyards, and occasionally go out for dinosaur McNuggets.

In contrast, L. D. Martin (1983) holds to an evolution of birds from crocodile-like ancestors. In spite of pictures to the contrary (see for example, Bakker, 1980, p. 310), *no* dinosaur has yet been found with feather evidence, or even with large surface pores that could support feathers.

Padian (1991, p. 9) also claims that the newly-found fossil bird from the Cretaceous sediments of China is not a challenge to *Archaeopteryx* but was in fact 10 million years younger and was the earliest-known bird with tree-living adaptations. Nevertheless, he acknowledges that ". . . Chinese stratigraphy is often difficult to correlate precisely with rock sequences known outside of China . . ." Just how much stratigraphic realignment may be needed to establish the Chinese bird into the supposed evolutionary tree is not stated, but one wonders how much of this gerrymandering

goes on behind the scenes. For example, with regard to the Early Jurassic fauna, Padian (1989, p. 12) notes ". . . the discoveries of recent years have been due not so much to new collecting as to stratigraphic realignment." Gauthier and Padian seem offended by the announcement from Chaterjee of a find called Protoavis. Assuring the reader that it will not substantially change the bird evolutionary tree, they nevertheless lament ". . . already the creationist press has seized upon Dr. Chatterjee's preliminary claims to mock the competence of paleontologists and their inferences about the fossil record" (Gauthier and Padian, 1989, p. 129).*

Stegosaurus Plates It is now agreed by most that Stegosaurus had a single row of bony, back plates down the middle of its back instead of the traditional double row. There are several possible functions of these extensions: cooling radiators, warming solar collectors, defense, or sexual selection. Bakker (1980, pp. 226-234) suggests that the plates were moveable and could be flipped down to ward off predators attacking from the side.

***T. rex* Forelimbs** It appears that the forelimbs of *T. rex* were too short to reach its mouth as an aid in eating. Some experts therefore believe the forelimbs were used to disengage the mouth after attacking prey. Others believe the short muscular arms helped the animal get up from a lying position. Only eight *T. rex* fossils have been found thus far.

Related to the *T. rex* forelimb problem are the large thumb spikes of the *Iguanodon.* When first discovered a century ago, the spikes were placed on the animal's nose! Some have now suggested that these thumb spikes were used to puncture prey. It is interesting that secular researchers characteristically look immediately for purpose and function in dinosaur studies. This is in marked contrast to the hunt for vestigial organs by physiologists and anatomists working on presently existing organisms (see Bergman and Howe, 1990, for an excellent, in-depth evaluation of the vestigial organ problem from a creationist perspective). Of course, evolutionists give credit to natural selection rather than created design.

Reproduction Many contrasting, imaginative ideas have been given to explain the reproductive strategies of heavily-armed, heavily-spiked dinosaurs! The trend is to ascribe "sexual display" function to any visible external structure whose function is unknown. Padian (1989, p. 4) summarizes that the crest on the head of the duckbill dinosaur has "been variously interpreted as a snorkel, an air-storage chamber, a butting organ, a honker, a device to enhance smelling and a sexual display organ." He goes on to suggest, tongue in cheek, "Besides, in paleontology, if you don't know what a structure is for, the fall-back answer is always 'sexual display'."

Extinction A clear, secular explanation for the demise of dinosaurs is still lacking. The meteorite hypothesis, presented with a flurry in 1980 (see Alvarez et al., 1980) no longer receives total support (see for example Alvarez et al., 1990). There are several basic problems with this popular view. *First,* possible impact sights for a large meteorite have proliferated, but none has gained wide acceptance. The recently reported evidence of a huge impact crater in the Yucatan penninsula (see Beatty, 1991, for a highly-readable popular account of this possible discovery) is a strong contender at the present time and will no doubt receive considerable popular support in the media in the months to come. It has not received universal acceptance among evolutionists at the present time, however. The above article (Alvarez et al., 1990, p. 40) quotes Virgil Sharpton of the Lunar and Planetary Institute as saying, "But we shouldn't be any less critical just because it's convenient."

Second, the much-touted iridium concentration in the Cretaceous/Tertiary clay layer is not as sharply defined as first reported. *Third,* some dinosaur groups went extinct well before the end of the Cretaceous; others will surely be found extending into the Paleocene. Thus there is not really a unique extinction point in the fossil record.

Periodic extinctions based on returns of the "Death Star," Nemesis, have been largely discounted. For a review of the original book by Raup on this subject see Lillo (1987). There is no clear evenly-spaced, cyclic-time correlation with the postulated nature of extinction in the fossils of the world.

Archibald (1989, p. 164) notes that there have been in excess of 85 different theories put forth to explain the demise of dinosaurs. He further states that, "If anything is clear from these various theories, it is that we may never be able to identify a *single* cause for dinosaur extinction." Clearly, a great deal of ink will spill over this issue before it reaches anything close to a consensus of opinion. It still remains one of the most fascinating problems in biology.

Current Interest Areas

Beyond the debated areas, dinosaur studies are active in other specific directions, as shown by the frequency of technical articles. Of course, the most recent ideas are not necessarily the correct ones ! Some of the special interest topics are:

Taphonomy Defined as the death conditions and arrangement of animal remains, this specialty relates to the orientation of individual bones in sedimentary rock as well as mass death assemblages. Clearly, because of the many hints of association with catastrophic flood events, this discipline is at the center of creationist interests. Mass graves of dinosaurs are extensive in some parts of the world. Dinosaur National Park in Utah and Dinosaur Provincial Park in Alberta are well-known examples.

High-Latitude Dinosaurs Evidence for dinosaurs is found in the Antarctic as well as Alaska (see for example Parrish et al., 1987) These polar regions experience long periods of darkness and relative cold. This gives rise to possibilities of dinosaur migration, hibernation, or torpor (sluggish, inactive state). On the other hand, high-latitude dinosaurs may provide indications of past moderate world-wide climates.

Dinosaur Era Over geologic time, the tenure of dinosaurs on earth is expanding in both directions,

*Editor's Note: For a most interesting exchange between an evolutionist and a creationist on this subject see Padian, K. 1989. "Protoavis"? *CRSQ* 25:201-202 and Calais, R. C. 1989. Response to Padian. *CRSQ* 25:202-207.

presently backward beyond middle Triassic and forward into the late Cretaceous and beyond. As dinosaur evidence proliferates in the geologic strata, the creationist model of dinosaur history can only be strengthened.

Diversity New species of dinosaurs are found regularly. The number of known dinosaur species has increased by 25-33% during the past two decades. The growing variety of animals shows rich diversity with unique features such as horns, crests, frills, and with an ever-increasing number of fundamental missing links. Chure (1989, p. 180) refers to ". . . unsuspected structural features that almost defy explanation" and to ". . . discoveries that hint that dinosaurs are likely much more structurally diverse than we suspect" (pp. 175, 189). As the number of specimens increases, unknown factors of special creation interest such as growth rates and diets may be clarified.

Social Behavior The primitive reputation of dinosaurs is rapidly disappearing. The behavioral complexity of these creatures has been revealed by the discovery of nest sites that were apparently reused year after year. Some of the nests still hold up to 30 petrified eggs (see for example, Homer, 1984). Herding instincts are shown by "nurseries" of multiple nests, and by large groups of parallel tracks. In many instances it is still not clear who was predator and who was prey. A study of tooth marks on bones might clarify this problem but few such studies have been published to date.

Locomotion and Track Sites Studies on the biomechanics of dinosaurs have just begun (for a recent review see Gillette and Lockley, 1989). Much of the data is derived from the abundant dinosaur tracks, in which creationists have had great interest for many years (see Rosnau et al., 1989). Gillette and Lockley (1989, p. 135) note that the mechanism by which tracks are preserved is poorly understood. They are found in great abundance at some sites in certain formations which may be very extensive in area. The existence of regional "megatracksites" covering up to 30 km^2 near Moab, Utah, are the focus of considerable current interest. Trampling of the substrate by herds of dinosaurs has been so extensive in some areas that it has been given the name "dinoturbation" and is the focus of some current work in sedimentology (see Gillette and Lockeley, 1989 for a summary of current studies in this fascinating field).

Molecular Paleontology The search goes on for dinosaur DNA fragments. The best chance may be high-latitude specimens, where the remains are more mummified and less calcified. It is very difficult to imagine that relatively-fragile DNA strands could be preserved intact for a minimum of 70 to 80 million years. Thus, the discovery of dinosaur DNA fragments in dinosaur remains would be of immense interest to creation scientists.*

Prospects and Challenges in the Future of Dinosaur Studies

There are few if any areas of dinosaur biology which are not of considerable interest in the creation/evolution controversy. We believe that the following may be of special interest in the years ahead:

1. Because evolutionists presuppose that birds must have specialhad a genetic link to lower forms, their frantic scramble to keep *Archaeopteryx* on its perch will no doubt produce much controversy, as well as media hype to strengthen the faithful and convert the wayward (for an excellent review of evolutionary thinking on *Archaeopteryx* see Wellenhofer, 1990). Nevertheless, feathers, the single diagnostic characteristic of birds, will continue to be a major stumbling block to evolutionary ancestory. The publication on details of Protoavis may be released before our paper appears and will no doubt fuel much controversy.

2. Dinosaur extinction scenarios will likely proliferate and will be popular subjects on TV natural-history programs as well as in science journals. Creationists should also give attention to this problem. What is the relationship of dinosaur tracks, not only to the underlying substrate and other adjacent tracks, but also to mass death assemblages? What can we learn from high lattitude fossil finds? Can mass dinosaur gravesites and megatrack sites be correlated with the Genesis Flood? Is there any possibility that either marine or terrestrial dinosaurs could have survived the Flood in large numbers to repopulate the post-Flood world? Could extinction and associated mass graves then have followed due to a deteriorating environment caused by meteorite impacts or volcanic activity? Should the major dinosaur fossil-bearing sediments be considered as Flood deposit, or were they actually post-Flood remnants?

3. What can creationists learn about the limits of variation and the nature of the Genesis "kinds" within the Dinosauria? Can modern taxonomic approaches be incorporated into creationist models, not only of the dinosaurs but of all taxa, both living and extinct? What are the limits of the Genesis "kinds" in the modern world?

4. Dinosaur footprints, long of considerable interest to creationists, need to be studied in much more detail. Techniques of image enhancement and substrate analysis must be developed for specific application to dinosaur footprint correlations with possible human footprints. In a major constructive challenge to creationists, Waisgerber has sagely observed (Rosnau et al., 1989),

> . . . the search for anachronistic evolutionary fossils and their footprints should be continued by creation scientists and hopefully others. If the Leakeys can spend years searching for evolutionary remains in Olduvai Gorge, Kenya, Africa, then creationists have every right and responsibility to spend years investigating the Glen Canyon Group of Formations.

5. Popularization of dinosaur studies through the media has provided evolutionists with a major evangelistic tool. Animated dinosaur exhibits produced by the Dinomation Company will continue to be a major attraction at natural history museums across the country. There is great need for a cadre of well-trained creationists to challenge these evolutionary propaganda

*Editor's Note: Also it is amazing to have surface dinosaur tracks preserved for millions of years. See Williams, E. L. 1990. Ichnofossils exposed to the elements. *CRSQ* 27:76 and Waisgerber, W. 1990. Reply to Williams. *CRSQ* 27:76-77.

ploys in the media, in creation conferences and in secular classrooms.

6. The extent and nature of attempts at stratigraphic realignment to salvage the evolutionary tree must be given careful attention. That is, we must determine and report how much of current stratigraphic studies is legitimate and how much is derived from the need to support evolutionary presuppositions.

7. The role of presuppositions in all origins interpretations must be carefully examined. How much of our present "understanding" of dinosaur biology depends on data and how much depends on presuppositions? For example, Chure (1989, p. 179) notes:

> Lewin (1988) has presented an intriguing account of how biases and preconceptions have shaped interpretation of hominid fossils and how this has often resulted in statements . . . that went far beyond the specimens in hand. . . . In reading Lewin's book I was struck by the similarity to dinosaurian studies. Once thought to be nothing more than giant lizards, dismal evolutionary dead ends waiting to be supplanted by the mammals, dinosaurs are now viewed as evolutionary successes. . . . Although the former view put recognizable and undue constraints on interpreting dinosaur biology, the clear and present danger of the latter view is not always recognized. In our zeal to rehabilitate the dinosaur, might we not go too far. . . . Are preconceptions once again driving our interpretations of the fossils?

Thus, the problem of presuppositions is recognized, even by some evolutionists.

Creation Research Society Research Station and Dinosaur Studies

The CRS research station near Chino Valley, AZ, can play a significant part in developing a creationist model for dinosaur biology. Located in north-central Arizona just below the Mogollon Rim of the Colorado Plateau, the station will be ideally situated to perform extensive surveys in the dinosaur country just a few hours away. Creationist field research and laboratory studies and analysis are greatly needed in these challenging fields.

Conclusion

Paleontology is one of the most fascinating and rapidly changing fields of science. The present time might be called the "age of dinosaurs" because of the flood of new data. Those who speak and write about dinosaurs should be aware of current thinking. Even experts in the field have a difficult time keeping up with the literature. A careful examination of the field will indicate that the creationist view of dinosaurs, including their existence in recent earth history, remains strong.

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> The issue is one of fact. Is the actual universe amenable to the laws of science, or is it not? Of course the truth is that it partly is, and partly isn't. One of the consequences of too much of the modern scientific training upon us is that we finally come to the point where we mistake the Uniformity of Nature, which is only the expression of a hope, for the statement of a fact. Mr. Millikan is typical of a great many scientists in his determination to force upon us the dogma, Science works. He will scarcely consent to the qualification, sometimes.
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THERMODYNAMIC ANALYSIS OF A CONDENSING VAPOR CANOPY

TRACY W. WALTERS*

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Abstract

A significant problem confronting vapor canopy theorists is the energy load on the atmosphere during the collapse of the canopy. Previous attempts to quantify this energy load have indicated that atmospheric temperatures would rise much too high to sustain life. However, up to this point the regulating effect of the ocean during canopy collapse has not been addressed. This investigation develops a more detailed energy balance than used in earlier work and also includes a simplified model to account for ocean-atmosphere coupling. Assuming that the entire energy load is released during the 40 days of the Flood, the simplified model predicts that the upper bound for canopy precipitable water is two feet.

Introduction

The possibility of a canopy of water vapor that rested on top of the atmosphere during pre-Flood times has generated a great deal of discussion by creationists. The existence of such a canopy has been used to explain a number of problems, including: 1. the source of water that would permit 40 days and nights of rain during the Noachian Flood, 2. the evidence for a more uniform and temperate worldwide climate in earth history, and 3. the longevity of the ancient patriarchs.

Whitcomb and Morris, in their classic creationist work *The Genesis Flood,* discussed the necessity of a pre-Flood vapor canopy. The Biblical evidence for the existence of a vapor canopy was exhaustively reviewed by Dillow (1981a). Dillow (1978, 1981a, 1981b) argued that, based on his analysis, the pre-Flood atmosphere could have supported a vapor canopy that would have provided an earth surface temperature hospitable to life. In his model Dillow assumed a canopy that held 40 feet of precipitable water. This proposition was challenged by Morton. Morton does not agree with the evidence for a worldwide temperate climate (1980), and thus asserts that the vapor canopy hypothesis was invented to solve a nonexistent problem. Believing that Dillow's assumptions were flawed, he attempted his own analysis (1979, 1981), where he concluded that a canopy with 40 feet of precipitable water would not have been able to provide an hospitable surface temperature, but would in fact result in surface temperatures over a thousand degrees. In addition, Morton found a critical error in Dillow's analysis (Morton, 1982). Dillow acknowledged the error, but proceeded to perform an improved analysis with a more detailed model (1983). His results again showed an hospitable earth surface temperature for a vapor canopy containing 40 feet of precipitable water.

This matter was left in a rather unsettled state until the recent work by Rush (1990). Rush used a much more rigorous analytical tool to investigate the canopy induced atmospheric temperature. Based on a detailed one-dimensional radiation balance analysis, Rush found that stable atmospheres would probably exist for vapor canopies containing up to 34 feet of precipitable water. However, surface temperatures increased dramatically with canopy thickness, although not nearly as high as estimated by Morton (1979). Rush speculated that the addition of clouds to the model would likely lower the surface temperature, but probably not enough to make feasible a canopy containing more than about 1.7 feet of precipitable water. These results were also discussed in Rush and Vardiman (1990).

The issue of the amount of precipitable water in the canopy is also of interest because of the effect of increased atmospheric pressure on living things. In today's 14.7 psi atmosphere the partial pressure of oxygen is about 3 psi. If the partial pressure deviated too far from this value, certain physiological effects can occur in humans, as well as in other animals and plants. As the earth surface pressure increases, the partial pressure of oxygen increases proportionally. Dillow (1981a) realized that more than 40 feet of precipitable water in the canopy (resulting in a surface pressure of 2.18 atmospheres) would likely be harmful to life, and constructed his model accordingly. Additional work by Smith (1980) indicated that atmospheric pressures above about 2 atmospheres were likely to be harmful. Thus, it is generally accepted that an upper bound for any hypothetical vapor canopy is about 40 feet of precipitable water.

Besides the surface temperature problem, Dillow (1981a) discussed the problem of energy load on the atmosphere during the canopy collapse. This energy load results primarily from the energy released by the canopy when it condenses. If it is assumed that all of this energy is transferred into the atmosphere, Dillow's preliminary calculations showed an atmospheric temperature increase on the order of thousands of degrees during the canopy collapse. Dillow attempted to sidestep this significant problem by hypothesizing that the canopy experienced a pre-collapse phase where energy was gradually released over a period of about a year, rather than just during the 40 days of the Flood. This was a rather weak hypothesis, and more work was clearly necessary. Rush's later work did not address this issue, although he acknowledged the problem and called for more work.

With Rush's more detailed pre-Flood canopy temperature profiles, a more indepth look at the collapsing canopy energy load is possible. This investigation attempts to improve upon Dillow's analysis (1981a) by adding the effects of ocean-atmosphere coupling.

A number of simplifying assumptions were made in the analysis, and are summarized below:

Assumptions

1. Radiative transfer of the energy generated during collapse is small when compared to the magnitude of other energy sources.

*Tracy W. Walters, P.E., 3917 Conrad Drive, #C-10, Spring Valley, CA 91977.

2. All of the energy from the canopy collapse was released at a constant rate during the 40 days of the Flood.
3. The energy released by the canopy during collapse transfers directly to the atmosphere.
4. The atmosphere can be represented as a bulk system (i.e., a single node). This means that the atmospheric temperature at the ocean's surface is equal to the bulk atmospheric temperature because the atmosphere is well mixed by gross turbulent motion.
5. The ocean can be represented as a bulk system (i.e., a single node). This means that the ocean surface temperature is equal to the the bulk ocean temperature because the ocean is well mixed by gross turbulent motion.
6. The ocean is sufficiently massive and well mixed that its temperature change is negligible when energy is transferred from the atmosphere.
7. The canopy and atmosphere structure is given by the radiation balance results generated by Rush (1990).
8. Before the canopy collapses the ocean and atmosphere are in thermal equilibrium such that their respective surface temperatures are approximately equal.
9. Evaporation from the ocean is negligible.
10. The ocean surface area is equal to the earth surface area (i. e., the whole earth is covered with water).
11. Energy sources into the atmosphere due to other postulated cataclysmic geophysical phenomena associated with the Flood are negligible.
12. Physical laws were not violated during the canopy collapse.

Energy Balance

In general, the First Law of Thermodynamics can be stated:

$$\Delta U = \Delta Q - \Delta W$$

where work is defined positive when done by the system, and heat is positive when transferred into the system. The First Law describes how a system changes during an energy exchange process, but does not address the rate of change. However, it is usually the case that the equilibrium is established quickly in a system, so that the First Law can be used in rate equations. Thus, by applying the First Law, a steady state energy balance on the atmosphere during the canopy collapse can be expressed:

$$\left\{\frac{\Delta U_a}{\Delta t}\right\} = \left\{-\dot{Q}_0 + \dot{Q}_{c,l} + \dot{Q}_{c,s} + \frac{\Delta PE_c}{\Delta t}\right\} - \left\{\frac{\Delta PE_a}{\Delta t}\right\}$$

where:

$\dot{Q}_0$ = rate of sensible heat transfer from atmosphere to ocean
$\dot{Q}_{c,l}$ = rate of latent heat release from canopy
$\dot{Q}_{c,s}$ = rate of sensible heat release from canopy
PE_c = canopy potential energy
PE_a = atmosphere potential energy
U_a = atmosphere internal energy
t = time

The quantities in brackets represent the same quantities as expressed in the First Law statement. The change in the atmosphere's potential energy is another way to express the work done by the atmosphere. This will be demonstrated in a later section.

For clarity, the atmosphere to ocean energy transfer, $\dot{Q}_0$, is defined positive when flowing out of the system. To be consistent with the First Law definition of positive energy transferring *into* the system. a negative sign has been placed in front of $\dot{Q}_0$. Figure 1 shows the energy terms accounted for in the analysis. It is assumed that the atmosphere responds as a lumped mass to these energy inputs (Assumption #4). Rearranging the energy balance:

$$\dot{Q}_0 = \dot{Q}_{c,l} + \dot{Q}_{c,s} + \frac{\Delta PE_c}{\Delta t} - \frac{\Delta PE_a}{\Delta t} - \frac{\Delta U_a}{\Delta t} \qquad (1)$$

Equation 1 states that in order to satisfy the First Law, the entire energy load on the atmosphere, including internal energy changes (everything on the right hand side of Equation 1) must be balanced by the energy transferring to the ocean. Each energy contribution will be discussed in turn.

Latent Energy

Energy is released when the vapor canopy condenses into liquid water. This energy due to the phase change into a liquid (i. e., latent energy) is relatively constant with temperature and is assumed to equal 1077 BTU / lbm. The released energy is,:

$$Q_{c,l} = m_c h_{lv} \qquad (2)$$

where m_c is the mass of the canopy and h_{lv} is the liquid to vapor enthalpy difference (the latent energy). All symbols are defined in the nomenclature section. The canopy mass, m_c, can also be written

$$m_c = \rho_w A \Delta z_w \qquad (3)$$

where ρ_w is the density of liquid water, A is the surface area of the earth (= 5.49 x 10^{15} ft^2), and Δz_w is the thickness of the canopy when in liquid form. By combining Equations 2 and 3 the latent energy can be expressed

$$Q_{c,l} = \rho_w A \Delta z_w h_{lv} \qquad (4)$$

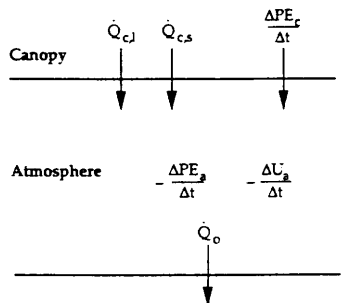

Figure 1. Schematic showing steady state energy balance on atmosphere.

Sensible Energy

Sensible energy is transferred between the condensed canopy waters to the atmosphere as it approaches the atmospheric bulk temperature. This energy is given by

$$Q_{c,s} = m_c c_{p,c}(T_c - T_a) \quad (5)$$

Combining Equation 3 with Equation 5 gives

$$Q_{c,s} = \rho_w A \Delta z_w c_{p,c}(T_c - T_a) \quad (6)$$

Dillow (1981a) approximated the temperature change, $T_c - T_a$ as being 75°C (135°F). However, this approximation is only reasonable if the final atmospheric temperature is near 75 °F. As the final atmospheric temperature increases, the sensible energy transfer decreases.

Potential Energy of Canopy

The potential energy of the canopy was postulated by Dillow (1981a) to transfer into the atmosphere through frictional heating from falling raindrops. This assumption is also retained. The canopy potential energy is

$$PE_c = m_c g z_{cg,c} \quad (7)$$

where g is the acceleration due to gravity (assumed to be constant with altitude), and $z_{cg,c}$ is the center of gravity of the canopy. Equation 7 can be rewritten by combining it with Equation 3

$$PE_c = \rho_w A \Delta z_w g z_{cg,c} \quad (8)$$

Dillow's (1981a) approximation for the canopy center of gravity was felt to be inaccurate. A better approximation was therefore developed. In general, the center of gravity can be expressed as

$$z_{cg,c} = \frac{\int_{z_b}^{z_t} \rho\, z\, dz}{\int_{z_b}^{z_t} \rho\, dz}$$

where *r* is the density of water vapor, z is altitude, z_b is the canopy bottom and z_t is the top. The bottom half of the fraction is merely the mass of the canopy divided by the earth surface area. The equation thus can be simplified to

$$z_{cg,c} = \frac{A}{m_c}\int_{z_b}^{z_t} \rho\, z\, dz$$

Using the ideal gas law this can also be written

$$z_{cg,c} = \frac{A}{m_c}\int_{z_b}^{z_t} \frac{P}{R_c T} z\, dz \quad (9)$$

For a linear temperature lapse rate, the temperature variation and pressure variation with altitude can be expressed as

$$T = T_b + \lambda(z - z_b) \text{ and}$$

$$P = P_b\left(1 + \frac{\lambda(z - z_b)}{T_b}\right)^{-g/\lambda R_c}$$

where λ is the temperature lapse rate. Substituting these relationships into Equation 9 gives the following integral

$$z_{cg,c} = C_4\int_{z_b}^{z_t} (C_1 + C_2 z)^{C_3} z\, dz \quad (10)$$

where:

$C_1 = 1 - \lambda z_b / T_b$
$C_2 = \lambda / T_b$
$C_3 = -(g/\lambda R_c + 1)$
$C_4 = P_b A/(R_c T_b m_c)$

From an integral table it can be shown that the solution to Equation 10 is

$$z_{cg,c} = C_4 \frac{(C_1 + C_2 z)^{(C_3+1)}}{C_z^2}\left[\frac{C_1 + C_2 z}{C_3 + 2} - \frac{C_1}{C_3 + 1}\right]_{z_b}^{z_t} \quad (11)$$

Potential Energy of Atmosphere

Dillow (1981a) includes the effect of work performed by the atmosphere in an isothermal expansion. A better approximation is to account for atmospheric work as the change in potential energy of the atmosphere. The reasoning behind this assertion is given in the Appendix. The change in potential energy can be expressed

$$\Delta PE_a = m_a g \Delta z_{cg,a} \quad (12)$$

where m_a is the mass of the atmosphere (= 1.14 x 10^{19} lbm.). From Rush's results (1990), the atmospheric temperature profile before the canopy collapse is approximately constant. The center of gravity for such an isothermal atmosphere becomes:

$$z_{cg,a} = \frac{\int_{z_b}^{z_t} \rho\, z\, dz}{\int_{z_b}^{z_t} \rho\, dz} = \frac{\int_{z_b}^{z_t} P\, z\, dz}{\int_{z_b}^{z_t} P\, dz}$$

Hess (1959) shows that the pressure variation in an isothermal atmosphere is exponential:

$$P = P_b e^{(z - z_b)/H}$$

where $H = R_a T / g$ is the scale height of the atmosphere. Substituting in to the above equation gives

$$z_{cg,c} = \frac{\int_{z_b}^{z_t} P_b e^{(z-z_b)/H} z\, dz}{\int_{z_b}^{z_t} P_b e^{(z-z_b)/H} dz}$$

The solution to this integral is

$$z_{cg,a} = H\frac{e^{(-z_t/H)}\left(\frac{z_t}{H} + 1\right) - e^{(-z_b/H)}\left(\frac{z_b}{H} + 1\right)}{e^{(-z_t/H)} - e^{(-z_b/H)}} \quad (13)$$

For the atmospheric center of gravity at the end of the 40 days, the top of the atmosphere, z_t, goes to infinity and, remembering that $z_b = 0$, the center of gravity reduces to the atmospheric scale height:

$$z_{cg,a} = H$$

Incorporating this into Equation 12 gives:

$$\Delta PE_a = m_a g(R_a T_{a,f}/g - z_{cg,a,i}) \quad (14)$$

The additional subscripts i and f have been added to denote the initial and final canopy conditions.

Internal Energy of Atmosphere

Dillow's (1981a) assumption of an isothermal atmospheric expansion did not allow him to consider the internal energy change of the atmosphere. The internal energy of the atmosphere before and after the canopy collapse is easily determined with a relationship developed by Hess (1959). In summary, it can be shown that

$$U = \frac{c_v}{R} PE + \frac{c_v}{R} P_t A z_t \quad (15)$$

where P_t is the pressure at the top of the section of air and z_t is the altitude of the top. For today's atmosphere P_t is equal to zero, making the last term of Equation 15 zero. However, this term is not zero when a canopy is present. Adding together the internal and potential energy gives

$$\begin{aligned} PE_a + U_a &= PE_a + \frac{c_{v,a}}{R_a} PE_a + \frac{c_{v,a}}{R_a} P_t A z_{a,t} \\ &= \left(1 + \frac{c_{v,a}}{R_a}\right) PE_a + \frac{c_{v,a}}{R_a} P_t A z_{a,t} \\ &= \frac{c_{p,a}}{R_a} PE_a + \frac{c_{v,a}}{R_a} P_t A z_{a,t} \end{aligned} \quad (16)$$

The pressure on the right hand side is just the hydrostatic pressure of the canopy. Thus,

$$P_t A z_{a,t} = \rho_w g \Delta z_w A z_{a,t} \quad (17)$$

Combining Equations 2, 16 and 17 gives

$$PE_a + U_a = \frac{c_{p,a}}{R_a} m_a g z_{cg,a} + \frac{c_{v,a}}{R_a} \rho_w g \Delta z_w A z_{a,t} \quad (18)$$

Ocean/Atmosphere Energy Transfer

A well accepted method for modelling sensible energy transfer between the ocean and the atmosphere under varying stability conditions is the "bulk aerodynamic method." This method makes use of a simplified equation that correlated experimental data for ocean-atmosphere sensible energy transfer. The energy transfer is expressed by the following equation (with our definition that positive heat flow is from the atmosphere to the ocean):

$$\dot{Q}_0 = K \rho_a c_{p,a} V_{10} A (T_{10} - T_0) \quad (19)$$

where K is found by experiment. K varies depending on the investigator, although it is generally found to be near 0.001. Equation 19 is an approximate correlation that has been found to be valid over a wide range of conditions. Good agreement with this correlation has been demonstrated by Smith (1977) for a location in the North Sea experiencing gale force winds (50 mph). Kraus (1972) gives a value of 0.0013±.0003. Kraus also discusses data for hurricanes that indicates that the constant may be even higher under hurricane conditions. However, the data is sketchy and no attempt is made to use it here. Resch and Silva (1977) performed detailed water/wind tunnel experiments and determined a value of 0.003 for the constant. However, most actual ocean data point to a value much nearer 0.001. The data of Smith (1977) encompasses very broad wind velocity conditions, and therefore his value of 0.001 appears to be the best for the present analysis.

Rearranging Equation 19

$$\frac{\dot{Q}_0}{\rho_a c_{p,a} V_{10} A (T_{10} - T_0)} = K \approx 0.001$$

Heat transfer specialists will recognize the left side of this equation as the nondimensional Stanton number. The variables V_{10} and T_{10} are, respectively, the mean wind velocity and mean temperature at 10 meters height above the ocean surface. With the assumption of a single node atmosphere (Assumption #4), then V_{10} and T_{10} become V_a and T_a, the atmosphere's velocity and temperature. These quantities represent *averaged* values around the globe during canopy collapse.

Substituting these values into Equation 19 gives

$$\dot{Q}_0 = K \rho_a c_p V_a A (T_a - T_0) \quad (20)$$

where K = 0.001

It should be noted that application of Equation 19 in this analysis involves an extrapolation for which there are no data. That the correlation retains its accuracy for this analysis is only an assumption. However, as already mentioned, the data that do exist indicate a value for K somewhere near 0.001. Thus, using the correlation in this analysis appears reasonable.

Results

Combining Equations 4, 6, 8, 14 and 18, the right-hand side of Equation 1 can be written

$$E_{Total} = \rho_w A \Delta z_w \left(h_{lv} + c_{p,w}(T_c - T_{a,f}) + g z_{cg,c} + \frac{c_{v,a}}{R_a} g z_{a,t}\right) + \frac{c_{p,a}}{R_a} m_a g z_{cg,a,i} - m_a c_{p,a} T_{a,f} \quad (21)$$

Table I. Comparison of energy quantities during canopy collapse.

Precipitable Water (ft)	$Q_{c,l}$	$Q_{c,s}$	$PE_{c,i}$	$PE_{a,i}$	$PE_{a,f}$	ΔPE_a	$U_{a,i}$	$U_{a,f}$	ΔU_a	Total (BTU)
0.33	1.24E+20	5.16E+18	2.48E+19	4.04E+20	4.45E+20	4.11E+19	1.06E+21	1.12E+21	5.42E+19	5.82E+19
1.67	6.18E+20	2.58E+19	1.21E+20	4.73E+20	4.45E+20	-2.79E+19	1.40E+21	1.12E+21	-2.82E+20	1.08E+21
4.19	1.54E+21	6.45E+19	2.75E+20	4.62E+20	4.45E+20	-1.69E+19	1.59E+21	1.12E+21	-4.74E+20	2.83E+21
33.93	1.25E+22	5.23E+20	1.44E+21	2.14E+20	4.45E+20	2.31E+20	1.74E+21	1.12E+21	-6.20E+20	1.49E+22

Note: Final atmosphere assumed to be at 110°F and ocean assumed to be at 60°F.

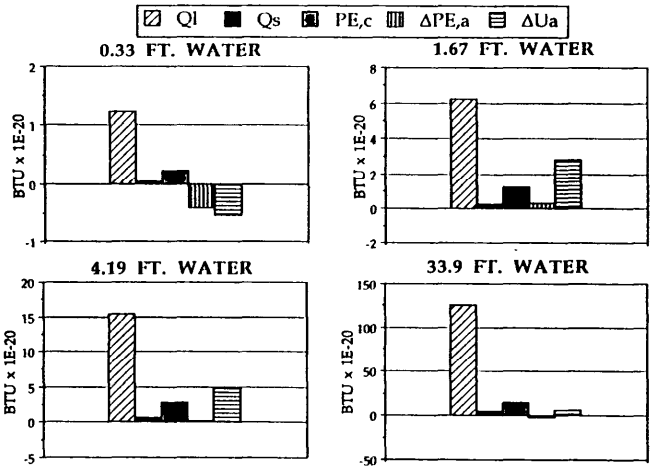

Figure 2. Relative energy magnitudes during canopy collapse for the four canopies analyzed by Rush (1990). Final atmosphere assumed to be at 110°F and ocean assumed to be at 60°F.

With an assumption of the mean canopy temperature after condensing, everything on the right-hand side of Equation 21 is known except for the terms containing $T_{a,f}$. For additional simplicity Equation 21 can be written

$$E_{Total} = E'_{Total} - (m_a c_{p,a} + \rho_w A \Delta z_w c_{p,w}) T_{a,f} \qquad (22)$$

where E'_{Total} is everything on the right side of Equation 21 not containing a $T_{a,f}$ term.

Although results from Rush (1990) and Rush and Vardiman (1990) indicate that the atmospheric surface temperature before canopy collapse increases significantly with canopy thickness, it is assumed for the purposes of this study that the pre-collapse earth surface temperature was hospitable to life. It should be pointed out that this is somewhat inconsistent with Assumption #7. Rush's results are used as initial conditions only for the purpose of determining canopy potential energy and the pre-collapse atmosphere potential and internal energy.

The energy load on the atmosphere during canopy collapse results from the canopy/atmosphere initial conditions described by Rush (1990). Table I shows the magnitude of the terms in Equation 21. Since the final atmospheric potential and internal energy and the average sensible energy transfer from the canopy are not known yet because of the yet to be determined final atmospheric temperature ($T_{a,f}$), it is assumed for discussion purposes that $T_{a,f}$ is 110°F.

It is apparent from Table I that the latent energy contribution is generally larger than the other energy sources, especially above 4 feet of water. This is the same conclusion reached by Dillow (1981a). Figure 2 shows the relative contributions to the energy load for the four canopies that Rush analyzed. The total energy load as a function of canopy precipitable water is shown plotted in Figure 3.

It is interesting to note that the change in atmospheric potential energy shown in Table I is positive for the 0.33 and 33.93 foot canopies and negative for the 1.67 and 4.19 foot canopies. This results from competing effects on the change in atmospheric center of gravity. From Equation 12 it can be seen that an increase in the center of gravity (i.e., the center of gravity moves *upward)* corresponds to a net increase in potential energy. And conversely, a decrease in center of gravity corresponds to a decrease in potential energy. Further, an increase in potential energy corresponds to work being performed *by* the atmosphere (an atmospheric expansion) and a reduction in total energy load on the atmosphere (Equation 1). This atmospheric expansion occurs for the 0.33 and 33.93 ft. canopies. On the other hand, the center of gravity actually decreased for the 1.67 and 4.19 ft. canopies, resulting in work being performed on the atmosphere (an atmospheric contraction). This condition adds to the total energy load.

It is easy to visualize how the atmosphere would expand with the collapse of the canopy, because of the removal of the canopy weight. However, the canopy itself also induces a particular temperature distribution within the atmosphere, which also affects the mass distribution. The nature (and magnitude) of this distribution influences the location of the atmospheric center of gravity, just as the canopy weight does. The result is that the canopy weight, which compresses the atmosphere, plays a stronger role for the 0.33 and 33.93 ft. canopies, while the initial canopy induced temperature and mass distribution plays a stronger role for the 1.67 and 4.19 ft. canopies. This can be seen from Table I.

A similar line of reasoning holds for the atmospheric internal energy change. The relationship between the atmospheric potential energy and internal energy is given by Equation 15. In (15) it is seen that the atmospheric internal energy depends on the canopy base pressure. This dependence is what leads to the sign difference in Table I between potential and internal energy change for the 33.93 ft. canopy.

In order to satisfy the First Law, the energy transfer to the ocean must equal the total energy load shown on the far right in Table 1. Using (20) and (22), Equation 1 can be simplified to

$$K\rho_a c_{p,a} V_a A(T_a - T_0) = \frac{\Delta E'_{Total}}{\Delta t} - \frac{(m_a c_{p,a} + \rho_w A \Delta z_w c_{p,w})}{\Delta t} T_a \qquad (23)$$

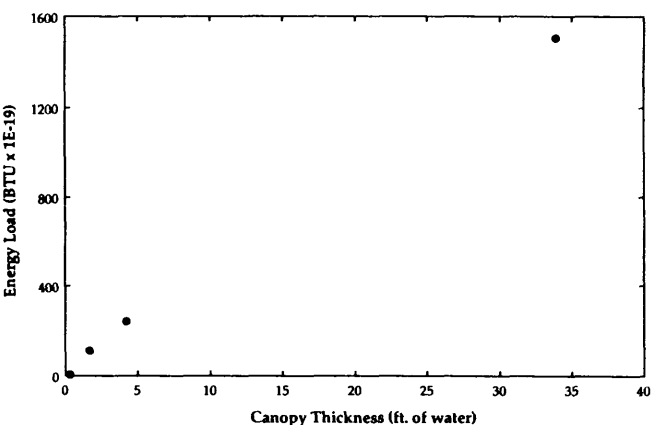

Figure 3. Energy load on the atmosphere vs. amount of precipitable water in the canopy (final atmosphere assumed to be at 110°F).

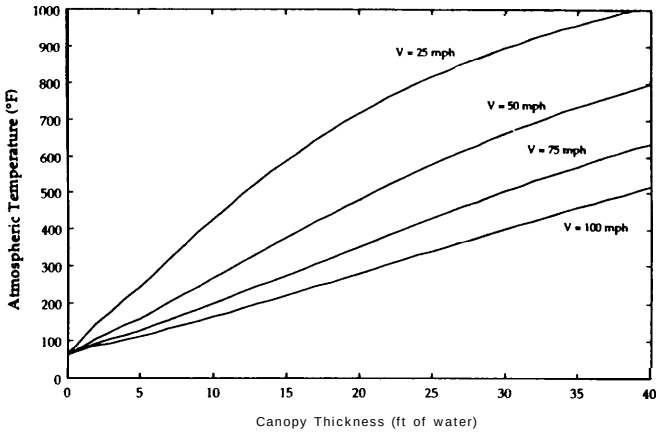

Figure 4. Atmospheric temperature vs. amount of precipitable water in the canopy for various average wind speeds around the earth (T_0 = 60°F).

where the f subscript has been dropped and it is to be understood that we are calculating T_a at the final conditions at the end of the 40 days. The average ocean temperature is not in fact a known term, but a reasonable approximation can be made in light of Assumption #8.

The rates of energy release, $\Delta E'_{Total} / \Delta t$, are constant for a given canopy thickness and assumed to be the average value over 40 days (Assumption #2). Since the specific heat of air is fairly constant with temperature, and the ocean temperature is assumed known, the only other variable in Equation 23 besides V_a is r_a, the density of air at the base of the atmosphere (i.e., at the ocean surface). The density will be affected by the change in air temperature and the change in air pressure at the surface. However, at the end of the 40 days, the canopy weight will have been removed and the pressure will be one atmosphere. Thus, using the ideal gas law with the surface pressure equal to a constant 1 atm., (23) can be written

$$\frac{KP_a c_{p,a} V_a A}{R_a T_a}(T_a - T_0) =$$

$$\frac{\Delta E'_{Total}}{\Delta t} - \frac{(m_a c_{p,a} + \rho_w A \Delta z_w c_{p,w})}{\Delta t} T_a$$

or

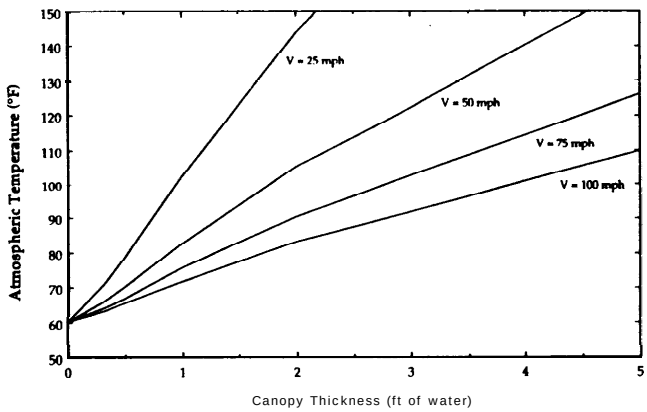

Figure 5. Enlargement of Figure 4 showing atmospheric temperature vs. canopy precipitable water thickness (T_0 = 60°F).

$$\frac{C_1 V_a}{T_a}(T_a - C_2) = C_3 - C_4 T_a$$

where:

$C_1 = KP_a c_{p,a} A / R_a$
$C_2 = T_0$
$C_3 = \Delta E'_{Total} / \Delta t$
$C_4 = (m_a c_{p,a} + r_w A \Delta z_w c_{p,w}) / \Delta t$

After some algebraic manipulation, this reduces to a quadratic equation of the form:

$$T_a^2 + \frac{C_1 V_a - C_3}{C_4} T_a + \frac{-C_1 C_2 V_a}{C_4} = 0$$

This can be solved using the quadratic formula yielding:

$$T_a = -\frac{C_1 V_a - C_3}{2C_4} + \sqrt{\left(\frac{C_1 V_a - C_3}{2C_4}\right)^2 + \frac{C_1 C_2 V_a}{C_4}} \quad (24)$$

Equation 24 relates the atmospheric driving temperature for various wind speeds that is required to transfer the energy load summarized in Table I. Equation

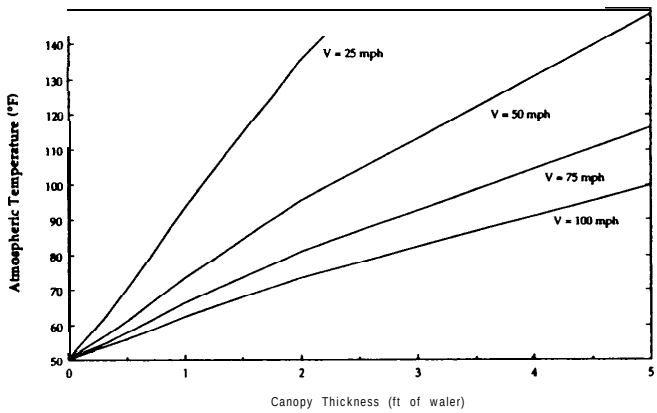

Figure 6. Atmospheric temperature vs. canopy precipitable water thickness for various average wind speeds around the earth (T_0 = 50°F).

24 is plotted parametrically in Figure 4 for an average ocean temperature of 60°F and mean canopy temperature after condensation of 212°F. The scale of Figure 4 is expanded in Figure 5 for clarity. It is apparent from Figures 4 and 5 that the wind velocity has a significant effect upon energy transfer from the atmosphere to the ocean, with higher wind velocities resulting in greater energy transfer, as expected.

A 60°F ocean temperature appears reasonable if Assumption #8 is true. For completeness, results are shown in Figure 6 for an average ocean temperature of 50°F and in Figure 7 for an average ocean temperature of 70°F. (Today's average ocean temperature is near 40°F.) The primary effect of varying the ocean temperature is to shift the scale of Figure 5-7 up and down.

Although the atmospheric temperature in Equation 24 technically represents the final temperature at the end of the 40 days, it is a simple matter to show that with a constant energy input the temperature would

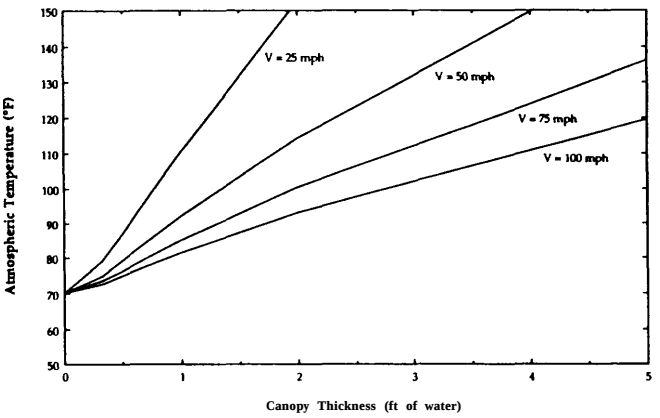

Figure 7. Atmospheric temperature vs. canopy precipitable water thickness for various average wind speeds around the earth (T_0 = 70°F).

remain relatively constant at T_a for the entire 40 days. After the 40 days the rains ceased and the atmosphere would have begun to establish a new equilibrium temperature profile, probably similar to the present one.

Since the atmospheric temperature remains fairly constant over the 40 days, a T_a of 110°F is a reasonable upper boundary that sustains life on the ark. This would allow a pre-collapse average earth temperature of 60°F to increase 50°F. In addition, it is difficult to conceive of an average wind speed around the globe greater than 50 mph, although this may be possible. Using these two constraints, inspection of Figure 5 indicates that a canopy thickness of about 2 ft. of precipitable water is the maximum allowable that permits life to survive.

It is interesting to note that this is similar to the conclusion made by Rush (1990) based on radiation balance considerations. These two independent indicators (Rush's results and the results presented here) give strong evidence that the vapor canopy as conceived by Dillow probably contained much less than 40 feet of precipitable water. It should be noted, however, that the atmosphere/vapor canopy structure analyzed by Dillow and Rush is only one possible structure. Perhaps another structure can be conceived which holds 40 feet of precipitable water but is not subject to these constraints.

Ramifications of a Thin Canopy

If the upper limit for precipitable water in a hypothetical canopy is really 2 ft., is the Vapor Canopy Theory then disproved? This question deserves careful consideration by creationists. If rainfall is to be maintained around the clock for 40 straight days, then 2 ft. of water in the canopy could supply, on the average, about 0.5 inches of water a day for 40 days. Although 0.5 inches a day of rainfall is not torrential, it is nevertheless not insignificant. Dillow (1981a) assumed that the downfall must have been very heavy, but is this really so? And did the rainfall have to cover the entire earth? Could it have been concentrated near the equatorial belt, with lighter rains in the more extreme latitudes? If so, then the equatorial regions could have received 1-2 inches a day, which my experience tells me is quite a bit of rain. The preliminary conclusion, therefore, is that a thin canopy (with about 2 ft. of water) may have been adequate to supply the required rainfall for 40 days and nights.

Discussion of Assumptions

Assumption 1 does not rule out radiative energy transfer altogether, only net radiative transfer. The radiative energy from the sun was in balance with reradiated energy from the earth before the canopy collapsed, so that any additional radiated energy effects would be effectively superimposed on the initial radiation balance. Since radiation energy transfer is not very efficient at the low temperatures of interest, and the magnitudes of the released energy are comparatively large, the effects of radiation energy transfer can be neglected. It should be noted, however, that at the higher temperatures shown in Figure 4 (~1000°F) that radiative effects would become significant. In addition, if the atmosphere increased above 212°F the rain water would boil and evaporate. For these two reasons the model becomes less accurate as the temperature increases to large values. However, the constraints previously obtained at lower temperatures would still remain valid.

Along the same line, a question arises as to whether the processes involved in a collapsing canopy could change the earth radiation balance sufficiently to affect the energy balance developed in this investigation. Probably not. The mean solar energy rate to the earth is roughly 1.5×10^{17} BTU/hr, or 1.4×10^{20} BTU if integrated over 40 days. This is the total energy from the sun to the earth. However, any possible change to the planetary radiation balance would have to be only a fraction of this total. Keeping this in mind, a comparison with Table I shows this quantity to be about 10% of the 1.67 ft. canopy. Thus the *total* energy from the sun is much smaller than the collapsing canopy energy load when the canopy is 1.67 ft. thick. Since only a fraction of this total energy could be involved in a net radiation balance change, this contribution can be ignored for the majority of cases we have considered. Since the total solar energy is about twice that of the energy load for the 0.33 ft. canopy, there could be some effect there. However, a detailed analysis would likely show the planetary radiation balance changes to be insignificant in this case as well. In any case, the conclusion about the 2 ft. canopy limit remains intact.

It seems reasonable that a relatively constant rainfall occurred during the Flood, so the assumption of constant energy transfer rates (Assumption #2) also appears reasonable. That the entire canopy condensation process occurred during the 40 days of the Flood is more difficult to ascertain. This uncertainty, in fact, is what Dillow (1981a) used to sidestep the whole energy load issue. Before the Flood rains began, the canopy would have had to already begin to condense so that waters were available to supply the rain. However, it is doubtful that significant condensation could have occurred without prematurely destabilizing the canopy/atmosphere system. Therefore, the condensation process would probably have taken much closer to 40 days than the 500+ days assumed by Dillow. Thus, some relief on the energy load may be possible, but not enough to significantly change the results of this analysis.

Assumption 3 is more difficult to justify. It is not clear how much energy from canopy condensation would heat the vapor in the canopy (and stop the condensation process), and how much would transfer into the atmosphere. A detailed look at the dominating mode of heat transfer in the canopy may be necessary to answer this question.

Under Assumption 4 a single node atmosphere is assumed. It seems reasonable that large atmospheric disturbances during the canopy collapse and the Flood would result in strong mixing of the atmosphere. It is not clear how uniform the resulting atmospheric temperature profile would be. It is clear, though, that a single node assumption permits us to obtain reasonable results. The next step may be to assume a two node model of the atmosphere, which could change the results of this analysis, although probably by less than a factor of three. A two node model would allow an atmospheric temperature gradient that was hospitable at the ocean surface, but much higher at the top of the atmosphere.

Assumptions 5 and 6 appear very reasonable in view of the ocean's very large thermal capacitance and hence ability to absorb large amounts of energy. Although prior to the Flood the ocean would probably have been stratified, a mixing mechanism as would be expected during the Flood would serve to keep the ocean fairly well uniform in temperature. (Editor's note: See Smith and Hagberg, 1984, for possible reasons for stratified Flood waters.)

Assumption 7 is somewhat inconsistent with assumption 8. The whole basis for this analysis is that hospitable earth surface temperatures existed before the Flood. However, Rush's results (1990) showed otherwise. What is essentially assumed, therefore, is that there was a rapid change from Rush's high atmospheric temperatures to hospitable surface temperatures in the lower atmosphere.

Assumption 9 appears reasonable in light of the fact that evaporation would add energy to the atmosphere by mass transfer, but would remove a roughly equivalent amount of energy from the atmosphere in order to drive the evaporation. The reason for this is that energy must be taken from the atmosphere to evaporate the water from the ocean surface, thus resulting in a cooling of the atmosphere. In addition, evaporation would be self-limiting, because the atmosphere would approach a saturated condition and evaporation would gradually decrease.

Another consideration is whether the atmosphere will become saturated due to the rain falling through it. If this happened, the saturation pressure of the atmosphere could exceed that of the ocean surface because of the higher temperature in the atmosphere. This then could allow additional energy transfer through mass transfer of vapor from the atmosphere to the ocean. However, calculations show that the amount of vapor needed to exceed the ocean partial pressure of water vapor would be on the same order as the rainfall itself. Thus, it is concluded that evaporation from the ocean or condensation at the ocean surface are not significant effects.

Since most of the earth surface is covered by water, and this was probably the case before the Flood as well, the possible error introduced by Assumption 10 is small.

Since there is no way to characterize "the other energy sources" in Assumption 11, assuming that other sources are negligible is the only practical approach at this point. It should be noted, however, that many creationist Flood scenarios involve considerable amounts of energy transfer into the atmosphere, thus aggravating the problems outlined in this investigation.

A final word is in order concerning Assumption 12. It seems to the author that any creationist models that require violation of physical laws, especially for extended time periods, should be viewed critically. An investigation by Johnson (1986) took this approach. It is true that the Creator can override the "laws" of nature as we know them, but it is also true that He rarely chooses to do so. A look at the Biblical account of the Flood shows the Creator working His purposes through natural means. For example, the Creator could have removed all the men and animals He planned to destroy in the Flood by merely speaking a word. But instead, He chose to work through the natural elements by using a Flood to destroy the earth, and using a wooden ark, built by Noah, to preserve Noah's family and the animals. It would seem inconsistent with the context of the account (although certainly not impossible) for the Creator to have employed large scale miracles here and there to solve energy balance problems that arose.

Perhaps an even greater reason against using miracles in creationist models is that aside from Scriptural evidence, there is no way to determine whether the said miracles actually occurred. So what good are the models? If, on the other hand, there is clear Scriptural evidence for a miraculous process (e.g., the gathering of the animals to the ark), then this can be more confidently incorporated into creationist models.

Conclusions

A more detailed model of the thermodynamics occurring during the collapse of the vapor canopy was developed which included the effect of ocean-atmosphere coupling. Results indicate that the canopy structure as conceived by Dillow could not have contained much more than 2 ft. of precipitable water. Although additional work may modify this conclusion, it appears unlikely that the results could be changed significantly. Vapor canopy theorists should incorporate this constraint into their thinking, or develop a new model of the canopy which is not subject to this constraint.

Recommendations

1. A more detailed model of the atmosphere may alleviate somewhat the results obtained from the single node model. Specifically, a two node model of the atmosphere would allow a temperature gradient to exist, which may lower surface temperatures, thus allowing more water in the canopy. However, it appears unlikely that this could increase the allowable water in the canopy by more than a factor of three.
2. An analysis of the heat transfer mechanisms within the canopy would show whether the energy released would transfer into the atmosphere or be stored in the canopy itself.
3. A more rigorous analysis of the pre-Flood period in which the canopy began to collapse may place

an upper bound on the allowable time in which to transfer the energy load.

4. More thinking about other possible canopy structures should be done. The main obstacle to confront is the latent energy release, so effort should be directed at minimizing this contribution.

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Nomenclature

A = surface area of earth
c_p = specific heat at constant pressure
c_v = specific heat at constant volume
E = energy
g = gravitational acceleration
h_{lv} = liquid/vapor enthalpy difference (heat of vaporization)
H = atmosphere scale height (RT/g)
m = mass
P = pressure
PE = potential energy
$\dot{Q}_0$ = rate of heat transfer from atmosphere to ocean
$Q_{c,l}$ = rate of latent heat release from canopy
$Q_{c,s}$ = rate of sensible heat release from canopy
R = gas constant
T = temperature
t = time
U = internal energy
V = velocity
W = work
z = altitude
z_{cg} = center of gravity

Greek symbols

λ = lapse rate ($\Delta T/\Delta z$)
r = density

Subscripts

a = atmosphere
b = base or bottom
c = canopy
cg = center of gravity
f = final conditions
i = initial conditions
l = latent
lv = liquid to vapor
o = ocean
s = sensible
t = top
w = water (liquid)

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Appendix

The change in atmosphere potential energy is expressed in Equation 12. As shown in the equation, the change is calculated by determining the change in the atmosphere's center of gravity. Calculating work by assuming an idealized expansion process (such as isothermal) is not accurate because the atmosphere is not undergoing an idealized thermodynamic process. In reality, great quantities of heat are being transferred into the atmosphere while it is expanding/contracting. An easier way to account for the work performed on or by the atmosphere is to determine the change in potential energy of the atmosphere. Once the potential energy is determined, the internal energy is easily found from Equation 18. This is possible because we know (approximately) the initial and final conditions of the atmosphere.

The equivalence of potential energy change and work performed can be best understood by employing an analogy. Consider an insulated gas-filled con-

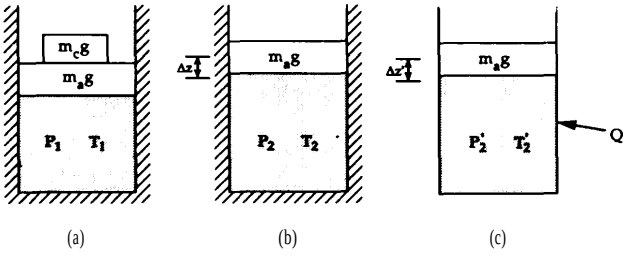

Figure 8. Illustration of work/potential energy analogy.

tainer that supports two weights (Figure 8a). The gas in the container represents the bouyant effect of the atmosphere, and the two weights represent the weights of the canopy and the atmosphere. When the canopy weight, $m_c g$, is removed, the gas will push the atmosphere, $m_a g$, upwards a distance Δz (Figure 8b). This distance is the change in potential energy of the atmosphere, and it is equal to the work performed by the gas.

The analogy can be extended further by considering an active heat source element transferring energy into the gas as it expands (Figure 8c). This energy transfer during expansion/contraction further changes the state of the gas and, hence, changes the height of the atmosphere, thus affecting the amount of work performed. With these considerations in view, it is apparent that the total work performed by the gas (and, by analogy, the atmosphere) is equal to the change in potential energy of the atmosphere. The internal energy of the atmosphere also changes, and can be calculated with a knowledge of the initial and final conditions of the atmosphere.

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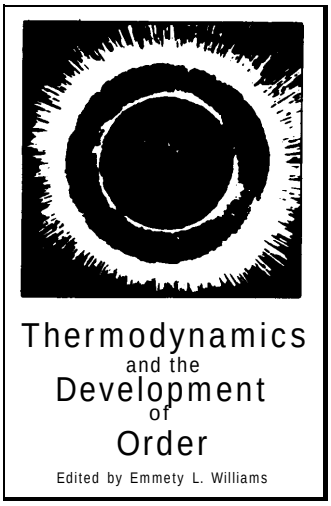

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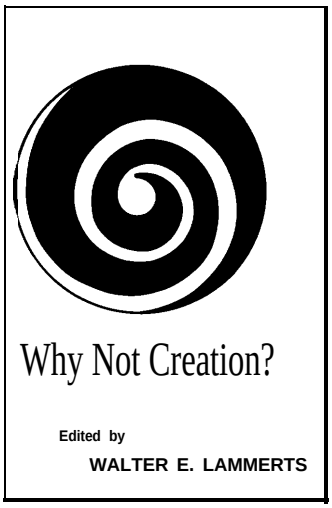

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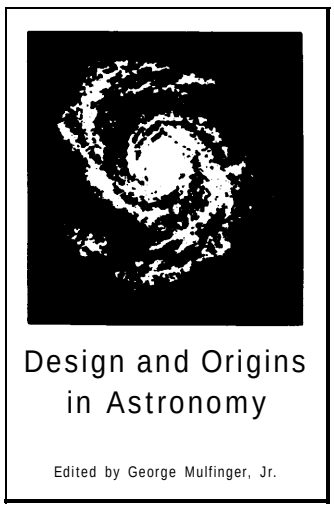

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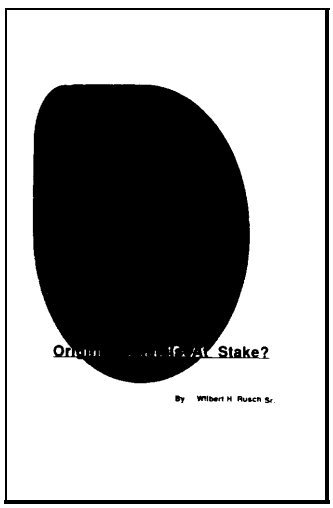

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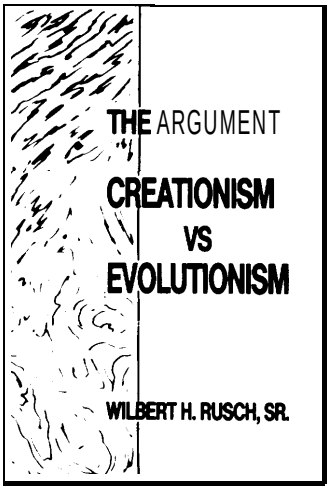

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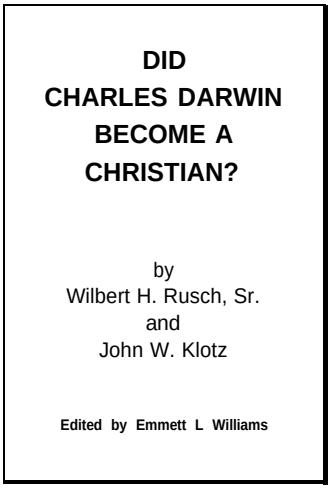

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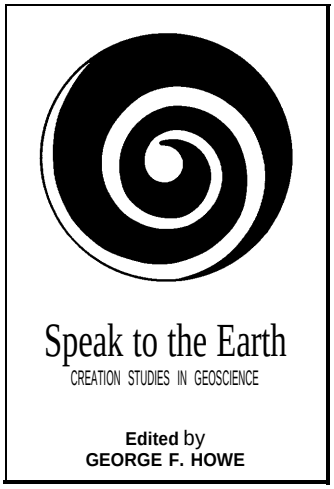

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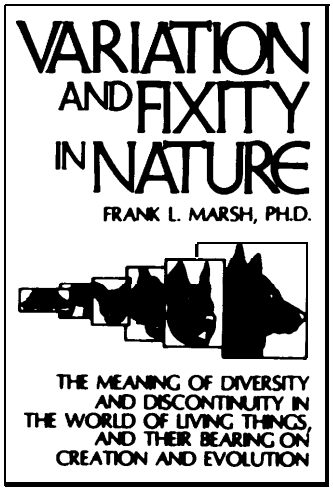

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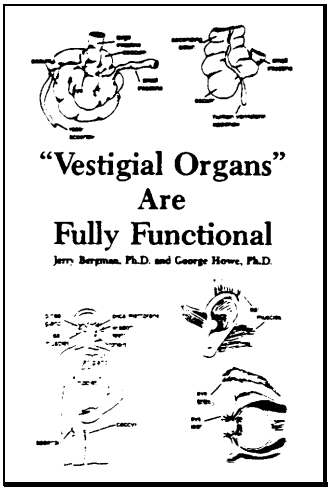

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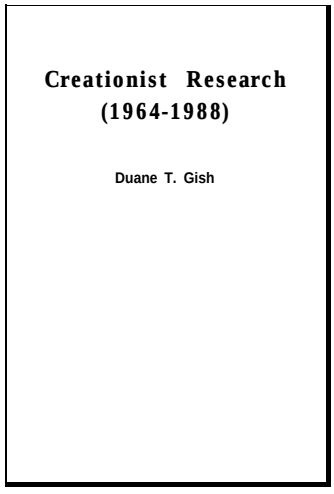

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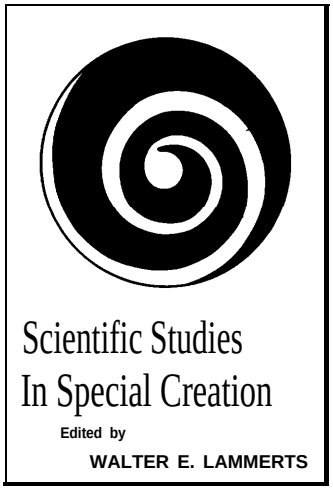

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