

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

CREATION RESEARCH SOCIETY QUARTERLY

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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 creationism, with a current membership of about 400 voting members (with graduate degrees in science) and over 1300 non-voting members. The *Creation Research Society Quarterly* has been gradually enlarged and improved and is now recognized as probably the outstanding publication in its 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.

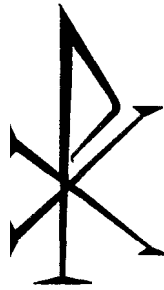


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COVER ILLUSTRATION

The cover illustration shows a tiny moth (*Pronuba yuccasella*) with apparent deliberate action, thrusting pollen down the stigma of a yucca flower. This well-known example of symbiosis has been photographed and discussed by Mr. Willis Keithley who took the colorprint from which this cover illustration was made. His article and another related photograph by him appear elsewhere in this *Quarterly*. He asks the question: If this reciprocal relationship arose through adaptative mutations and progressive differentiation over even a short period of time, how did either survive until this association was

perfected?

Mr. Keithley is an experienced evangelist, naturalist, and photographer. He has been head instructor of photography at Okinawa University and taught photography at Oregon College of Education. He has served as official photographer for the Biology Department of The University of Oregon under the National Science Foundation. He is presently active giving Bible-science lectures and can be reached at Rt. 2, Box 1417, Madras, Oregon. The black and white copy work was done by Mr. Ed Silverman, photographer of Saugus, California.

EDITORIAL COMMENTS

Two years ago a leading creationist brought to my attention the fact that little research or writing had been done by creationists on the problem of "fossil reefs." These supposed reefs are assumed by uniformitarians to prove vast periods of biological earth history. Their argument has some merit, too, because if there are true fossil reefs, and if these were formed at about the rate at which reefs arise today, then surely some lengthy span of time was involved.

I referred the question to a young geologist in Creation Research Society, Mr. Stewart Nevins. He produced a splendid library research paper but when this was reviewed, Dr. Lammerts suggested that Mr. Nevins travel and study directly a reef in Texas. Dr. Larry Butler and the research committee approved the project so that travel and research expenses were funded from the C. R. S. Research Fund.

Mr. Nevins spent many days in the field going by jeep to the localities he discusses in his paper. He worked many additional days in the laboratory performing much-needed lithological studies. We are grateful for his dedication which has led to the astounding conclusion that the Capitan Reef in Texas was probably not a reef at all and would not require vast ages of algal and animal accretion!

This paper should challenge many who have financial means to support the Research Fund. Dr. Butler has been wise and cautious in the use of the monies. Presently several projects are being funded and a few others are under consideration at the same time that the fund itself is almost exhausted. Contributions to the fund may be mailed directly to the treasurer, Prof. Richard Korthals, 2716 Page Ave., Ann Arbor, Mich., and they are tax deductible.

In this March issue, the following people have lent considerable assistance by way of reviewing manuscripts for publication: Dr. John Moore, Dr. Walter Lammerts, Mr. Mark Tippetts, Dr. Thomas G. Barnes, and Dr. Emmett Williams, Jr. It is Dr. Moore, of course, who takes the manuscript through from rough form to finished copy. I am also continually indebted to Dr. Moore for specific counsel on editorial affairs.

Two papers on overthrusts appear in this issue. The California earthquake of February 9, 1971, afforded several opportunities to observe overthrust action on a small scale. Each of these thrust faults provided ample evidence for the fact that overthrusting HAD actually occurred. Thus there can be no "gentle overthrusts," it seems, that would leave no marks of their action. This fact makes it difficult for the uniformitarian geologist to suggest "overthrust action" when

there is little or no evidence of it—such as at the so-called Lewis Overthrust of Montana.

Then too, in this issue, Dr. Lammerts has analyzed the so-called Glarus Overthrust of Switzerland. He points out several weaknesses in the only uniformitarian explanation of this "wrong-order" sequence and he presents an interpretation of the same facts in keeping with flood geology.

Soon evolutionary theorists will be brought face to face with an overwhelming load of physical evidence which flatly controverts their view. Creationist interest in the two laws of thermodynamics has been growing recently. This month we are favored by a highly readable and yet a competent paper by Mr. David C. Penny on implications of the thermodynamic principles in the origin and destiny of the universe. This young scientist-theologian shows that the only coherent explanation for the origin of the universe is that which is found in biblical revelation. Furthermore, Mr. Penny demonstrates the need for transformation of our cosmos as the only way to escape decay and ultimate dissolution.

Dr. Henry M. Morris, our esteemed president, has recently entered the field of Christian College teaching and has prepared a series of class notes on original topics. We have the privilege of sharing with readers one of these sections entitled "Theistic Evolution." We hope that this article and many others in each issue will be of interest and help our many sustaining and student members. Some voting members will also recognize the importance of a "position paper" on this very important topic because we are frequently asked such a question as this: "Why not accept evolution as God's method of creation and simply interpret Genesis 1-2 somewhat more figuratively?" The answers to that question are made emphatically plain by Dr. Morris in terms of hermeneutics and theology.

It is widely known that rodents are intelligent, but who realized that mole rats work on an "assembly-line" basis? Luminous organs in shallow-water fish point toward design and defy evolutionary speculations. Food conducting vessels in land plants present origins problems too, because plants without them do not need them and plants with them depend on them! These and other fascinating topics are discussed by Professor Armstrong in his informative column, "Comments on Scientific News and Views."

In his review of the book, *Biochemical Predetermination*, Dr. Duane Gish has shown that complex macromolecules are not necessarily "predestined" to arise just by virtue of the physicochemical properties latent in the simplest "starting" com-

pounds. Authors Kenyon and Steinman, however, have argued that the origin of life by natural abiogenesis has been "a very likely occurrence" in ages past. Dr. Gish skillfully points out that many of the proposed steps of life synthesis are actually very *unlikely* and even violate expectations of what conditions on a real "primitive earth" would allow. This review is an important paper and should be widely recommended to our colleagues.

Finally, a series of interesting letters, replies, and a booklet review round out another March issue of the C. R. S. *Quarterly*. As December has come to be "book review month," the March issue, it seems, for two years, has afforded an emphasis on geology. We hope that such papers as those by Mr. Nevins and Dr. Lammerts will be "prods and goads" forcing uniformitarians to either abandon their cause of "long ages!" for earth history or else begin a careful re-analysis of data which they have assumed to support their views and their interpretations alone.

We remind readers that the June issue will center on the amazing topics of evidences for Design in nature. That theme should be of value from the standpoint of origins and also from the vantage of providing incontrovertible defense of the existence and craftsmanship of Almighty God. Contents of the September issue (1972) is still being outlined and readers are encouraged to consider writing a research report, review article, short note, book review, or even a letter.

Sustained contribution from interested creationist authors is a primary human factor which maintains publication of the *Creation Research Society Quarterly*. When God's people in the scientific fields contribute fresh publishable material, the witness of C. R. S. flourishes. Our prayer in the editorial staff is that this flow of good manuscripts will not diminish in days ahead, but will increase instead as more and more workers feel constrained to communicate the results of their disciplined and Christ-centered scholarship in the natural sciences.

THE YUCCA AND ITS YUCCA MOTH

WILLIS E. KEITHLEY*

Probably the most intimate of all symbiotic relationships exists in the desert lily, *Yucca baccata*. The stigma-anther configuration is such that the flower cannot be pollinated, either by self-pollination or by insect pollination, unless done deliberately. And this is precisely what occurs as shown in the accompanying illustrations.

The tiny moth, *Pronuba yuccasella*, after carefully, drilling a hole in the ovary, deposits her eggs where the larvae can then feed on the Yucca seed. Next she flies to another flower, and in her specially constructed mouth parts, gathers a quantity of pollen, then flies back to the first flower, and with apparent deliberate action thrusts it down the stigma. Hence the plant is fertilized, and the Yucca is perpetuated! (See cover illustration and Figure 1.)

Consequently, the plant is wholly dependent upon the moth for its existence, and likewise the



Figure 1. *Pronuba* on Yucca flower.

moth's survival is contingent upon the plant's perpetuation. Without the other, neither could survive. If this reciprocal relationship arose through adaptive mutations and progressive differentiation over even a short period of time, how did either survive until this association was perfected?

*Willis E. Keithley is a wildlife photographer and an evangelist. His mailing address is Rt. 2, Box 1417, Madras, Oregon.

COMMENTS FROM PRESIDENT MORRIS

"We believe in creation *and* evolution!" So declare many evangelical scientists today who believe strongly in a no-compromise stance firmly straddling the fence in the middle of the road. Whether they are evolutionary creationists or creationary evolutionists, uniformitarian catastrophists or catastropharian uniformists, is not yet spelled out as clearly as their semantic artistry should permit.

It does seem strange, however, that this terminological nonsense should be promoted by *scientists*, of all people! Scientists are supposed to be meticulously careful in defining terms and specifying boundary conditions. Why can't they distinguish between two such antonymical concepts as creation and evolution?

One suspects this vocabulary problem may be related more to convenience than conviction. "Creation" is more productive of the esteem of the brethren in the Bible class on Sunday; "evolution" is more acceptable in the Faculty Club on Monday. It is nice to enjoy the best of both worlds.

But why can't they be semantically specific and acknowledge that what they really mean to say is "theistic evolution"? Theistic evolution is a venerable concept, held by many scientists and theologians alike through the years, and there is no reason to muddle our jargon at this late date by expanding it to "creation-by-evolution." If they wish to be theistic evolutionists, it is a free country, but why can't they at least let creationists be creationists and evolutionists be evolutionists?

The question of theistic evolution versus non-theistic evolution cannot be evaluated scientifically of course. That is, if the "evolutionary" process (mutation, natural selection, etc.) is the mechanism by which present life forms have come into existence, there is no scientific test which could possibly be applied to the question whether there is or is not a God behind the process.

The non-theistic evolutionist, in fact, makes this very point; insisting that, since he can use evolution to "explain" all forms of life, and life itself, in terms of natural processes, there is therefore no scientific need to invoke a deity of some kind to keep the process going. The theistic evolutionist must explain any given phenomenon in exactly the same physical terms as the atheistic evolutionist. By faith, the latter believes that God initiated and maintains the so-called evolutionary process; by faith, the former says that since this idea is of no help scientifically, he believes that the process initiated and maintains itself.

Theistic evolution is therefore not a scientific position, even though it may be a valid philosophical or theological option. Its validity or non-validity must be determined theologically, not scientifically.

The question of creation versus evolution (whether the latter is theistic, pantheistic or atheistic makes no difference), on the other hand, *can* be formulated in scientific terms and therefore this is a problem that *can be addressed scientifically*.

That is, it is feasible to formulate a Creation Model and an Evolution Model and then to compare these two models of origins on the basis of their ability to correlate and predict observable data in the natural world. This is exactly the way in which competing scientific hypotheses in any field are evaluated.

The Evolution Model is based on *present* processes; proponents assume that present natural laws and processes are adequate to account for the origin and development of all things. Proponents of the Creation Model, on the other hand, state that present processes are not adequate to explain things—there must have been one or more periods of special creative or catastrophic processes in the past which are not operating at present, in order to explain the world as it is. Expressed in this way, the Creation Model is not necessarily limited to the Genesis account of creation and does not even include anything about the nature of the Creator; it is strictly a scientific model.

To illustrate how the two models can be used, consider the phenomenon of the fossil record as an example. A scientist using the Evolution Model would predict that, since all forms of life have been derived from a common ancestral form by the same natural processes that operate today, there ought to have been gradual transitions occurring from form to form all during earth history, and that the fossil record ought to demonstrate such transitions by at least a statistically random collection of such transitional forms.

A scientist using the Creation Model would predict, however, that since the basic kinds of organisms were created by non-continuing processes in the beginning, the fossil record ought to show essentially the same gaps between basic kinds that exist in the modern world, together with the kinds that have become extinct since the beginning. These are clear and definite predictions which may be tested through study of fossils observed in sedimentary rocks.

Any number of similar predictions about observable phenomena can be made from the two models and then compared. In every case the

Creation Model will be found to fit the observed facts at least as well as the Evolution Model. The main point, however, is that creation and evolution can be evaluated scientifically in this manner, and a choice between them made on this basis. It is absurd, therefore, for anyone to say: "I believe in creation and evolution." What is really meant is: "I believe in theistic evolution," and this should be said plainly, especially if the person involved is a scientist.

This is not to say, of course, that one can *prove* either evolution or creation. The scientific method never arrives at ultimate proof concerning any theory; it is simply a means to test predictions. The decision as to which of two rival theories is more likely to be correct must always be based to some extent on subjective evaluation of the "degree of fit" of the data within the predictive framework of each, and this limitation is especially pertinent when non-reproducible events of history are involved in the controversy. Nevertheless, the scientific method, applied in this way to the evaluation of the two basic

theories of origins, does provide a clear basis for discrimination between them, and there is no excuse for semantic subterfuges which blur this distinction.

Members of the Creation Research Society are consciously and vigorously using the Creation Model in their studies and are continually finding it to be a most powerful and satisfying framework for correlating and predicting data. Authors in this issue of the *Quarterly* deal in this manner with such diverse phenomena as coral reefs, overthrusts, the origin of life, and even the basic laws of nature, and find as always that these can all be understood much better in terms of creationism and catastrophism than evolutionism and uniformitarianism.

"God is not the author of confusion" (I Corinthians 14:33), above all in the realm of communication via human language, "For if the trumpet give forth an uncertain sound, who shall prepare himself to the battle—" (I Corinthians 14:8)

CREATION RESEARCH SOCIETY

Membership Voting membership is limited to scientists having at least an earned graduate degree in a natural or applied science. Dues are \$7.00 (Foreign, \$8.00 U. S.) per year and may be sent to Wilbert H. Rusch, Sr., Membership Secretary, 2717 Cranbrook Road, Ann Arbor, Michigan 48104. 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 \$7.00 (Foreign, \$8.00 U. S.) per year and includes subscription to the Annual Issue and Quarterlies. All others interested in receiving copies of these publications may do so at the rate of the subscription price for all issues for one year: (\$10.00 (Foreign, \$11.00 U.S.).

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 man, 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 an historic event worldwide in its extent and effect.

4. We are an organization of Christian men 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 Saviour for all mankind. Therefore, salvation can come only through accepting Jesus Christ as our Saviour.

IS THE CAPITAN LIMESTONE A FOSSIL REEF?†

STUART E. NEVINS*

The occurrence of alleged fossil "reefs" in various portions of the geologic column is recognized by many observers to be a very difficult problem to reconcile with Biblical chronology. If accumulated at approximately the same rate as modern reefs, a single fossil "reef" would take thousands of years to form, and, therefore, could negate the Genesis implication of a young earth and also seriously question the role of the Noachian Flood in earth history.

The famous Capitan Limestone in the Guadalupe Mountains of southeastern New Mexico and western Texas is alleged by many geologists to be a classic example of a fossil "barrier reef." Study of the strata cast doubt on the various depositional and ecologic environments alleged to be associated with "Capitan Reef." So-called "backreef lagoon" and "forereef talus" deposits were not contemporaneous with "reef" accumulation. Furthermore, the Capitan lacks large, in situ, organically-bound framework and deposits of broken debris which can be shown to be derived from an organic framework.

The Capitan is composed primarily of broken fossil fragments in a fine-grained matrix of lime silt and sand which were not wave-resistant when deposited. The fossil flora and fauna of "Capitan Reef" represent a shallow water assemblage which was not especially adapted to a wave or strong current environment. Reef-forming organisms which could bind sediments and build frameworks are either altogether absent or largely inconspicuous.

The available data certainly do not require many thousands of years for the Capitan to accumulate, and, therefore, seem to present little problem for Biblical chronology. Instead, the lack of large organically-bound structures, which would grow during thousands of years, suggests that deposition was very rapid. It is proposed that the Capitan Limestone accumulated either during the last stages of the Noachian Flood or shortly thereafter.

Introduction

One has only to refer to the index of any recent historical geology text to find a number of examples of so-called fossil organic "reefs." These "reef" deposits, which are found in various portions of the geological column, have been recognized by many observers to be very difficult to reconcile with Biblical chronology.

The great thickness of calcium carbonate found in a single ancient "reef" appears to represent thousands of years of accumulation of coralline and algal organisms one on top of another if cemented at roughly the same rate as modern organic reefs. How then can the Noachian Flood be considered important in rapidly depositing certain portions of the geological record if strata implying very slow rates of accumulation are common? Doesn't the occurrence of so many fossil "reefs" require that many thousands of years be added to the relatively short duration of earth history implied in the book of Genesis?

That the so-called "reefs" of the fossil record provide difficulty for Biblical chronology was recognized by John C. Whitcomb and Henry M. Morris in *The Genesis Flood*.¹ They suggest that many of these fossil "reefs" are not *in situ*, organically-bound frameworks, but fossiliferous debris which has been transported in the waters of the universal Noachian Flood. Many structures which may appear to be *in situ*, they propose, are products of resedimentation.

Harold W. Clark² in his book *Fossils, Flood and Fire* considers that Permian "reefs" were growing before the Flood and, therefore, suggests that these structures are organically constructed in quiet water over a period of time longer than the year of the Flood. Clark argues that the rate of growth of Paleozoic "reefs" need not be as slow as the rate for modern reefs. He is not obligated to the long period of time advocated by uniformitarian geologists.

The problem of fossil "reefs" was also brought to many people's attention in an article by J. R. van de Fliert³ written as a critique of *The Genesis Flood*. Van de Fliert advocates that strict adherence to the Biblical chronology is untenable because of the very long period of time necessary to form a single fossil "reef." He mentions several "barrier reefs" in the stratigraphic record as particular problems and insists that modern historical geologists are correct in estimating the age of many of the earth's sedimentary deposits in the order of hundreds of millions of years.

The problem of fossil "reefs" is therefore a crucial issue to Bible-believing Christians.

†Research for this paper was supported by the Research Fund of the Creation Research Society. Contributions for the support of such research projects may be mailed to Richard Korthals, 2716 Page Avenue, Ann Arbor, Michigan 48104 and may be designated for the Research Fund.

*Stuart E. Nevins holds an M.S. degree in geology.

EDITOR'S NOTE: A number of problems of interpretation from the creationistic point of view remain for discussion after further investigation of multiple layers of evaporites known to be associated with "Capitan Reef" and with similar formations in central Canada.

In response to a research challenge from several members of the Creation Research Society, an investigation was conducted into one of the so-called "barrier reefs" of the fossil record. This is the world famous "Permian Reef Complex" of the Guadalupe Mountains of southeastern New Mexico and western Texas (more commonly referred to by geologists as "Capitan Reef"). The purpose of the present research paper is to evaluate critically the stratigraphic, lithologic, and ecologic criteria which have led many modern geologists to consider the Capitan Limestone and associated sediments as an example of a fossil "barrier reef."

Terminology

To avoid confusion many terms must be defined. They are used widely by modern geologists. These definitions are found in the Appendix.

Definition of "Reef"

Before beginning an analysis of the data relevant to "Capitan Reef" it is necessary that agreement be obtained on the definition of the term "reef." Geologists of the past have used different criteria to define "reef," and the term has been misapplied to many fossil deposits which have since been understood to be deposits of tumbled debris, sheet-like strata, or of other non-reefal origin.

The layman usually pictures a reef as a massive structure composed of solid, organically-bound, *in situ* organisms on or near the shore of the ocean. He may recognize that a reef has a particular topographic expression (it rises above the surrounding depositional surface), has an internal structure which is largely unbedded or obscurely bedded, and is chemically composed mainly of calcium carbonate (CaCO_3). To those in the nautical profession, the term "reef" has very precise meaning denoting an organic structure which intercepts waves and is a hazard to navigation.

Present-day reefs have been grouped into three main classes: *fringing reefs* — linear reefs which occur at the shoreline; *barrier reefs* — linear or curved reef strips which follow the shoreline yet are separated from it by a lagoon usually many tens of feet deep; and *atolls* — circular reef strips which surround empty lagoons.

In the study of ancient "reefs" the historical geologist would be severely handicapped by definitions as specific as those just stated. When examining a stratum which is suspected to contain a "reef" deposit, it is often very difficult to determine whether the organisms were bound together at the time they lived. This is often due to recrystallization of the carbonate after deposition which obscures many of the features of the deposit. There is always extreme difficulty in

estimating the depth of water and the position of the shoreline at the time the organisms lived mainly because these are rarely apparent in the stratigraphic outcrop.

The geometry of the suspected "reef" deposit is sometimes changed by erosion subsequent to the period of deposition. Also, the stratigraphic outcrop contains no isochronous datum lines which can tell the geologist what the characteristic topographic expression of the deposit was at a particular moment in time. For many reasons the historical geologist has been content with using a very vague definition of ancient "reefs."

W. C. Krumbein and L. L. Sloss in their text, *Stratigraphy and Sedimentation*, begin their discussion of fossil "reefs" with the following admission concerning the misuse of the term:

Recognition of the oil-trapping potentials of mound-like carbonate masses and the relationship of some of these to modern organic reefs has led to the rather indiscriminate application of the term "reef" to almost any permeable carbonate mass that exhibits a degree of upward convexity. The development of a definition that would cover ancient organic reefs, but which would exclude unrelated masses of similar geometry, is hampered by a number of factors.⁴

The inappropriate use by geologists of the term "reef" which reflects a very poor definition is also emphasized by J. Keith Rigby:

The term "reef" has been applied loosely to several structures by different workers. Locally, it has been used for merely a faunal association, even though the organisms are present as loose, discrete fragments and the rocks in which they occur are evenly bedded in moderately thin layers. The term also has been applied to carbonate lenses in noncarbonate sequences, even though these lenses are of bedded, unbound detritus, oolites, or crinoid columnals. It also has been applied to sheetlike deposits of *in situ* corals or algal crusts or other reef-associated organisms even though the deposit is widespread, thin, and with no demonstrable topographic expression. Massive tumbled blocks also have been considered to be reefs, particularly if the blocks are abundantly fossiliferous and occur in distinctly more thinly bedded rocks. The term "reef" also has been applied to large carbonate structures which may be truly of reef origin at their margins, but which are composed mainly of bedded, clastic debris.⁵

Thus, we see that part of the misconceptions associated with the "reef" problem comes from the vague definition of the term "reef." Since the term has been widely misapplied, we have abun-

dant reason here to question the authenticity of the "reef" interpretation of many geologists. If we were to ask for a more strict definition of the term "reef," it is evident that many (and probably most) of these ancient deposits would not qualify for consideration as "reefs."

Probably the greatest difficulty in identifying so-called ancient "reefs" is that the modern examples generally have little resemblance to those of the past. Krumbein and Sloss recognize that modern and ancient "reefs" are products of different environments. They write:

... much of our knowledge of modern reefs is derived from the study of oceanic realms in which reefs are found on seamounts or islands that rise from abyssal depths. The data have but little applicability to the majority of ancient reef masses available for investigation, since the latter are products of relatively shallow epicontinental seas, commonly associated with restricted euxinic or evaporitic environments that are not duplicated among modern settings. Finally, the dolomitization and recrystallization of carbonate rocks serve to obscure many of the details of structure, texture, and paleontology that would aid in relating ancient reefs to their modern counterparts.⁶

W. H. Easton in his popular text, *Invertebrate Paleontology*, has suggested that the reason for dissimilarity between modern and ancient "reefs" is also due to differences in the type of organisms forming each. Modern reef-forming organisms (mainly scleractinian corals and coralline algae) were not responsible for building Paleozoic "reefs."

Furthermore, most of the ancient "reef" organisms are extinct today and their ecologic affinities are to some degree unknown. Easton recommends that the ancient deposits should not be referred to as "reefs." Specifically,

Recent coral reefs are not typical of coral growths in the past. Intergrown build-ups as large as the Great Barrier Reef east of Australia are unknown in the fossil record. Moreover, many tropical "coral reefs" of today actually consist of more than 50 per cent (some as high as 80 per cent) of calcareous red algae such as *Lithothamnium* and *Hali-medea*. It is also true that ancient reefs commonly (or even mostly) consisted of less coralline material than other material. For instance, many Paleozoic reefs were composed largely of tabulate corals and stromatoporoids, or even of crinoids or brachiopods. For this reason it has seemed desirable for a word to be coined which has neither the connotation of corals nor of rocks and shoals such as mariners have in mind when they speak of

reefs. The term *bioherm* has achieved wide acceptance by geologists for build-ups of any kind of organic skeletal material. In addition, the companion term, *biostrome*, refers to stratified deposits of fossils or fossil debris which do not stand in any appreciable relief above the general surface of deposition.⁷

Since the modern and ancient deposits differ, there are very few features of modern reefs which can be used to identify ancient "reefs." Thus the "reef complex" problem becomes very apparent because we do not know exactly what characteristics to expect in ancient "reefs."

In the previous discussion some of the problems relating to identification of fossil "reefs" have been presented. Yet, many geologists feel that ancient "reefs" exist in the stratigraphic record. How is this identification made? The recognition is based mainly on three logical schemes which come from different subfields of geology. These subfields are 1) stratigraphy, 2) lithology, and 3) paleoecology.

1) Stratigraphy, a discipline of geology which deals with the position and geometry of stratified rocks, is claimed by many geologists to prove the existence of "reefs" in the fossil record. These geologists say the presence of a reef should modify the sedimentation of an area to such an extent that three typical depositional environments (the "reef core," the "backreef," and the "forereef") should exist and be readily apparent from study of the strata.

Since a reef cannot exist without modifying surrounding sedimentation, the environments and strata associated with the alleged "reef" proper are termed a "reef complex." Very characteristic facies relationships should exist in an ancient "reef" and any synchronous depositional surface should change laterally in a seaward direction from "backreef" to "reef core" to "fore-reef." Furthermore, a study of the position of each environment of the so-called "reef complex" should show that the "reef core" rose topographically above the surrounding depositional surface.

2) Lithology, the megascopic and microscopic study of the composition and structure of rocks, is also alleged to be very useful in identifying different environments of an alleged fossil "reef complex." The "reef core," which represents the actual "reef" proper accumulated in the zone of breaking waves, is made of organically-bound sediments and precipitated calcium carbonate from *in situ* organisms. This unbedded framework must be wave-resistant and lack large bodies of mud, silt, or sand which could be easily eroded by waves. Cavities within the "reef core," however, could be filled with fine sediment which has been "baffled" down into the framework.

The "forereef" is on the seaward side of the "reef" and is located in deeper water. Here bedded deposits dipping at some angle away from the massive "reef core" form from fossil fragments and chunks of "core" which have been torn loose by waves and rolled downslope.

The "backreef" is thought to represent a broad and shallow lagoonal environment behind the "reef core" where there is little turbulence caused by waves. Here fine grained materials such as mudstone or siltstone, or chemical precipitates such as calcium carbonate or calcium sulfate are deposited.

3) Paleoecology, the study of the relationship between ancient organisms and their environment, is considered by many geologists to distinguish the various parts of the "reef complex." Thus, the "reef core" should be characterized mainly by rugged life forms which could bind themselves and other sediments. Thin-shelled or free-floating forms would be at a disadvantage. The "backreef" should logically contain fragile organisms and forms which could tolerate higher salinity. Due to the depth below the photic zone, the majority of the "forereef" environment should lack *in situ* growths of algae. Many of the organisms of the "forereef" could be expected to be out of place due to transportation from the "reef core."

Having discussed the problems and techniques used to recognize fossil "reefs," an attempt can now be made to formulate a definition of the term "reef" which will be both restrictive and useful to the geologist. J. Keith Rigby defines "reef" as follows:

Reefs are considered as largely unbedded or obscurely bedded, massive structures which are composed of solid, organically bound, *in situ* organisms, and which were at least potentially wave-resistant structures that rose topographically above the surrounding depositional surface.⁸

Another excellent definition was made by William G. Hart who suggests that a "reef" is:

. . . a wave-resistant organic build-up composed of frame-builders, cementing organisms, and detrital fill which modifies the surrounding sedimentation.⁹

Combining the better features of both Rigby's and Hart's definitions, we attempt a definition which clearly encompasses the stratigraphic, lithologic and ecologic criteria which have been useful in identifying so-called fossil "reefs." It is suggested that a "reef" is a largely unbedded, wave resistant structure composed of *in situ*, organically-bound, frame-building organisms, cementing organisms, and sediment filling which modifies the surrounding sedimentation. This

definition can be used to assess the "reefishness" of many of the so-called "reefs" of the fossil record. It will be employed when examining "Capitan Reef" which is one of the most widely claimed examples of an ancient "barrier reef."

General Description of Capitan Limestone

While the Capitan Limestone is present in several areas in southeastern New Mexico and western Texas, one of the best exposures occurs in the Guadalupe Mountains southwest of Carlsbad, New Mexico. The very light gray limestone which is about 2,000 feet thick outcrops in a narrow strip up to five miles wide and about 47 miles long (See Figure 1).

This limestone tends to form the southeast escarpment of the northeast-southwest trending Guadalupe Mountains. Carlsbad Caverns and Guadalupe Mountains National Parks are located in the Guadalupe Mountains and the exceptional scenery and enormous caverns are due to the distinctive Capitan Limestone.

The Permian Capitan Limestone has been considered for the past 40 years by many geologists to be a classic example of a fossil "barrier reef." Probably more has been written on the Capitan than on any other ancient "reef" in North America. K. H. Crandall¹⁰ was the first to publish data in 1929 advancing the "barrier reef" explanation.

Since then numerous authors have supported Crandall's idea. The "reef" interpretation has been solidly "enthroned" in the literature and in geologists' minds by popular guidebooks and textbooks. Only a few notable articles^{11,12,13} have taken exception to the popular view.

According to advocates of the popular interpretation, one of the best exposures of Capitan Limestone illustrating the appropriateness of the "reef" view is in the Guadalupe Mountains. By far the greatest amount of data on the Capitan comes from this area.

In order to test the "reef" interpretation for the Capitan Limestone of the Guadalupe Mountains, extensive literature search and field investigation was conducted. Since the Capitan is most readily studied in the field where it is cut by canyons on the southeast side of the Guadalupe Mountains, seven canyons were studied in the field research. These are Walnut Canyon, Bat Cave Canyon, Rattlesnake Canyon, Slaughter Canyon, Double Canyon, McKittrick Canyon, and Pine Spring Canyon (See Figure 1). The present research concentrated on the stratigraphy, lithology and to some extent the paleoecology of the Capitan Limestone.

Stratigraphy

Strata of the Permian System¹⁴ and of the Guadalupian Stage of the Middle Permian are well exposed in southeastern New Mexico and

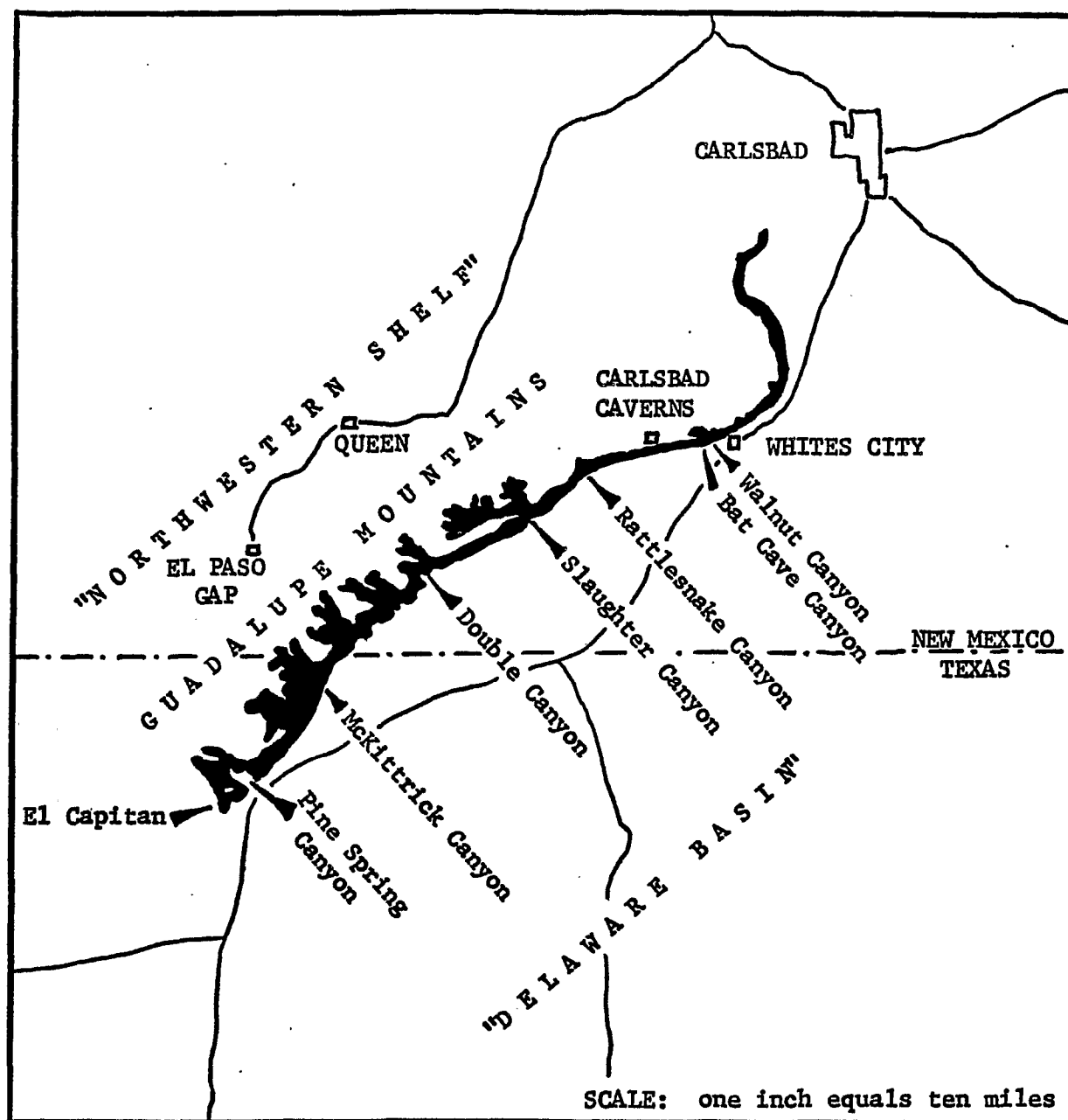


Figure 1. Location map of Guadalupe Mountains in southeastern New Mexico and western Texas. The zone of outcroppings of Capitan Limestone is blackened.

western Texas. For a number of years many geologists have attempted to interpret the environment of deposition of these strata.

To the southeast of the Guadalupe Mountains the Bell Canyon and Cherry Canyon formations (predominantly strata of fine grained quartzose sandstone with some beds of limestone) are present over wide areas. Because of the regular bedding of the fine material in widespread strata and the lack of fossils, the Bell Canyon and Cherry

Canyon formations are interpreted to be deposited in a marine basin (called the "Delaware Basin") which was about one to two thousand feet deep.

To the northwest of the Guadalupe Mountains strata of dolomite, sandstone, and evaporite of the Tansill, Yates, Seven Rivers, Queen, and Grayburg formations are present. These are presumed to have been deposited at the same time as the Bell Canyon and much of the Cherry

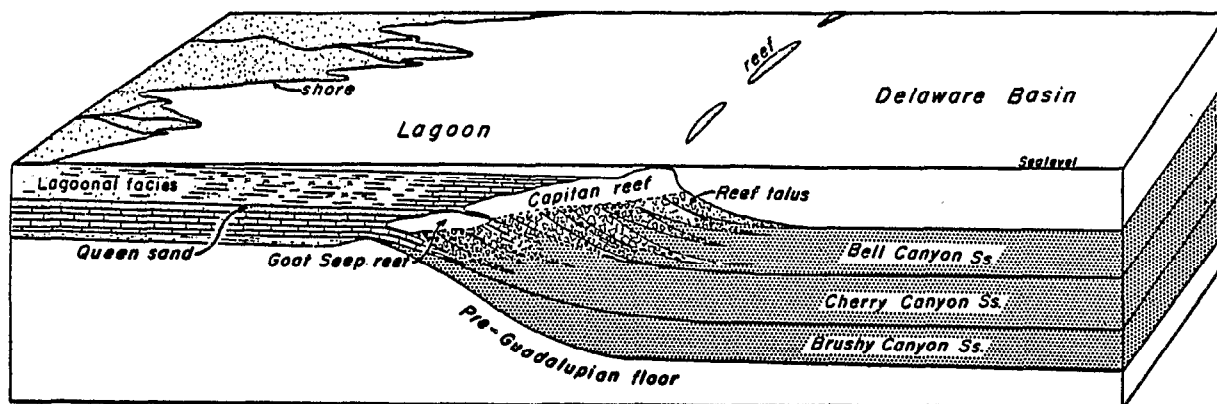


Figure 2. Block diagram showing different ecologic and depositional environments alleged to be associated with "Capitan Reef." (After Carl O. Dunbar and Karl M. Waage.¹⁵)

Canyon formations. These strata of dolomite, sandstone, and evaporite to the northwest of the Guadalupe Mountains are considered by many geologists to have been deposited in a shallow sea or broad lagoon (called the "Northwestern Shelf") because of the chemical characteristics of the rocks and presence of rare shallow marine fossils.

Thus, many geologists envision the existence of an oceanic basin, (the "Delaware Basin") to the southeast of the Guadalupe Mountains, and a shallow sea or broad lagoon (the "Northwestern Shelf") to the northwest during the Guadalupian Stage of the Permian. The Guadalupe Mountains, then, are of particular interest because they are generally considered to have been an area of transition between the shallow sea and the deep ocean.

The alleged transition zone is represented by a distinctive type of limestone and dolomite known as the Goat Seep Limestone (dolomitized limestone with rare fossils) and the Capitan Limestone (limestone and dolomitized limestone with common shallow marine fossils). The Capitan Limestone and Goat Seep Limestone, which are thought to represent a "barrier reef," intertongue laterally to the northwest with the Tansill, Yates, Seven Rivers, Queen, and Grayburg formations. To the southeast the Goat Seep Limestone and Capitan Limestone intertongue laterally with the Bell Canyon and Cherry Canyon sandstones and limestones. The interpreted environments and facies relationship between formations are shown in Figure 2.

Many geologists who hold to the above interpretation have also speculated on how the strata and depositional environments developed over millions of years. A common explanation given to students is that at the beginning of the Guadalupian Stage a shallow sea covered much of the area. To the northwest was a land area which continually supplied sediments to the sea. At or

near the shore of this sea, "Goat Seep Reef" began to grow and trap sediments on its shoreward side. This started a differentiation between "shallow sea" and "deep-sea basin."

Because of nutrient-rich waters upwelling from the stagnant basin to the highly saline shallow sea, "reef" growth was ideal and a linear "barrier reef" ("Capitan Reef") developed. Waves tore chunks of "reef core" loose and these rolled down the steep slope on the basinward side of the "reef" to form vast "talus" deposits.

Supposedly, while sea level rose gradually over millions of years, "Capitan Reef" could not grow upward at a fast rate but grew basinward over the talus deposits. A broad and shallow lagoon existed behind the "barrier reef" which trapped sediments coming from the land. Basin sediments may have come from the land through narrow breaks in the "reef." "Reef" construction was concluded when sea level began to lower.

After the Guadalupian Stage was deposited, the sea occupied "Delaware Basin" and was very shallow. As the sea dried up it left vast amounts of evaporites (anhydrite, gypsum, salt, etc.) comprising the Castile Formation which exists to the southeast of the Guadalupe Mountains. The southeast escarpment of the Guadalupe Mountains is the shelf-basin margin caused by the Permian "reef complex."

Figure 3 shows two different stratigraphic interpretations through the Guadalupe Mountains. The top illustration displays the conventional diagram advocated by geologists who hold the "barrier reef" view. Notice that the Capitan Formation is divided into two units—a "reef core" unit above a "reef talus" unit.

The "reef core" unit is thought to represent the organically-bound build-up which formed a wave-resistant "reef." The "reef talus" unit is considered to represent the "forereef" deposits which accumulated on the seaward side of the "reef core." Thus, P. B. King¹⁷ and P. T. Hayes

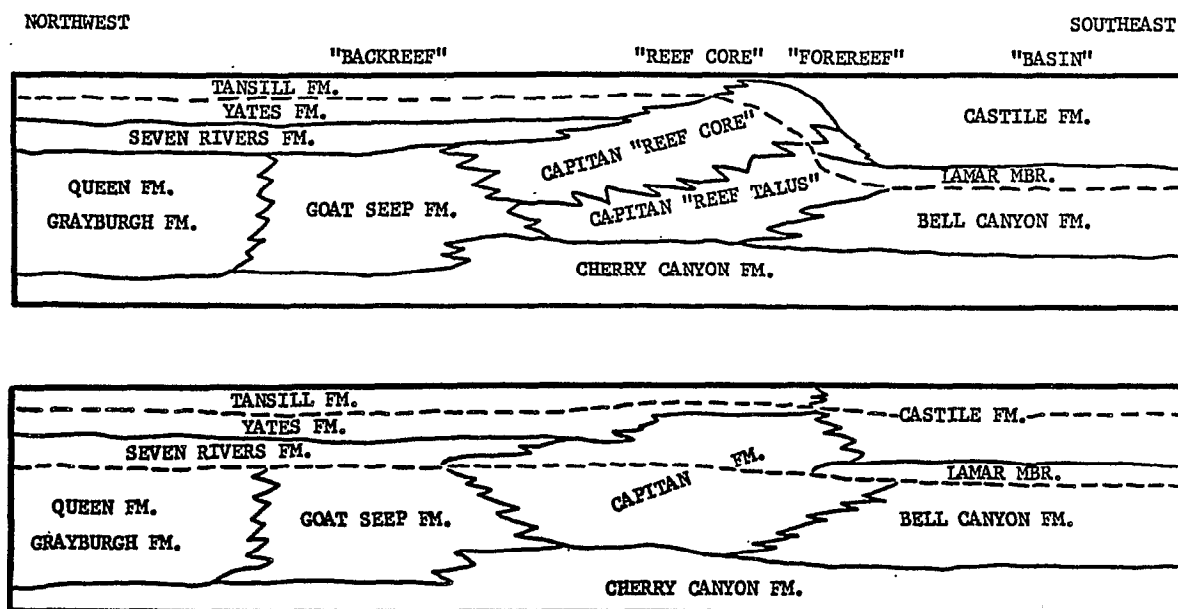


Figure 3. Two generalized cross-sectional diagrams through the Guadalupe Mountains showing different stratigraphic interpretations before any flexure or erosion of strata. Top, diagram suggested by advocates of the "barrier reef" view (modified from P. T. Hayes and R. L. Koogle¹⁶). Bottom, diagram proposed from our research. Dashed lines are interpreted to be synchronous depositional surfaces. Vertical thickness of strata is variable but approximately 3,000 feet; horizontal width of diagrams is about nine miles (note the use of extreme vertical exaggeration).

and R. L. Koogle¹⁸ of the U. S. Geological Survey differentiated the two units in their geological mapping. They map the boundary between the two units of the Capitan Limestone at a prominent topographic break.

Figure 4 shows the mouth of Slaughter Canyon and the supposed lithologic boundary between the unbedded (massive) "reef core" and the bedded and steeply dipping rocks of the "reef talus" unit.

Our field work does not support the above division of the Capitan. Lithologic data presented later in the paper will be used to show the absence of lithologic change at the topographic break. Furthermore, we will show that the alleged "reef core" lacks large masses of frame-building organisms and, therefore, is a poor example of the wave-resistant portion of the proposed "reef complex."

Also, it will be suggested that there is absence of demonstrable "reef-derived" talus in what is interpreted to be the "forereef" portion of the Capitan. The distinction of a massive "reef core" unit from a bedded and steeply dipping "reef talus" unit is therefore *imaginary*.

In our interpretation of the stratigraphy (See Figure 3, bottom diagram) we have avoided making the division. The Capitan Formation is shown as a single unit. It is noteworthy that C. W. Achauer,^{19,20} a petroleum geologist, re-

fuses to make the distinction between "reef core" and "reef talus" for similar reasons.

Advocates of the "barrier reef" interpretation also imagine characteristic facies relationships to exist. Thus, "backreef," "reef core," "forereef," and "basin" sedimentation are considered to be coeval. In Figure 3 (top diagram) the dashed line is used to indicate a synchronous depositional surface. The base of the Tansill Formation is correlated in time with the Lamar

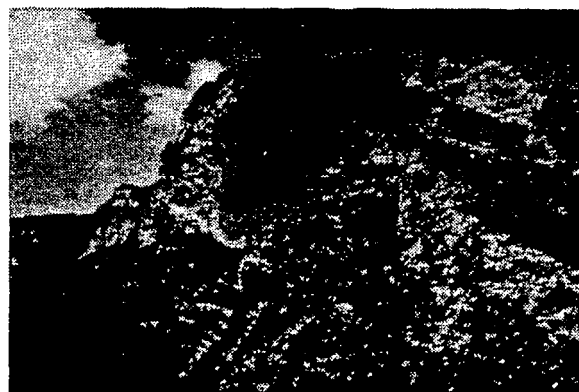


Figure 4. Capitan Limestone at the mouth of Slaughter Canyon. The massive cliff-making limestone alleged to be "reef core" is above beds thought to be "reef talus" which dip steeply toward the camera. At the extreme left are "backreef" beds of the Yates and Tansill formations. Vertical exposure is about 1,000 feet.

Limestone Member (calclutite) of the "basin" deposited Bell Canyon Formation.

According to W. W. Tyrell²¹ the Tansill-Lamar correlation is based on the presence of common species of fusulinids (small planktonic animals the size and shape of a grain of wheat) in both units. This time correlation surface is considered to pass through both the alleged "reef core" and "forereef talus" of the Capitan.

C. W. Achauer,²² however, disputes this paleontological correlation with stratigraphic evidence. His field work seems to indicate that the Lamar Limestone Member passes into the upper part of the Capitan Limestone but does not pass into the Tansill Formation. Achauer correlates the Lamar Member through the upper Capitan with the Seven Rivers Formation. Harold S. Cave,²³ a geologist who is also critical of the "barrier reef" view, correlates the Lamar Member with the Grayburg Formation.

Our field work also does not substantiate the Tansill-Lamar correlation. In the stratigraphic diagram presented in Figure 3 (bottom diagram) we correlate the Lamar through the upper Capitan with the Seven Rivers or Queen formations. Figure 5 shows alleged "backreef," "reef core," and "forereef" beds in McKittrick Canyon. The "talus" of the "forereef" Capitan in the foreground is stratigraphically above beds which correlate in time with the Lamar Member, yet, these foreground beds appear to merge into the massive "reef core" Capitan and not into the Tansill Formation above the Capitan. The Tansill seems to consistently cap the "reef core" Capitan (except where removed by erosion). To suggest the Lamar-Tansill correlation here seems inappropriate.

The Tansill Formation in a southeast direction must be correlated in time with the Castile Formation because of the presence of intertonguing between Capitan and Castile as noted by C. L. Jones²⁴ and H. S. Cave.²⁵ Yet, advocates of the "barrier reef" view commonly place the deposition of the evaporites of the Castile Formation (gypsum, anhydrite, salt, and limestone—See Figure 6) after the entire Guadalupian Stage. Thus they deny Capitan-Castile intertonguing to any large extent. The evidence which suggests simultaneous evaporite-carbonate deposition is difficult for the "reef" view. Could ocean waters which had reached a high enough concentration to precipitate calcium sulfate have been conducive to reef growth?

Advocates of the "barrier reef" interpretation also suppose that considerable topography existed at the junction of the "Northwestern Shelf" and "Delaware Basin." The dashed line in Figure 3 (top diagram) is thought to represent a synchronous depositional surface. Notice that



Figure 5. "Backreef," "reef core," and "forereef talus" in McKittrick Canyon. The massive cliff-making "reef core" (calcsiltite) is above so-called "reef talus" (sponge-algal limestone). "Backreef" beds of Yates and Tansill overlie the "reef core."

the surface rises about one thousand feet as it passes through the Capitan Limestone.

The need for this topography is seen in Figure 7. Here beds of "Delaware Basin" rocks are seen approaching the alleged "reef" to the northwest. In the right foreground of Figure 7 are sandstones of the Brushy Canyon Formation, and in the center left are sandstones of the Cherry Canyon Formation. The peak at the right is El Capitan; the upper portion of which is Capitan Limestone.

While the Brushy Canyon and Cherry Canyon formation pass under the Capitan Limestone, the Bell Canyon Formation, which lies above the Cherry Canyon and below the Capitan, intertongues with the Capitan. There seems to be a rise in altitude of synchronous beds through the Capitan. Upholders of the "reef" view who endorse the Tansill-Lamar correlation must imagine Bell Canyon strata correlating in time with strata which overlie the Capitan—hence a change in altitude of synchronous beds of about one thousand feet.

Since our field work does not suggest the Tansill-Lamar correlation, but that the deposition of the Lamar Member of the Bell Canyon Formation is contemporaneous with the upper Capitan, we see considerably less change in altitude of synchronous beds. Yet, even our interpretation must allow for some change in altitude. How is this accounted for?

Those who hold the "barrier reef" view maintain that the change in altitude is due largely to the depositional slope which existed during Guadalupian time between the supposed "shelf" and the "basin." They tend to deny evidence of large tectonics (deformations by folding). But, if the southeast side of the Guadalupe Mountains where the Capitan outcrops is a zone of flexure of strata, the change in altitude of synchronous



Figure 6. Laminated gypsum of the Castile Formation.

strata need not be caused by original deposition along a junction between "shelf" and "basin." Harold S. Cave says:

Since publication of the paper entitled, "Permian Stratigraphy of Southeastern New Mexico and Adjacent Parts of Western Texas," by K. H. Crandall, . . . it seems to have been a generally accepted fact by many geologists that the generally southeast dips shown in the Capitan limestone outcrops in the general Carlsbad Cavern area are the result of fore-setting in reef building. It is herein suggested that the dips in question are, in large part at least, comparable with other formational dips coming off the southeast and east flanks of the Guadalupe Mountains. Hence said dips could well be perfectly normal inclinations resulting from the post-Cretaceous orogeny that built the mountains.²⁶

Our field work showed evidences of tectonics (orogeny). Probably the most obvious evidence of flexure through the Capitan comes from the steep angle of dip of the alleged Capitan "reef talus." In some places these beds dip at angles of 45° away from the supposed "reef core." (Commonly encountered dips are usually about 20°.)

Due to the buoyancy of rocks and sand in water it is nearly impossible to accumulate mate-



Figure 7. Strata of sandstones of Brushy Canyon, Cherry Canyon, and Bell Canyon formations below the prominent peak (El Capitan); the upper portion of which is Capitan Limestone.

rials at such steep angles. Tectonics seems at least in part necessary to imagine formation of this slope. Achauer²⁷ observes that some rock fragments in the Capitan "reef talus" can be fit together along fracture planes, and such is evidence of tectonics.

Evidence is available to suggest uplift of the Capitan "reef core" and/or downwarping near the base of the "reef talus." Thus, in Figure 8; beds of Yates and Tansill formations can be seen dipping at 8° toward the northwest away from the "reef core." When Tansill beds are present on top of Capitan "reef core," they usually dip toward the "basin" (southeast) at 5° or more. Bell Canyon beds are also warped upward as they approach the Capitan "reef talus."

Since our field work indicates that at least a major part of the structural features associated with the Capitan Formation are post-depositional, we have avoided including these on our stratigraphic diagram (Figure 3, bottom diagram). Thus, our time lines pass through the Capitan horizontally (or nearly so) with little distortion.

In the previous discussion several stratigraphic objections have been presented to the classical "barrier reef" interpretation of the Capitan Limestone. Those who maintain that the Capitan Limestone and associated strata represent a fossil "reef complex" with simultaneous deposition of "backreef," "reef core," and "forereef" do so on very scanty evidence.

Lithology

One of the best ways to disprove the young age of the earth's sedimentary deposits implied by Biblical chronology would be to find evidence of long history within the stratigraphic record. Such an evidence would be a large organically-bound framework composing the "reef core" of a fossil "barrier reef." It would take thousands of



Figure 8. Beds of Yates and Tansill formations in Rattlesnake Canyon dipping at 8° toward the northwest away from the “reef core.”

years to cement a framework of algal and coral-line organisms one on top of another if deposited at roughly the same rate as modern reef core.

If several fossil “reef cores” could be found at various levels in the stratigraphic succession, evidence for slow accumulation over long periods of time would be well documented. Lithology should either substantiate or refute the presence of these alleged “reef cores” in the ancient sedimentary deposits.

When geologists first suggested the “barrier reef” interpretation for the Capitan Limestone 40 years ago, they were primarily impressed by the stratigraphy. Since the Capitan had massive limestone above steeply dipping beds of brecciated material, the proposal was that it represented a “reef” on the junction between “shelf” and “basin” environments. Little consideration was given to the lithology of the Capitan at that time. The lack of large organically-bound frameworks was known, but it was reasoned that recrystallization had destroyed them, or that future field investigations would find some.

Today there is wide agreement among geologists that the alleged Capitan “reef core” lacks large organically-bound frameworks. One of the first geologists to clearly note the absence of “reef core” was Donald L. Baars:

In cross-section the Capitan complex . . . is composed of steeply dipping “fore-reef” beds of skeletal sands and gravels that inter-finger basinward with clastics of the relatively deep Delaware Basin. The skeletal particles deposited on the basinward slope grade abruptly to a massive limestone facies in a shelfward direction. *This so-called “reef core” is, upon close inspection, massive but composed of calcilutites (lithified lime muds) which would not now be considered “frame-built” or particularly wave resistant in the unlithified state.*

This facies is narrow, and in some places is lacking. Core sediments (or, in some cases, the fore-slope skeletal sands) grade abruptly shelfward to beds of definite intertidal character, demonstrating very shallow water to mud-flat environments. *Diligent search has shown that reefoid structures are rare indeed, and are not responsible for the shelf construction but occur only as superficial small structures.*²⁸ (Emphases added.)

Probably the most qualified person to speak concerning Capitan “reef core” is C. W. Achauer who has examined hundreds of slabbed and etched samples and hundreds of thin sections under the microscope. He agrees with Baars concerning the lack of framework, but correctly observes that the “reef core” is not mostly clay-size materials as Baars suggests, but predominantly silt- and sand-size debris, as follows:

Most of the Capitan lacks reef cores or large masses of colonial frame-building organisms. . . . Primarily the Capitan consists of silt- and sand-size skeletal debris derived from many kinds of organisms that thrived along the edge of the Northwest shelf.²⁹

Examination of the so-called “reef talus” should also provide clues about the supposed binding of the “reef core.” Achauer says, “The Capitan lacks stratified deposits of bioclastic debris which can be shown to have been derived from reef cores.”³⁰ And R. J. Dunham says:

Use of this criterion [examination of the binding of the “reef talus”] on the surface Capitan reef and on the subsurface Scurry reef indicates that the binding was wholly or largely inorganic, which accords with other evidence. . . . The Capitan reef and the Scurry reef thus are examples of a large class of stratigraphic reefs that are not ecologic reefs, not “really reefs.” Organisms provided their skeletal debris, their bulk; but organisms did not provide their rigid framework (except perhaps locally, and incidentally).³¹

Based on our field work, we can conclude that the Capitan Limestone lacks an organically-bound framework. The Capitan is composed largely of calcarenite and calcisiltite. Fossils, except where noted in the discussion on paleoecology, are usually fragments and are not cemented in an organic framework.

The massive so-called “reef core” limestone tends to be very hard and poorly stratified due to some recrystallization of calcite. The lower portion of the Capitan has been partially dolomitized. Calcirudite “fossil hash” is sometimes found in both the “reef core” and “reef talus.”

Figure 9 shows what may be called typical Capitan “reef core” from McKittrick Canyon.

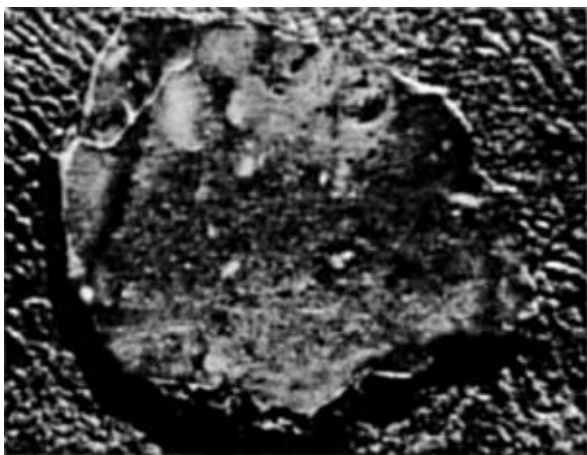


Figure 9. Cut and polished slab of typical Capitan "reef core" rock from McKittrick Canyon. It is calcisiltite which was not wave-resistant. Structure is blurred due to recrystallization. An encrusting bryozoan is present in the upper left (2X actual size).

The sample comes from the lower part of the massive cliff in the center of Figure 5. The limestone (calcisiltite) is composed mainly of silt-size particles of broken skeletal calcite and calcite of nonorganic origin. There is no wave-resistant framework present! A small encrusting bryozoan cemented in the silt matrix is present in the upper left.

There is some evidence of recrystallization of the calcite (a characteristic of "reef core" limestone) which tends to obliterate fossils and make the rock extremely hard. Some geologists have actually maintained that recrystallization has destroyed the framework which is postulated to have existed, but this view seems rather extreme because of the presence of unrecrystallized fossils.

Many of the most perfect fossil specimens presented later come from the "reef core" and these are also cemented in calcisiltite or calcarenite matrix. Arguing for destruction of the organic framework by recrystallization therefore seems pointless.

Figure 10 shows Capitan from Pine Spring Canyon near the boundary between Capitan and Tansill formations. The limestone is composed predominantly of pisoliths (the larger concentrically layered spheres) and oololiths (the smaller, gray, pellet-like spheres). The origin of the two are still uncertain. Some geologists speculate that both objects formed from sticky particles which have rolled collecting clay- and silt-size particles. Other geologists postulate that the pisoliths formed from weathering and recrystallization around nuclei. One thing seems certain, they are not evidence for an organic framework.

A sample of what may be considered somewhat representative of Capitan "reef talus" is seen in



Figure 10. Cut, polished, and etched slab of Capitan Limestone from Pine Spring Canyon containing pisoliths (large concentrically laminated spheres) and oololiths (small gray spheres) (1.5X actual size).

Figure 11. It was collected in McKittrick Canyon near the foreground in Figure 5. The term "reef talus" is certainly misleading because this sample shows no evidence of having originated from the destruction of "reef core." It is very much like what has been called "reef core" as it is composed of calcisiltite matrix with abundant broken fossils.

The only notable lithologic difference between this sample and the "reef core" sample of Figure 9 is the presence of recrystallization in the latter. A cross-section of a whole, thin-shelled brachiopod is seen in the lower right of Figure 11. To the left of center is an encrusting bryozoan. No organic binding is evident.

It is most evident that "Capitan Reef" is very different from modern reefs when careful lithologic examination is conducted. Since "Capitan Reef" does not contain large masses of demon-

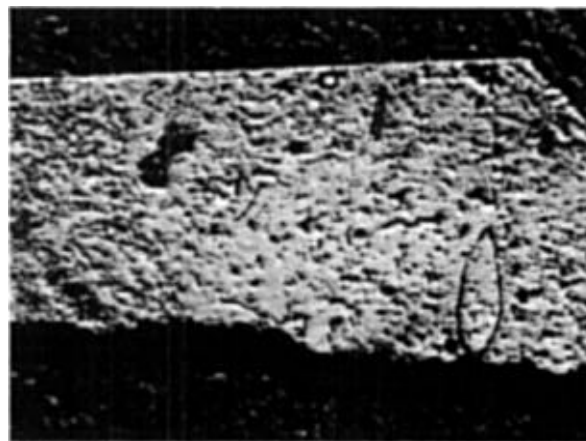


Figure 11. Cut, polished, and etched slab of Capitan "reef talus" (calcisiltite) from McKittrick Canyon. Many different fossils are evident due to the absence of recrystallization (1.5X actual size).

strated "reef core," and "reef talus" which can be shown to be derived from destruction of "reef core," there is ample justification in denying its alleged reefal origin.

"Capitan Reef" in the Guadalupe Mountains did not build large organically-bound, wave-resistant, colonial frameworks and therefore did not *require* thousands of years of *in situ* growth. The presence of calcisiltite, calcarenite, and calcirudite in the alleged "reef core" suggests that the broken fragments were transported and deposited. *In situ* material is very rare if it exists. The rate of deposition need not be anything comparable to modern reefs.

Paleoecology

Many factors hinder proper ecologic interpretation of "Capitan Reef." The fact that most Paleozoic "reef-building" organisms are extinct restricts our knowledge of any biological affinities of these organisms. Recrystallization and dolomitization also tend to obscure some fossils and their matrix. The presence of exotic organisms transported from different environments to a single portion of the "reef" also presents problems.

What is known about the ecology of Capitan organisms does not lend exclusive support to the "barrier reef" interpretation. Concerning the ecology of Capitan organisms, P. B. King says:

From a study of the calcitic limestone, it is clear that lime-secreting organisms contributed to the formation of the rock. Brachio-pods, various molluscs, and some other groups are very abundant in certain beds. These organisms, however, do not show any special adaptation to a reef environment. There is not, for example, a noteworthy abundance of thick-shelled forms that would thrive in strong currents and pounding waves of the exposed parts of a reef and would, therefore, contribute a considerable amount of limestone to the deposit; instead, the assemblage seems to be a normal neritic fauna, such as would grow in any region of clear, shallow water.³²

The possibility that organisms found in the Capitan were capable of withstanding the turbulence of a wave environment is denied by Achauer. Of the alleged "reef-building" Capitan organisms he says:

... the most prominent forms are calcareous sponges and bryozoans. These organisms may have been capable of forming, and actually may have formed, sediment baffles in the Capitan; however, they did not build a wave-resistant structure in the Capitan, nor probably did they have the ecologic potential to do so.³³



Figure 12. Cut and polished slab of spherical, concentrically laminated algae from Capitan "reef talus" of Slaughter Canyon. Nuclei are commonly a broken piece of bryozoan or other fossil fragment. Rolling of the spheres is evident and there is little evidence of organic framework or wave-resistant characteristics.

According to advocates of the popular "reef" view, algae were responsible for the major part of sediment trapping and binding, and, hence, are thought to be the major "reef-forming" organisms. Our field work and subsequent laboratory analysis of rock samples gave special attention to algae.

Figure 12 shows the commonest type of algae observed. These are small, spherical, cabbage-like (although of smaller size) colonies which tend to be crowded together. They seem to be composed mainly of filamentous green and blue-green algae which formed crude laminations around a bryozoan or other fossil fragment.

The majority of the structure, however, is not algae but frequently lime mud which was trapped between algal laminations. Promoters of the "barrier reef" interpretation feature this type of rock as a prime example of "reef core." Samples very similar to Figure 12 are on display at the exhibits at Carlsbad Caverns National Park labeled as "reef core" rock.

What is interesting about these algal structures is that they are most common in the so-called "reef talus" with sponges as stratified beds between layers of calcisiltite (such as Figure 11), calcarenite, and calcirudite. The "reef talus" beds in the foreground of Figures 4 and 5 are composed largely of this type of algal structure.

That this type of algae composes an *in situ* "reef core" within the "reef talus" deposits is most unlikely because of its position in the alleged "reef complex." Algae can grow only in shallow water where sunlight is available and should not live hundreds of feet below the alleged wave intercepting portion of the "reef." Since these algae are filamentous and build structures by trapping mud between calcareous lami-



Figure 13. Photomicrograph of Capitan "reef core" algal sphere (right) in a nonorganically-bound matrix of silt-size particles (left). Algal structures have dominant orientation of calcite crystals that is not found in the matrix (35X actual size).

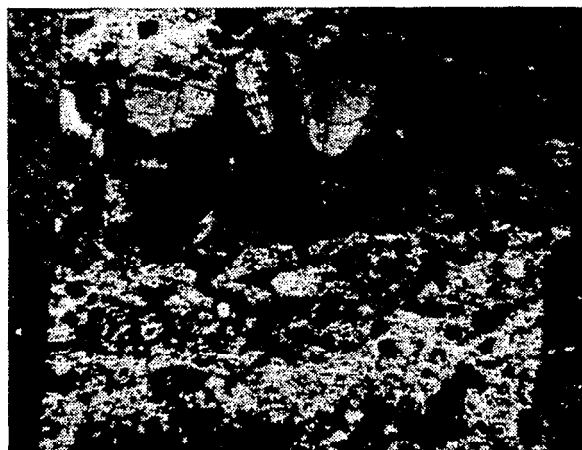


Figure 14. Cut, polished, and etched slab of Capitan "reef core" showing "stromatolitic algae" structure apparently in growth position over nonorganically-bound calcarenite with abundant dasyclad algae (1.5X actual size).

nations, there is little evidence of rigid framework or wave-resistant characteristics.

Some geologists may argue that these colonies of algae are not *in situ* "reef cores" when found in the "reef talus," but are transported from the wave-intercepting "core" of the deposit where they are truly *in situ*. Careful mapping by Achauer of this algal and sponge deposit shows that it is characteristic of the "forereef" position and is sometimes in the "reef core" area. Both the "reef core" and the "reef talus" of Figure 4 in Slaughter Canyon, according to Achauer,³⁴ are composed of this association.

This algae and sponge relation is found with the Lamar Limestone in McKittrick Canyon which has been considered a deep water deposit and proceeds up the sloping beds of "reef talus" to near the massive "reef core" in Figure 5. The "reef core" in Figure 5 is not characterized by algae or sponges but by calcarenite and calcisiltite.

Such data are most perplexing. Achauer³⁵ correctly observes that the algae and sponge association common to the alleged "forereef" is the most "reef-like" structure in the entire Capitan complex. The most "talus-like" part of the Capitan in McKittrick Canyon seems to be the alleged "reef core!"

There is good evidence that even these "reef-like" algal structures are of transported origin. The characteristic roundness of these structures with enclosed fossil fragment nuclei suggests that they have been rolled. Also, microscopic examination (See Figure 13) shows that colonies are usually in a matrix of nonorganically-bound calcisiltite.

Evidences of what may be a sediment trapping organic framework are seen in Figure 14. This

rock is from the Capitan "reef core" just below the Tansill Formation in Slaughter Canyon. What appears to be "stromatolitic algae" occur as a mat in growth position over nonorganically-bound calcarenite bearing abundant dasyclad algae.

According to John M. Cys,³⁶ some stromatolitic structures in the Capitan have been shown to be of inorganic origin. Several features of Figure 14, to the contrary, indicate algal origin.

If these are *in situ* algae, then the Noachian Flood evidently was not responsible for depositing them. However, it is possible that resedimentation (transport, deposition, and burial) has occurred with the mat of algae being redeposited in appearance of growth position.

If many more mats could be found in the appearance of growth position, then *in situ* growth would seem necessary. At the present time it seems appropriate to reserve judgment about the *in situ* character of these algae.

The dasyclad algae, a green algae forming a nonorganically-bound structure in the bottom of Figure 14 and in Figure 15, are distinctive forms common in the Capitan. While alive, their thalli were composed of a central fleshy stem with branches arranged in whorls. Calcite was secreted as a cylinder enveloping the central stem and the bases of the branches. After fossilization the only remaining parts are the hollow lime cylinders with pores in the walls where branches penetrated.

The presence of dasyclad algae in the "reef core" and "forereef" as well as in the "backreef" seems to present problems for the "reef" view. How could algae of such delicate structure have survived in a wave environment?

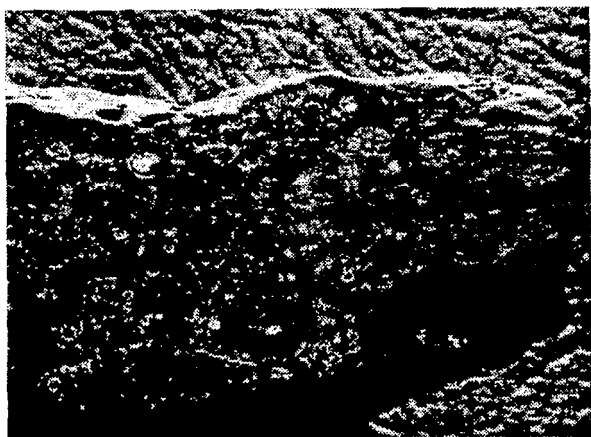


Figure 15. Cut, polished, and etched slab of Capitan Limestone from Walnut Canyon which is very closely associated with "backreef" beds. Dasyclad algae (left) and cross-sections of brachiopods (right) are in a nonorganically-bound matrix (2x actual size).

Another type of algae found in the Capitan belongs to the extinct family of lime-secreting red algae called Solenoporaceae. This family very closely resembles the modern calcareous red algae of the family Corallinaceae which commonly from 50% to 80% of reefs at the present.

What is amazing in our study of the algae of the Capitan is the unimportance of Solenoporaceae as a "reef-builder." It was not found as a frame-builder or as a sediment-binder but simply as an encrusting form often around fenestrate bryozoans. Thus, one of the organisms which should have been well adapted to a wave environment, building strong organic structures and binding sediments, is relatively insignificant in the so-called "Capitan Reef."

Calcareous sponges are found in the "reef core" and "forereef" areas. They have the ecologic potential to build frameworks and bind sediments to form a "reef." But the sponges are usually small, the largest being up to two or three centimeters in diameter and not more than ten or twenty centimeters long (Figure 16 shows a cross-section of a sponge).

The sponges are not found in colonial frameworks, but are usually separate from each other embedded in a nonorganically-bound matrix of calcarenite. They, therefore, do not seem to have formed wave-resistant frameworks in the Capitan. Attempts to determine if these sponges are in growth position (in situ) seem to be somewhat subjective although. Achauer³⁷ thinks that some are in position of growth.

As noted earlier, sponges are associated with transported algal spheres in deposits which are somewhat typical of the "forereef" or "reef talus" environment. The "reef core" as stated earlier is dominantly calcisiltite or calcarenite with a char-

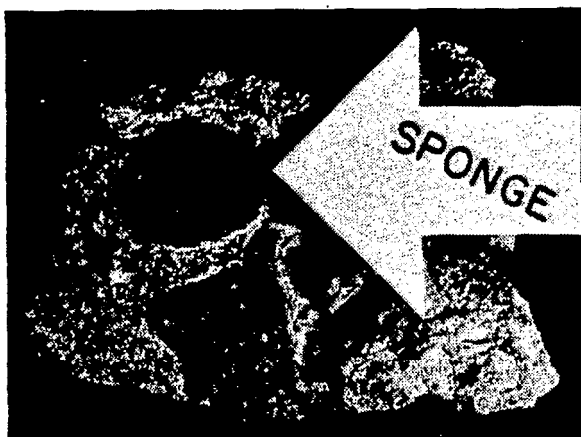


Figure 16. Naturally weathered rock surface showing cross-section of a sponge from Capitan "reef talus" in McKittrick Canyon. Matrix is nonorganically-bound calcarenite (actual size).

acteristic lack of what are considered to be wave-resistant, frame-building sponges or algae.

Two general types of bryozoans are very common in the Capitan. First there are small encrusting forms which are usually found as fragments. These are found embedded in calcisiltite or calcarenite "reef core" rock (See Figure 9), or in the central part of concentrically laminated algal spheres (See Figure 12), or in supposed "reef talus" beds (See Figure 11). Encrusting bryozoans were evidently shallow marine creatures, but they show little ability to build wave-resistant frameworks and could not bind sediments.

The second variety are the fenestrate bryozoans (See Figure 17). They are large fans having a lacy, net-like frame which has great delicacy and beauty. When alive, the fans stood erect attached to the substrate by a flimsy base. Fenestrate bryozoans, which are common to the Capitan "reef core," most certainly could not withstand a wave environment and they could not bind sediment. They are mute testimony of the inadequacy of the "reef" interpretation.

Fusulinids are also common to the Capitan (See Figure 18). They are the size and shape of a grain of wheat and form by coiling around a central axis. These are planktonic animals which show no special adaptation to a "reef" environment. When observed in the "reef core," fusulinids are usually cemented by calcarenite or calcisiltite, and their tests often show preferred orientation, an evidence of current action during deposition.

Brachiopods are very frequently encountered in "backreef," "reef core," and "forereef" deposits. Many of the skeletal fragments making up the limestone are pieces of broken brachiopods. Whole brachiopods are fairly common (See

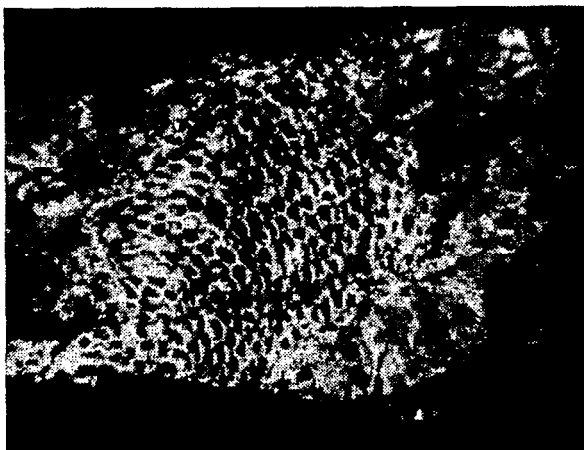


Figure 17. Fenestrate bryozoan from Capitan "reef core." This fragile creature could not have survived in a wave environment, Matrix is calcisiltite (actual size).

Figure 19) and just a few species comprise the majority of those observed. These brachiopods were sessile, bottom dwelling creatures which could not bind themselves to the substrate and show no special adaptation to a wave environment.

Other fossil forms found in the Capitan Limestone include crinoids (animals with a floating "head" having numerous radiating arms and long jointed stem which attached to sea floor—not frame-builders and not able to thrive in surf environments), cephalopods (chambered, coiled mollusks which could swim—not a "reef-builder"), pelecypods (thin shelled clams which are not especially adapted to surf zones), and trilobites (arthropods characterized by a body having three parts or lobes—probably not a surf animal). *Corals, creatures which could be considered ideally adapted to a reef environment, are very rare in "Capitan Reef."*

From the above discussion it appears that the fossil flora and fauna of "Capitan Reef" represent a shallow water assemblage which was not especially adapted to a wave or strong current environment. "Reef-forming" organisms which could bind sediments and build frameworks are either altogether absent or largely inconspicuous.

Other Alleged Fossil "Reefs"

Are the stratigraphic, lithologic, and ecologic characteristics of "Capitan Reef," as described, above, also found in other alleged Late Paleozoic "reefs"—or is the Capitan somewhat unique?

The lack of frame-builders is noted in "Goat Seep Reef" by P. B. King:

Like the other limestones along the margin of the Delaware Basin the Goat Seep limestone is quite generally dolomitized, with the result that many of the details of its original structure are now lost. Not many reef-

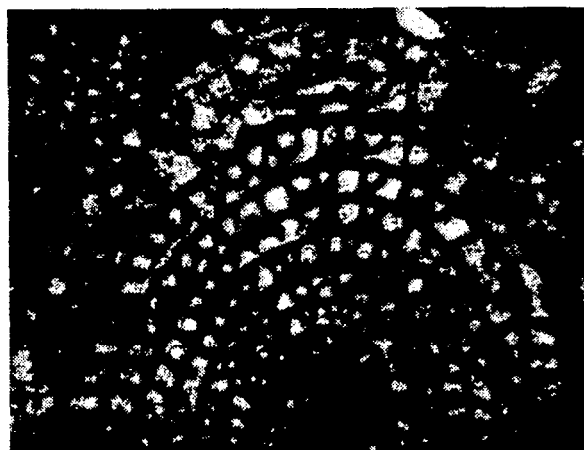


Figure 18. Photomicrograph of fusulinid in silty matrix from Capitan "reef core." The sample is from Carlsbad Caverns National Park elevator shaft #2 at a depth of 499 feet below the surface (35X actual size).

building organisms have been collected from it. No corals have been found, but Dr. Girty reports the presence of sponges. It is not possible, therefore, to determine whether the Goat Seep reef was built by organisms or by inorganic growth.³⁸

Oil companies have been intensely interested in Pennsylvanian and Permian rocks in the subsurface in northern Texas. Here the so-called "Horseshoe atoll" (also known as "Scurry Reef") has been penetrated numerous times by drill bit. Concerning this limestone deposit P. T. Stafford says:

Because of certain characteristics of the Horseshoe atoll, applicability of the terms "reef" or "atoll" to this carbonate mass may be questioned. The relationships of the different lithologic types in the Horseshoe atoll are unlike those of any reef described in the

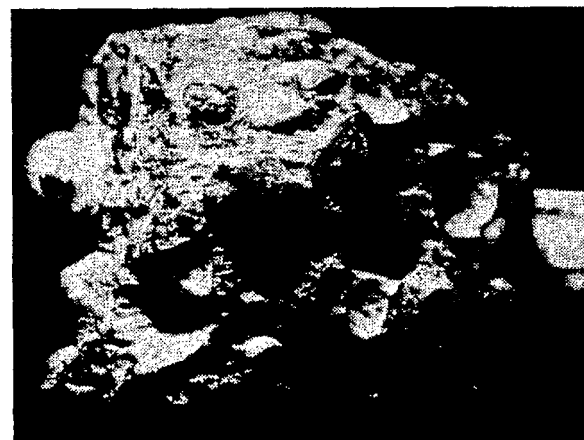


Figure 19. Brachiopods (*Squirmularia guadalupensis*) in Capitan calcarenite from Carlsbad Caverns elevator shaft #2 (1/2X actual size).

literature. Rock composed of a growth lattice of organisms was not observed; only detrital limestone has been noted. In areas that would commonly be considered reef core, calcirudite is found. Furthermore, the slopes on the flanks of the Horseshoe atoll are generally low compared to those of the so-called Capitan reef of western Texas and New Mexico or the Quaternary reefs in the Pacific.³⁹

Donald L. Baars comments on some alleged "reefs" of the Pennsylvanian System of New Mexico, and that a demonstrated "reef core" is absent:

Banks composed of carbonate sediments are present in rocks of Upper Pennsylvanian (Virgil) age in both the Sacramento and San Andreas Mountains of south-central New Mexico. . . . The bioherms are made up of skeletal debris and carbonate muds, with the chief constituent being codiacean algae. . . . Although some geologists have argued for a reefal origin of these buildups, there is no evidence of a rigid framework or wave-resistant characteristics.⁴⁰

Mississippian bioherms in New Mexico were studied by Lloyd C. Pray. He begins his paper with the following statement:

Abrupt mound and ridge-shaped carbonate masses of Mississippian (Osagian) age that are up to 350 feet thick crop out in southern New Mexico where they were first reported and described in considerable detail by Laudon and Bowsher (1941). These structures and apparently similar ones in the subsurface of north-central Texas have commonly been referred to as "crinoidal bioherms." Although the New Mexico occurrences have been known and examined by many geologists, including the writer, since 1941, their genesis has remained obscure, particularly the nature of the core facies. *The most enigmatic aspect has been the identity of the frame-builders, if indeed frame-builders were ever present.*⁴¹ (Emphasis added.)

Thus, it seems that many highly fossiliferous limestones of the Late Paleozoic are in no sense organic frame-built reefs. Since general characteristics can be associated among fossiliferous limestones of the Late Paleozoic, it would seem logical to seek a common mode of origin.

Capitan Limestone: What Is It?

The above comments on the Capitan Limestone have shown the inadequacy of the "barrier reef" interpretation. So far remarks on what the Capitan is have been very brief. In a word the Capitan is here considered to be a *biostrome* — a highly fossiliferous stratified deposit which shows

little topographic relief and is surrounded mostly by nonfossiliferous strata.

To the southeast of the Guadalupe Mountains the Capitan intertongues with gypsum, limestone, and sandstone, while to the northwest it intertongues with dolomite, siltstone, sandstone, and limestone. The lower dolomitized unit of the Capitan appears to be very continuous to the northwest where it passes laterally into the dolomitized Goat Seep Limestone and then into the Queen and Grayburg formations. Thus, the Capitan is not a narrow facies from 3 to 5 miles wide but a portion of a widespread layer of limestone. The formation names seem to confuse the true geometry of the deposits.

When was the Capitan Limestone deposited relative to the Noachian Flood? Did it accumulate before, during, or after? In our opinion some of the most obvious evidences of the universal Noachian Flood occur in Late Precambrian and Early and Middle Paleozoic strata. Here are found vast blanket-like marine sediments covering entire continents with a lack of subaerial deposits such as widespread lava flows. When volcanics are found in the Late Precambrian and Early and Middle Paleozoic strata, they show many evidences of submarine extrusion.

In a previous paper⁴² it was shown that most of the Cenozoic strata (which were deposited after both the Paleozoic and Mesozoic strata) could not have been deposited during the Flood and they were interpreted to be post-Flood. This conclusion was based on the observation that Cenozoic lava flows in the northwestern United States are commonly subaerial.

The Mesozoic strata also seem to be post-Flood as subaerial lava flows are well documented. Thus, in the Meridian Formation (Triassic) of central Connecticut, basalt strata with manifold evidences of subaerial flow are up to 500 feet thick and are continuous laterally over distances up to 30 miles. Sedimentary strata between and above the Meridian flows contain abundant dinosaur footprints.⁴³

Also, enormous Triassic or Jurassic lava flows of the Parana Basin of Brazil probably covered at least 375,000 square miles to a depth of up to 2,000 feet.⁴⁴ Similar flows to those in Brazil deposited about the same time are found in South Africa.

It is our opinion at the present time that the Late Paleozoic strata are associated with the final stages of the Noachian Flood. Thus, the Capitan Limestone, which is among the youngest of the Late Paleozoic strata, could be either deposited during the last part of the Flood or shortly thereafter. If fossils such as Figure 14 can be well documented as *in situ* occurring on several horizons, then the Capitan would have to belong to our post-Flood era.

Since the Capitan is composed largely of loose, unbound sediments and fossils, much of the material could have been transported by flood waves. Studies on the texture of the Bell Canyon and Cherry Canyon sandstones show that the grain size *increases* toward the southeast (toward the Gulf of Mexico and this indicates the source direction of the sand.⁴⁵

It is possible that much of the Capitan sediment was washed into its present location by tidal waves from seismic disturbances or meteorite impact immediately after the Noachian Flood. The data certainly do not *require* many thousands of years for the Capitan to accumulate and, therefore, seem to present little problem for Biblical chronology. Instead, the lack of large organically-bound structures, which would grow during thousands of years, suggests that deposition was very rapid.

Acknowledgments

I wish to thank the Creation Research Society Research Fund chairman for amply funding field investigations during the summer of 1971 in southeastern New Mexico and western Texas. The permission of Carlsbad Caverns and Guadalupe Mountains National Parks to collect hand specimens of limestone was essential to completion of the project. I am grateful for the cooperation of Carlsbad Caverns National Park and Humble Oil Company for graciously allowing me to examine well cores and rock thin sections of Capitan Limestone.

Appendix: Terminology

General terms:

Reef: a largely unbedded, wave-resistant structure composed of *in situ*, organically-bound, frame-building organisms, cementing organisms, and sediment filling which modifies the surrounding sedimentation.

Reef Complex: the suite of environments and resulting sediments associated with a reef.⁴⁶

Terms relating to stratigraphy:

Stratigraphy: a discipline of geology which deals with the position and geometry of stratified rocks.

Reef Core: the wave-resistant, *in situ*, organically-bound portion of a reef complex.

Forereef: the sediments on the seaward side of the reef core which are composed largely of transported debris (also known as "reef talus").

Backreef: the sediments on the shoreward side of the reef core often deposited in a lagoon.

Biostrome: a nonorganically-bound fossiliferous limestone which has no appreciable topographic relief but tends to be a widespread layer.

Bioherm: a nonorganically-bound fossiliferous limestone which rose topographically above the surrounding depositional surface.

Formation: a mappable rock unit.

Member: a subdivision of a formation.

Facies: refers to lateral variance in rock type within a stratigraphic interval.

Cenozoic Strata: the most recently deposited strata noted for fossil mammals.

Mesozoic Strata: strata deposited immediately before Cenozoic strata and are known for dinosaur fossils.

Paleozoic Strata: strata deposited immediately before Mesozoic strata and have abundant marine organisms.

Precambrian Strata: the oldest strata which have few fossils.

Tectonics: deformational processes in the earth's crust.

Terms relating to lithology:

Lithology: a discipline of geology which deals with the megascopic and microscopic composition and structure of rocks.

Limestone: a sedimentary rock composed chiefly of calcium carbonate— CaCO_3 .

Dolomite: a sedimentary rock composed chiefly of calcium-magnesium carbonate— $\text{CaMg}(\text{CO}_3)_2$.

Calcite: a mineral composed of calcium carbonate.

Calcilutite: limestone composed chiefly of clay-size particles.

Calcisiltite: limestone composed of chiefly silt-size particles.

Calcarenite: limestone composed of chiefly sand-size particles.

Calcirudite: limestone composed chiefly of particles larger than sand-size.

Dolomitized: refers to limestone which has been partially changed to dolomite through the addition of magnesium ions.

Recrystallized: refers to limestone in which the original crystal structure of calcite has been modified.

Calcareous: containing calcium carbonate.

Anhydrite: mineral composed of calcium sulfate— CaSO_4 .

Gypsum: mineral composed of calcium sulfate and water— $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$.

Evaporite: rock composed of anhydrite, gypsum, or salt.

Pisolith: a sphere of concentrically laminated limestone or dolomite generally larger than 2 mm.

Ooliths: a sphere of limestone or dolomite usually smaller than 2 mm.

Terms relating to paleoecology:

Paleoecology: the study of the relationship between ancient organisms and their environment.

Stromatolitic algae: algae which build structures which have more or less planar lamination.

Dasycladaceae (Dasyclad): family of fragile green algae which construct calcareous tubes.

Solenoporaceae: extinct family of calcareous red algae having the ability to construct organically-bound frameworks.

Corallinaceae: modern family of calcareous red algae which build modern reefs.

Scleractinida: order of modern corals which build modern reefs.

Bryozoan: member of phylum of colonial animals which build calcareous structures.

Fusulinid: extinct animal about the size and shape of a grain of wheat.

Brachiopod: member of phylum of marine shelled animals with two unequal shells or valves.

Crinoids: marine animals with a floating "head" having numerous radiating arms and long jointed stem which attaches to the sea floor.

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- ⁴⁵Advocates of the "barrier reef" view need to have the sand coming from the northwest and must be able to explain how it escaped being trapped in the "back-reef." Where in any modern environment are limestones and evaporites being deposited behind a barrier reef while sand from the shore is being deposited in widespread strata in deep water beyond the reef?
- ⁴⁶The term "reef complex" may also have meaning to the psychologist when describing a geologist's tendency to indiscriminately call any highly fossiliferous and unbedded limestone deposit a "reef." A geologist encumbered with such a bias may be said to possess a "reef complex."

LETTERS TO THE EDITOR

I enjoyed the article review by Robert Harris in the September, 1971 *Quarterly* (Review of "Carlsbad Caverns in Color" from *National Geographic Magazine*).

I think Mr. Harris will find a note in the *Journal of Chemical Education* of September, 1971, page 608 entitled "Instant Coral" [See below-Editor] of interest in support of his views. I had the pleasure of visiting the lakes referred to in the article in 1970 and everything is exactly as the author reports.

More confusion to the evolutionists.

Sincerely yours,
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Round Hill Lane
Port Washington, N. Y. 11050

CHEMICAL VIGNETTES*

ROBERT C. BRASTED

University of Minnesota, Minneapolis 55455

"Instant Coral," Jugoslavian Style

A magnificent combination of underwater beauty and solution chemistry is observable in one of nature's wonderlands, the Plitvicka Jezera (lakes) country a hundred miles south of Zagreb in Jugoslavia. Here are located a chain of some 15 lakes with coral-like deposits in a sylvan mountain setting with each lake feeding water to the one below by a system of water falls. The total lowering is not more than 50 m, but each water fall has an individual beauty with a drop that may be as small as several meters or as much as 20 m.

There are some who will justifiably question not only the travelog introduction to a *Chemical Vignette* but also the aquatic biology of "coral" formation. The column editor hopefully can explain the latter and pleads journalistic license for the former.

The water feeding into the first lake is part of an underground system that provides a magnificent example of metal salt equilibrium. Almost any general text of chemistry will provide the fundamental concepts of water hardness, but the stress is usually on boiling the temporarily hard water to deposit CaCO_3 while releasing CO_2 from the dissolved $\text{Ca}(\text{HCO}_3)_2$. Or, that over the centuries stalactites and stalagmites grow in caves, for basically the same reason (the former having to stick "tite" to the roof or they

will fall off, while the latter "mite" grow big enough to reach the ceiling and then again they "mite" not, which indicates the low degree of geological training on the part of your column editor).

These Plitvicka waters come out of their limestone underground beds so charged with CO_2 and loaded with $\text{Ca}(\text{HCO}_3)_2$ that the time factor for depositing calcium carbonate is more in the hour range than the century. Twigs, limbs, rocks, and even grass coming in contact with the water are soon coated with a white carbonate deposit. The lake bottom and shore are white with the encrustation. Just as do many of the mineral baths of the continent so do these lakes literally effervesce CO_2 when the water is agitated.

It seems that the lower lakes exhibit a slower carbonate deposition rate than that found in the upper lakes, however, an equilibrium is established as the water flow progresses, since the stream and lake beds (at times 10-20 m in lake depth) are limestone.

The color of the water is a distinctive green color due to an algae that flourishes in these hydrogencarbonate-charged waters. The concentration is not so great that trout cannot survive since many of the good eating size are observed (without a white crust).

An earlier *Vignette* pointed out a not-so-pleasant or beautiful natural phenomenon associated with underground waters coming from mine areas. Sulfides provided not only undesirable deposits but odor and taste to waters. Here we have somewhat similar chemistry but a much more asthetic result.

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A View on Evidence

During the past summer it was my privilege to participate for a third time in a field study of the Absaroka fossil forests. These fossil features in the Yellowstone area are in my judgment a particularly impressive example of ambivalence in the data produced by scientific investigation.

Many observers of the agatized stumps, logs and organic horizons in this area see evidence for successive growth over a span of years many times greater than indicated by the specifications given in the fifth and eleventh chapters of Genesis. Others on close analysis find features which are not satisfactorily accounted for on the basis of *in situ* growth, and which seem to indicate tidal deposit of flood-accumulated debris in a mud and rock slurry during a period of intense volcanic activity.

After analyzing the various interpretations which have been advanced and observing reactions of differing types of minds to these interpretations I have concluded that the presently available physical evidence can be accommodated to whichever viewpoint of earth history (conservative Biblical or unrestricted time models) one may prefer *a priori*. Until further

evidence has become available and adequately analyzed it would be unwise to claim that these fossil forests provide compulsive evidence in favor of either flood deposits approximately four thousand years ago or "normal" growth and volcanic sequences over tens of thousands of years.

There is a tendency to expect that sufficiently extensive and intensive scientific investigation will provide unassailable evidence in support of a model for earth history which conforms with the most obvious and straightforward reading of Genesis. Rather, we should emphasize that acceptance of God's Word depends on faith—faith which is supported by adequate, but not compulsive, evidence; and that one does not need to become skilled in scientific endeavor to find an ample basis for this faith. We ought to stress that no compulsive evidence is available *against* the testimony given to us by Moses, and that models can be developed which make it intellectually respectable to accept this testimony as an authentic revelation from God.

Cordially yours in our Master's service,
R. H. BROWN,
President, Union College
Lincoln, Nebraska 68506

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THE GLARUS OVERTHRUST

WALTER E. LAMMERTS*

In June of 1970 it was my privilege to spend several days studying the classical Lochseite of the Glarus overthrust near Schwanden, Switzerland. Before going there I had an interview with Dr. K. I. Hsu of Zurich, who recently published a study of his interpretation of how this overthrust of Jurassic limestone on Eocene rock occurred. In this article a resumé of Hsu's observations and conclusions will be given first, followed by my own observations and experiments. A discussion of how this series of stratified rocks may be interpreted in terms of flood geology will then be given. A comparison of this overthrust with the far more extensive wrong order formation known as the Lewis overthrust, and recently observed small overthrusts resulting from the earthquake in the Newhall area described by Dr. George Howe in this issue will also be made.

Resumé of K. J. Hsu's Observations and Conclusions

K. J. Hsu¹ reported on his studies of the Glarus over-thrust in 1969. He concluded that the overthrust has a dimension of 35 kilometers (or about 21 miles) in length by about five to six kilometers in thickness. It lies upon an Eocene formation and consists of Jurassic limestone at the base and Verrucano conglomerate above. The limestone above the fault line is classified as Malm, and below as probably Vanlangien (L and L-2 in Figure 1).

The overthrust took place in two phases at least. The earlier phase of main movement was related to the flowage of the Lochseitenkalk (limestone) within the thrust zone. The later phase of frictional sliding produced the thin film of fault gouge within the Lochseitenkalk.

The later movement was probably related to an uplift of the autochthonous (sediment deposited in place) massif, which caused the present 10° to 12° northerly dip of the Glarus overthrust. If the pore pressure (in the rock) had remained abnormally high, the block would have to slide under its own weight. If the pore pressure had dropped to normal, then a push from behind would be necessary.

The earlier movement was related to a push from behind along a nearly horizontal thrust plane where the pore pressure was equal, or nearly equal to the overburden pressure.

The rate of the earlier displacement through the flowage of the Lochseitenkalk was estimated as ranging from .2 to 10 cm/year at a temperature of 300-400°C. at the base of the thrust, which is at about six kilometers of depth. The heat generated by overthrusting may have contributed to the steep geothermal gradient then prevailing in the Glarus region.

The rate of later displacement by frictional sliding was governed by either the rate of stress built up as a result of the push from behind by

an advancing nappe, or by the rate of erosion of the toe which obstructed gravity sliding. In either case the displacement would be a jerky sliding resulting in a series of shallow earthquakes.

More precise study of strain rate; stress, and temperature, based upon experimental creep studies or tests of the Lochseitenkalk are planned.

Critique of Earlier Studies

K. J. Hsu believes that earlier studies of overthrusting erred in that only the friction at the base was considered in estimating minimum resistance. Thus Smoluchowski² concluded that the friction factor alone would restrict maximum length of an over-thrust to eight kilometers (about five miles). Oldham³ suggested large overthrusts move like the crawl of a caterpillar which advances one part of its body at a time, and all parts in succession.

Hubbert and Ruby⁴ substituted for the term "caterpillar crawl," the terminology "dislocation mechanism," which purportedly eliminated the cohesion strength in succession so that resistance to overthrusting was by friction only. This faulty analysis led them to greatly underestimate the shearing resistance at the base of overthrusts, and greatly overestimated their length and the ease of gravitational sliding along very gentle slopes. Hsu shows that their analysis is not applicable to those overthrusts whose movement is related to flowage of ductile materials within the thrust zone, and proposes a new treatment of the mechanism of such thrusts.

Hsu's Proposed Explanation

By a rather complicated mathematical analysis Hsu shows that brittle fracture depends on the initial shear strength or cohesive strength, and a variable friction term directly proportional to the effective normal stress. He maintains that Hubbert and Ruby erred in that they considered only the variable friction. Thrust faults as long as the Glarus cannot therefore be explained by their proposed mechanism.

Between the upper Verrucano and lower Eocene is the Lochseitenkalk, less than one meter

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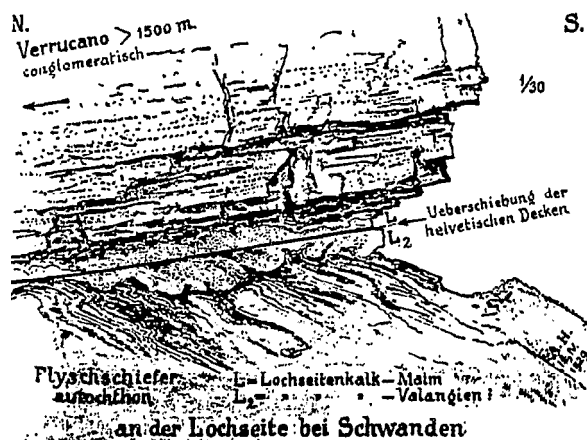


Figure 1. The thrust contact of the Glarus overthrust at Lochseite near Schwanden (Glarus), reproduced from Albert Heim, 1929, *Naturforschende gesellschaft, Zurich, Viertel Jahrschrift*, pp. 213-233.

thick. This smeared out limestone shows signs of flowage and is present practically everywhere as the lowest layer of the Glarus thrust (labeled L and L-2 in Figure 1). This Hsu considers as evidence that the upper thrust plate moved forward as the limestone *flowed*. There is in addition a fault gouge zone or a clay film, a few millimeters thick present as a planar system within the limestone.

Now fault gouge has been produced experimentally when one block slid past another along a pre-existing fracture surface as noted by Byerlee.⁵ This gouge is then considered as evidence that the thrust later moved along a cohesionless plane by frictional sliding after the limestone had fractured with a loss of cohesion.

The main thrust was followed by uplift of the autochthonous massifs, which resulted in arching of the thrust plane and produced its present northerly dip of 10° to 12°. During the main phase the thrust plane was more nearly horizontal, and northerly dip not more than 5°. Since the plane was originally dipping only about 5°, the main movement could not have been due to gravity sliding. A push from behind must be assumed. Because of obstructions in front of such a thrust producing the so-called toe effect, the minimum angle would have to be at least 11.6° and more probably 20° to cause gravity sliding.

The rocks of the Glarus are re-crystallized in part. Sericite and Chlorite are present in the Verrucano formation. But there is no evidence of amphibolite facies metamorphism which starts at 540°C. and 2 Kilobars pressure at K-1. Hence the average temperature at the time of deformation and flow of the limestone could not have been more than 500°C.

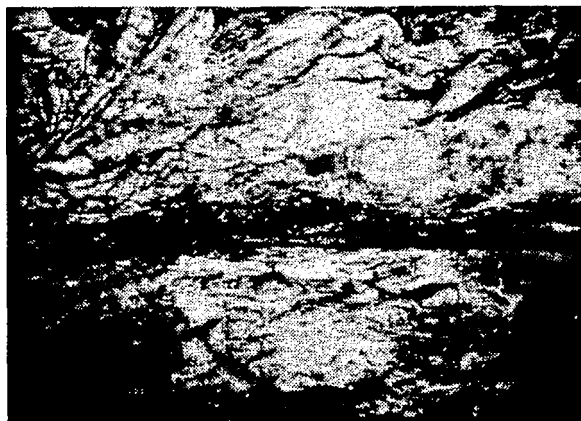


Figure 2. Almost straight line of contact L and L2.

A temperature of 400°C. seems to be higher than expected judging from the largely unmetamorphosed nature of the Flysch (Eocene) under the thrust. In the later phase of frictional sliding resulting in the gouge, a "stick-slip" jerky movement occurred. The stress built up and was then relieved by small slips such as those now causing earthquakes along the San Andreas fault.

Observations June, 1970

I left for Schwanden, Switzerland, by train from Zurich at 9:20 A.M. June 3, 1970. It was surprising how much open land and forests still remain. We arrived at 1:30, and after checking in at the Adler Hotel, immediately went up the Sernf river road, and after one wrong turn, soon found the little steps described by Dr. Hsu. A rather well worn pathway led to the outcrop shown in Figure 1. Unfortunately it was cloudy so pictures could not be taken.

The following day was clearer so some pictures of the contact line were quite clear cut. The following notes are most pertinent:

(1) The broken up clay at the contact line separating L and L-2 varies from 1/8 to one inch in thickness and is mostly 1/8 to 1/4 inch thick. This layer is almost horizontal and a very straight line. (Figure 2).

(2) The limestone is about six inches thick above and six to seven inches thick below the broken up clay layer.

(3) The limestone both above and below the contact is mostly very hard, though some is quite soft and does not seem metamorphosed.

(4) The contact of the limestone with the Verrucano above is very irregular.

(5) Also the contact with the Eocene below is even more irregular.

(6) The Eocene is very hard and a type of slate formation.

(7) Toward the north end of the exposure the contact line separating L and L-2 is lying



Figure 3. Shows black streaks of clay particles in L-2.

directly on the Eocene rock in places with very little of the L-2 part below it anywhere.

(8) Soft areas like the gouge layer extend down as streaks for about 4 inches into the lower Jurassic (L-2). (Figure 3).

One of the most difficult facts as regards accepting Hsu's concept of flowage of the limestone, followed by a secondary movement of frictional sliding after its fracture between L and L-2, is that the gouge layer is mostly clay instead of ground up limestone particles. If the gouge layer is actually the result of the grinding action of the upper layer L sliding over the lower layer L-2, it would seem that a chalky, powdery type of layer would be formed. Chemical tests of this clay layer show that only about 5 to 10% of it is CaCO_3 , the rest remaining insoluble in hydrochloric acid.

Even more important is the present order of the formations. In order to have the Verrucano, a Permian formation, on top of the Jurassic, Hsu postulates a recumbent fold of these formations, or overturning of them. They were then according to his concept thrust over the Eocene by the flow type of mechanism he postulates.

Now the usual order of these formations is of course Permian, Jurassic, and then much later the Eocene. An assumed overturning would have to occur after the Eocene above the Permian and Jurassic had been eroded away in the area they were located before the overthrusting, but *not in the present location at the overthrust*.

The fact that the Eocene rock is very hard and slaty makes it difficult to see how this differential localized erosion could have occurred. Besides the contact line of the Jurassic with the Eocene below is very irregular. Hsu's flow concept would allow for this but as noted above some of the limestone is quite soft and does not seem to have flowed. Though there is no question as to the fact of metamorphosis it seems

strange this was not complete if heated to 300-400°C. long enough to make it flow for over 21 miles.

Also as indicated the contact of the limestone with the Verrucano now above it is also very irregular. This indicates that considerable erosion of the Verrucano took place before the Jurassic was deposited on it. Though in itself not conflicting with the concept of overturning and then thrusting over the Eocene, this evidence of large scale erosion would seem to fit in much better with a flood geology interpretation.

Flood Geology Interpretation

If one looks at this famous exposure of wrong order rock formations without any bias in favor of the authenticity of the geologic time table, a much simpler explanation of it can be given in terms of flood geology concepts. According to this view point the various formations have no time value in the sense of millions or even thousands of years of time, but were all deposited rather rapidly during or relatively soon after the world wide flood action.

The Eocene formation at the bottom of L-2 was deposited, hardened or rather consolidated to some extent and then eroded into its present irregular surface. Then the Jurassic L-2 layer of almost pure limestone was deposited but not in a completely uniform manner, the amount being greater in the south end than toward the north end.

After this a change of current and a quieter deposition period led to the formation of the 1/8 to one inch deposit of mostly clay particles, though some limestone particles were still in the water. That the transition was an uneven one may be supported by the fact that the streaks of black clay particles extend down into the L-2 layer of limestone.

This was followed by a renewed current carrying limestone particles resulting in the deposition of the Jurassic L layer above the clay. No erosion took place between the deposition of L-2, the clay layer, and L, hence these layers form an almost straight line. Following the deposition of L, considerable erosion took place causing the irregular surface. This erosion was followed by a long period of deposition from a different source, thus causing the very thick Permian or Verrucano conglomerate to be formed.

Most of the deposits have been more or less metamorphosed into partly crystalline rock. This is particularly true of the Jurassic formation and it may well be, as Hsu suggests, that they were heated to a temperature of 300-400°C. and flowed into their present position. The remarkable continuity of the Jurassic into the Verrucano above and Eocene below would then be accounted for.

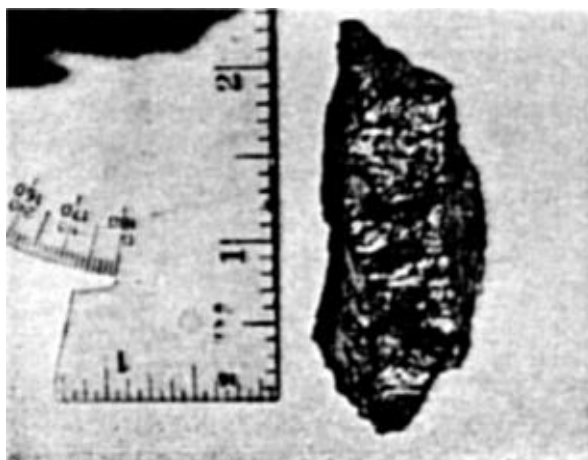


Figure 4. Sample from upper surface of thrust plane. Jurassic L just above the layer of clay. The limestone is noticeably metamorphosed. (Scale is in inches.)

As may be seen by a careful study of Figure 2 these contacts are no longer depositional but the rock is actually so intimately united that it is difficult to obtain samples of one without some of the other. (Note irregular black Eocene in very close contact with the Jurassic at bottom of Figure 2.) The Eocene formation was also much hardened and as Figure 1 shows is now inclined and much distorted. The Verrucano above is also a very hard rock formation, though relatively unaltered as compared to the Jurassic and Eocene.

The flow postulated by Hsu could hardly have resulted in a movement of over 21 miles since some of the Jurassic limestone has not been metamorphosed. This part is a rather loosely compacted material which can be broken off and pulverized with one's fingers. It is mostly found in the lower or L-2 layer. Both it and the crystalline metamorphic parts consist of almost pure limestone dissolving rapidly in hydrochloric acid. About 1% or even less consists of magnesium carbonate since part of it dissolves in hot hydrochloric acid, and the rest is made up of dark almost black particles and some undetermined mineral.

It is interesting to note that the upper or L layer contains no black streaks of clay particles, and is a remarkably pure limestone, dissolving completely in hydrochloric acid. Microscopic study of both L and L-2 particles indicated that they are of inorganic origin. No evidence of any even minute fossils was found.

The flow mechanism suggested by Hsu could hardly apply to such large scale wrong order formations as the so-called Lewis overthrust. As described by Burdick the contact line shows no evidence of any gouge layer, breccia, or striation.

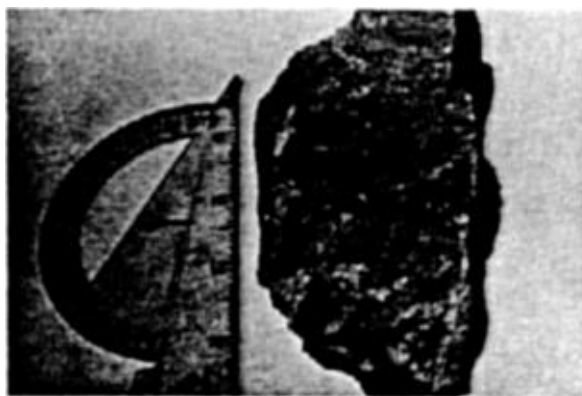


Figure 5. Sample from lower surface of thrust plane. L 2 surface just below the layer of clay. Some of the limestone was quite soft. (Scale is in inches.)

Also the Altyn limestone above unlike the Jurassic of the Glarus overthrust shows no evidence of flowing and resultant metamorphosis. It is a relatively soft, sandy dolomite of light buff color.

As regards the later phase of movement, there is no question as to its occurrence leading to the thrust plane now visible. Any stress built up would be most readily relieved at this comparatively thin weak layer of clay. It is however, difficult to see how this movement *caused* the clay layer as postulated by Hsu since movement of two surfaces of limestone against each other would result in a gouge of limestone particles.

Clay or kaolin results from the breakdown of feldspar. As mentioned above only 5 to 10% of this layer is calcium carbonate. Furthermore the upper L and lower L-2 contact surfaces of the very hard Jurassic with this clay layer are very glossy, black, and uneven. Not the slightest trace of even a striation can be seen (Figures 4 and 5).

Undoubtedly many small movements each accompanied by an earthquake have occurred. This resulted in the highly polished look of both surfaces as they moved along the comparatively soft black clay layer separating them. These "stick-slip" jerky movements are the same as those now occurring along the famous San Andreas fault.

As shown by Howe⁷ these result in very bad breakage and gouging when hard surfaces slide against each other, but relatively little damage if one surface is soft. Certainly phenomena such as these could never result in any major 21 mile movement such as is postulated at the Glarus overthrust. This part of Hsu's able analysis is undoubtedly correct.

Conclusions

In conclusion the following has been established:

(1) The Glarus "overthrust" is a complex one in which the formations instead of being in their correct order according to the commonly accepted geologic time table (i.e. Permian, Jurassic, Eocene) are actually Eocene, Jurassic, Permian.

(2) In order to explain this order, Hsu postulates a recumbent fold placing the Jurassic under the Permian followed by a 21 miles thrust over the Eocene formation.

(3) This thrust resulted from a push from behind, heating the Jurassic rock to from 300-400°C. so that they flowed into their present position.

(4) A secondary series of small movements is also postulated resulting in the gouge layer of clay from 1/4 to one inch thick.

(5) As opposed to Hsu's conclusions it is shown that the so-called gouge layer is only 5 to 10% limestone, the rest being clay particles. Also the surfaces of both L and L-2 in contact with this clay layer are shiny and black, show no striations, and even their irregularities have not been worn away.

(6) The small "stick-slip" movements resulting from stress were thus rather easily made against the relatively soft clay layer.

(7) Undoubtedly a major movement such as postulated by Hsu also occurred which initiated the almost level fault line. The stress may very well have heated this rock to 300-400°C. so that it flowed into its present position physically united with the uneven Verrucano or Permian above and irregular Eocene surface below.

(8) The evidence for a flow of 21 miles is lacking since only the major part of the Jurassic

limestone was metamorphosed into its present crystalline structure. Much of the limestone is quite soft and shows no evidence of metamorphoses and movement.

(9) From the view point of a world wide flood and later resultant settling stresses there is no need to postulate a flow of 21 miles. It is more likely that this limestone flowed only as far as necessary to relieve stress.

(10) An outline is given as to how these deposits may have been laid down in their present order, and later subjected to pressures and vulcanism resulting in their partial metamorphoses.

(11) It is shown that the flow type of mechanism postulated by Hsu will not explain such vast wrong order formations as the so-called Lewis overthrust since no large scale flow type of metamorphism is found in the Altyn limestone lying immediately above the Cretaceous shales.

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OVERTHRUST EVIDENCE AS OBSERVED AT FAULTS CAUSED BY THE SAN FERNANDO EARTHQUAKE†

GEORGE F. HOWE*

Creation geologists have shown that where overthrust faulting has taken place, there is considerable evidence to support such action. Uniformitarian geologists assert that overthrust faulting must have taken place in order to explain vast rock sequences that are "out of order" with respect to the evolutionary geologic column. In some of these supposed instances of overthrusting, there are none of the usual physical evidences to support overthrust action.

Overthrust activity has been observed on a small scale along various fault escarpments of the San Fernando earthquake of February 9, 1971. In each case, the small overthrust manifested one or more of the expected evidences for overthrusting. This evidence supports the creation geologists in rejecting the overthrust hypothesis wherever physical evidence is lacking, despite the fact that large rock sequences are indeed out of order with the geologic column. It is asserted that the Flood view is a more natural view in that it does not demand a certain preconceived ordering of the fossils, and hence does not require postulating overthrusts where no physical evidence exists.

Introduction

Geologists have recognized for many years that fault surfaces or "planes" show the motion of one fault face against the other by striations, slicken-sides, fluting, tectonic breccia, and ground rock powder.¹ Flood geologists such as Clifford Burdick and Harold Slusher² have insisted that overthrust faults should also show such evidence. When such signs of tectonic activity are absent and one stratum lies in apparent conformity above another, there is no *physical* reason to affirm the overthrust hypothesis in such a locality.

Yet in several locations such as the so-called "Lewis Overthrust" in Montana and Canada (as reported by Clifford Burdick³ and Walter Lammerts⁴), and in the Empire Mountains of Arizona (as reported by Clifford Burdick and Harold Slusher⁵) uniformitarian geologists have argued for ancient overthrusts because rock formations that are considerably "younger" in terms of the evolutionary-uniformitarian geologic column) rest under rocks that are supposedly "older."

Flood geologists have reasoned that these so-called "upside down" formations in the strata were actually deposited in sequence as a result of the Global Flood or subsequent related cataclysm, and therefore may be used as evidence against the evolutionary geologic column. Because of their great confidence in the column, however, uniformitarian geologists continue to hold that such regions must have been overthrust in past ages. If this were so, then some overthrusts must have taken place with few or none of the usual marks of tectonic activity.

In fact the present concept as stated by K. J. Hsu⁶ is that the major movement occurred when the rocks were at 400° C. and flowed over the lower layers. The classic example of this is the Glarus overthrust of jurassic rocks over Eocene near Schwanden, Switzerland.* This same explanation is given for similar low angle thrusts such as can be found in Glacier National Park. Such a "rock flow" concept is not inconsistent with flood geology postulates except that from our viewpoint the sediment would readily flow if under any pressure since it had not yet hardened.

In any event the older view of solid rock being thrust over equally solid lower layers is no longer tenable or indeed held by younger theoreticians such as Hsu. The amount of shearing and rock breakage would simply be too great as shown by even the small overthrusts resulting from the recent San Fernando earthquake.

During that earthquake, February 9, 1971, the ground north and east of the fault moved as much as six feet vertically, and six feet horizontally with an acceleration of over one gravity, registering about 6.6 on the Richter scale. Three obvious fault escarpments of this earthquake will be pictured and discussed: 1) The Interstate 210 escarpment, 2) the Foothill Boulevard escarpment, 3) and the Lopez Canyon escarpment. In addition, some discussion of blacktop sliding is also undertaken.

Observations

Interstate 210 Escarpment

This line of faulting is located about 0.2 miles north and west of the Maclay Avenue bridge of Interstate 210 (Foothill Freeway). The concrete of this highway buckled and fractured such that a concrete block northwest of the fracture was

†While the author alone is responsible for the content of this paper, he wishes to express gratitude to Mr. Mark Tippetts, geologist, and Dr. Walter E. Lammerts for careful reading of the manuscript in preparatory stages and for constructive criticism.

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*See article by Dr. Walter E. Lammerts elsewhere in this issue.



Figure 1. Interstate 210 fault line in concrete: overall view. As the concrete was broken, whole slabs were shoved across other slabs during the earthquake. Barbara Howe is seen in this and other photographs.

shoved south over the concrete block on the opposite side of the fracture line (Figure 1). At some points along this fault, the one concrete block (northwest) was elevated at least nine inches higher than the other block and was pushed south some distance laterally. The movement of these two blocks against each other provides an example of overthrust activity on a very small scale (Figure 2).

In the earth fill at the side of the freeway, some 50 feet north and east of this cement fracture, the fault escarpment is seen as a simple crack in the clay soil (Figure 3). The earth above the clay fracture line is about six inches higher than that immediately to the south and east. There is no evidence of actual overthrusting in this clay region of the Interstate 210 fault escarpment.

Foothill Boulevard Escarpment

This fault line runs northeast and southwest parallel to the north edge of Foothill Boulevard, about 0.1 mile south and east of the Vaughn Street intersection. Although a general buckling and breaking of both concrete and blacktop can be seen (Figures 4 and 5) the Foothill Boulevard fault does not present a valuable area in which to study overthrusting, because the overthrust which existed was removed by highway crews soon after the earthquake, and now one can view only the embankment remaining after the road repair. This escarpment does demonstrate the great vertical component in this earthquake, however, as the curbing and land northeast of the fracture now stand more than three feet above the road itself (Figure 5) which lies southwest of the fault.

In the vacant lot somewhat northwest of the road edge where Figure 4 was taken, the fault line is located in loose soil. Here one finds no line of fracture or overthrust but only a mound of earth resembling the work of some giant mole.



Figure 2. Interstate 210 fault line in concrete: closeup. Here actual overthrusting occurred. Slab to left was elevated more than nine inches higher than that at right and moved across the other slab during the earthquake. This site provides an excellent model of overthrusting. Note the ground concrete and powdered material nearby. There were striae apparent on the surfaces which rubbed against each other.

Lopez Canyon Fault Escarpment

This fault line is found on the property at 12221 Lopez Canyon Road. A long escarpment is visible in the Repetto Formation.⁸ Along the line of fracture one side moved three feet upward and a few inches to the south (Figure 6). Since there was both vertical and some lateral thrusting here, it is another example of overthrust action on small scale. Figure 7 shows the actual face of material which slipped up and against the other side of the fault line during the earthquake. This locality is an excellent site at which to judge the effects of overthrust faulting on rock faces involved.

Trailer Park Blacktop

On a dead-end street within the Blue Star Trailer Court, Filmore Ave., San Fernando, California, the earthquake caused considerable move-



Figure 3. Interstate 210 fault line in clay road bank. North and east of the highway the fault line is visible in the earth fill. There is no evidence of overthrusting in this soft material although the one side of the fissure is now about six inches higher than the other.



Figure 4. Foothill Boulevard fault escarpment. Here the actual fault line can no longer be seen because of road repair. It is obvious, however, that the sidewalk was elevated several feet in relation to the road bed. This view is toward the southwest, along the fault.



Figure 5. Foothill Boulevard escarpment. Despite road repair, the great vertical component of the San Fernando earthquake is fully evident in this view toward the northeast.



Figure 6. Lopez Canyon fault escarpment: overall view. A long escarpment is visible here where the stratum portion at the right (Repetto formation) was elevated as high as three feet vertically and shoved several inches south across the portion of the same stratum at the left. Small superimposed white arrow indicates direction of the overthrust. Behind Barbara Howe is a portable seismograph placed at at this location by Museum scientists.

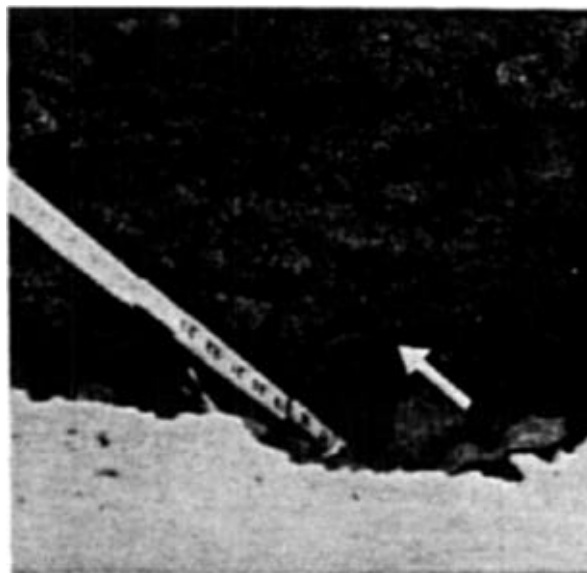


Figure 7. Lopez Canyon fault escarpment: closeup view of striated clay surface. Here the surface of the northern block (which slid up and over the southern block) can be seen. Note cracking in the moist Repetto clays which occurred through drying since the earthquake and has nothing to do with overthrust action. Note slickensides faintly visible almost parallel to the measuring stick. Rock movement occurred in the direction of the superimposed arrow up and sideways. The slickensides are faintly visible parallel to and ahead of the arrow. In a miniature overthrust the slickensides were present as testimony to the overthrust action.



Figure 8. Overall view of twisting and faulting in blacktop of Blue Star Trailer Court, San Fernando, California. The fracturing, slanting, and toppled nature of the blacktop would in itself be evidence of overthrusting.



Figure 9. A blacktop, concrete overthrust. Philip Howe is standing on a blacktop slab which was moved some three feet laterally southwestward (direction of superimposed arrow) during the San Fernando earthquake. This is an example of a soft material (asphalt) moving over a harder material (concrete).

ment and thrusting of blacktop. Figure 8 illustrates the overview of faulting which occurred in that trailer park.

At certain locations sheets of blacktop were thrust up and over slabs of concrete or other pieces of blacktop. Some blacktop was thrust about three feet laterally (southwestward) over a slab of concrete (Figure 9). The thrust occurred in the direction of the superimposed arrow beneath. The blacktop was turned over manually to expose the surfaces of thrust which are photographed in Figure 10.

In this instance, striations were evident on the under surface of the blacktop but not in the concrete. Some sandstone which had been beneath the blacktop originally was carried along and striations could be seen in this material although they were not deep. When one piece of blacktop slid over another piece of blacktop, striations were visible in the sand carried along and there was some grinding of the stones in the blacktop against other stones present in the lower strata of blacktop. Marks of sliding and grinding were not nearly so evident as at the Interstate 210 escarpment where concrete was thrust over concrete.



Figure 10. Closeup view of overthrust surfaces, blacktop on concrete. The blacktop slab of Figure 9 was lifted manually and turned so that to the left one can see the surface of blacktop which slid across the concrete to the right. Some sandstone which had been originally beneath the blacktop can be seen as it was moved along with the blacktop. Some evidence of sliding is evident on the blacktop surface but not on the hard concrete. Perhaps a greater weight of sediments atop the blacktop would have caused greater evidence for overthrust action here. Overthrust evidences are not as obvious at this location as they were at the Interstate 210 escarpment where concrete overrode concrete.

Discussion

Not every fault zone in the San Fernando earthquake provides a situation in which to analyze overthrust faulting. In soft beds of loose earth or clay the fault may be seen as a ridge or mound rather than a fracture (as in the field near the Foothill Boulevard Fault). Sometimes soft clay will simply crack as on the roadside of the Interstate 210 fault. While faults in such soft materials do not help illustrate common effects of overthrust faulting, they do suggest that extremely soft material will not submit to overthrust faulting but will buckle or simply crack instead.

At the Interstate 210 overthrust one can view what happens when blocks of concrete rub against one another. As Burdick and Slusher indicated for large overthrusts⁹, there are such evidences as ground rock powder and striae apparent where the two slabs have rubbed against each other during the earthquake.

In a somewhat softer matrix (the Repetto Formation at Lopez Canyon) there are also evidences of overthrusting at the contact line—slickensides visible on the claystone. Scientists from the Los Angeles County Museum of Natural History collected fresh slickensides two days after the earthquake in the Saugus Formation of Little Tujunga Canyon (a canyon not far from Lopez Canyon). Grooves in the clay were formed during the earthquake or one of its after-shocks.

Museum scientists report that soon the clay began to dry and crack such that there was crumbling of the stratum when it was being placed in the museum.¹⁰ But certain samples of these slickensides were preserved and are presently on display in the museum as evidence of overthrusting.

It is probable that at the trailer park and at the Interstate 210 escarpment scratches, grooves, and other evidences of thrusting would have been more marked had there been a heavy burden of sediments above the rocks which slid. In the case of the blacktop, there was only the weight of about three inches of blacktop to press the sliding stratum against the lower layer. Accordingly, evidences of overthrusting were only very slight.

In a typical overthrust (as conceived by the historical geologist), a tremendous overburden of sediments would have weighted down upon the thrusting stratum to accentuate the evidences for grinding beneath. The greatly twisted and broken condition of the blacktop would have been further conclusive evidence of overthrusting. In contrast certain of the supposed over-

thrusts of historical geology have perfectly flat and otherwise unbroken contact lines with strata beneath for vast distances.

The large overthrusts such as those postulated to account for the wrong order of formations at Glarus, Switzerland, and in Glacier National Park were then either deposited in this position or flowed into place as suggested by K. T. Hsu, when under great pressure and at over 400° C. Certainly if overthrust after the rock had hardened, these strata would show abundant evidences of faulting such as indicated even in these very small movements. A more careful study of all these supposed overthrusts is needed to see if there is indeed any evidence for melting and flow of the rock.

Conclusions

Data from this analysis of both concrete and soft strata indicate that where thrust faulting took place it was accompanied by one or more of the usual evidences—gouge layers, slickensides, ground rock powder, etc. Such consistent hallmarks of overthrusting confirm the previous assertions of Burdick and others.

This evidence also highlights the severe problems facing a uniformitarian geologist who holds that thrust faulting has occurred where there is no physical evidence to support such a claim. Problems arise for the uniformitarian geologist because of his persistent attempt to preserve the geologic column in the face of negative evidence.

In the flood view, however, fossil sequences would be expected to vary somewhat from place to place. The flood view of stratification is a more natural one because it does not require vast and unreasonable overthrusts to preserve a preconceived notion about the order in which fossils "ought" to occur.

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THE IMPLICATIONS OF THE TWO LAWS OF THERMODYNAMICS IN THE ORIGIN AND DESTINY OF THE UNIVERSE?

DAVID PENNY*

The first two laws of thermodynamics are explained and illustrated. According to the second law of thermodynamics, the universe is destined to a slow and irreversible heat-death outside divine intervention.

The two thermodynamic laws are shown to be at odds with any naturalistic scheme of origins but in good keeping with special creationism. The only escape from some possible heat-death is seen in a transformation of the cosmos as a consequence and fulfillment of the resurrection of Jesus Christ.

The First Law of Thermodynamics

The first law of thermodynamics states that quantitatively energy is conserved; nothing is gained or lost in transformations. If the universe is a closed or finite system, as Einstein and others thought, then the total amount of energy and mass equivalent of energy ($E = mc^2$) in the universe is constant for all time. This energy density concept can be applied to a finite universe. The first law can therefore be plotted as a graph of average energy density versus time. (See Figure 1.)

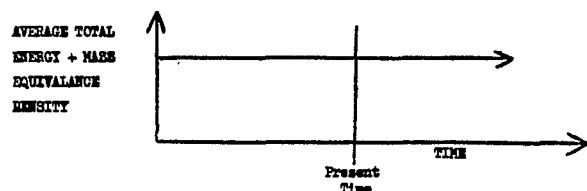


Figure 1. Average energy density versus time. In a finite universe there is the same amount of energy today as there was 1000 years ago and as there will be 1000 years from today, according to the first law of thermodynamics.

The universe has the same amount of energy today as it had a 1000 years ago and as it will have a 1000 years from today according to the first law of thermodynamics. The *quantity* of energy, including mass equivalence, is conserved.

The Second Law of Thermodynamics

The second law of thermodynamics is understood today in three ways: (1) the classical or work-heat approach, (2) the statistical or kinetic theory approach, and (3) the information theory approach. A closed system will go from ordered states to disordered states, unless order is injected into the system from the outside.

†The author submitted a dissertation of this title to the Dallas Theological Seminary, Dallas, Texas. The present paper is an abridgement of one section in that thesis, and is published by special permission of Dr. John F. Walvoord, President, Dallas Theological Seminary

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In the statistical approach, a closed system will statistically go in any interaction from a less probable state (order) to its more probable state (disorder). In the information theory approach, information in any closed system will, in any interaction or transmission, become more random or disordered.

The second law says that the entropy of a closed system always increases. The word, *entropy*, "is a compound from the Greek *en* (=in) and *trepen* (= to turn, veer, give direction to). Entropy accordingly means 'being directed inwards'."¹

Entropy thus simply indicates the direction that the closed system goes, and that is toward greater randomness. It is what Eddington called *time's arrow*, that is, a pointer of the drift of natural processes. "Entropy is the measure of randomness,"² and randomness is always increasing. Harold Blum, a Princeton evolutionary biologist, capsulized the concept of entropy:

A major consequence of the second law of thermodynamics is that all real processes go toward a condition of greater probability. The probability function generally used in thermodynamics in *entropy*. . . . Thus, orderliness is associated with low entropy; randomness with high entropy. . . . The second law of thermodynamics says that left to itself any isolated system will go toward greater entropy, which also means toward greater randomness and greater likelihood.³

Increasing entropy, the second law, is simply increasing disorder of a closed system. (See Figure 2).

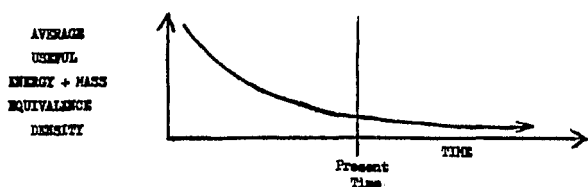


Figure 2. Available energy versus time. In the universe, the average useful energy density decreases with time according to the second law of thermodynamics which indicates that energy continually becomes less available and more randomly distributed.

However, two methods are believed to exist whereby order can be produced out of disorder within the limits of this law: (1) chance and time whereby the improbable state is supposed to come about and (2) an agent and a degradable energy supply. The first of these proposed methods is invalid because chance and time both innerringly favor increasing entropy. In the second method proposed, some pre-existing agent must have a minimum amount of complexity or order equal to or greater than the order to be produced.

Also, the energy supplied must be degraded to greater disorder such that the degradation of order is equal to or greater than the local increase of order produced by the agent. "Therefore there may be local decreases of entropy as bodies interact with each other, but every decrease is more than balanced by an increase of entropy elsewhere so that the total entropy of the system increases."⁴

An illustration clarifies the difference between the two methods of producing order. Take a watch apart and throw the parts into a bag. Now we can produce order, the reassembled watch, by (1) shaking the bag, allowing chance and enough time, or (2) placing a watchmaker in the bag and giving him enough energy in the form of food. In the first, time and chance might produce the watch, but in the second, the agent and degradable energy supply achieve the order.

Likewise, a fertilized egg can become a human being as long as it has its agent, DNA (the genetic molecule), and an energy supply, food. Take either away and the egg is left only to time and chance to produce a human, an impossible feat according to any known naturally occurring events. Furthermore, the effects of harmful changes in the DNA are neglected in this analogy as is also the fact that the human will eventually die.

Specific Applications of the Second Law

More specifically what is the significance of entropy from the classical, work-heat approach?

The term "Entropy" used in this law is of a rather curious and negative character. It indicates the degree of randomness or disorder in the constituent particles of any substance or, alternatively, it may be said to indicate the degree to which energy becomes converted from a useful into a useless form. The Second Law of Thermodynamics is in fact a physical law of irreversibility, since it states that in any physical or chemical process the amount of available energy must at the end of the process either remain exactly what it was at the beginning or, alternatively, must decrease. Such a decrease of available energy is an increase in Entropy.⁵

The available, useful (non-random) energy always decreases in a closed system. In simple terms work energy (useful, ordered) is turned into randomly distributed, unuseful, heat energy. In reference to the universe as a whole,

the entropy of the universe increases in an irreversible process. . . . Since all processes in nature are irreversible . . . it follows that the universe continuously runs toward higher and higher entropy, that heat is degraded as it is transferred from regions of high temperature to regions of low temperature and that entropy is a measure of this degradation.⁶

This degradation of energy is probably an exponential decay because the rate of entropic increase is proportional to the potential differences (temperature, pressure and probability differences) which decrease with time. Therefore the entropic increase is more rapid at a given time and slower at any subsequent time as the available energy asymptotically approaches zero. This decreasing of available energy can be graphed as the average useful energy density over the whole universe versus time, although the rate will be unknown.

What is the significance of entropy in the statistical or kinetical theory approach?

In all cases observed in nature there is a tendency for processes to proceed toward a state of greater disorder. We have already seen that natural processes tend toward a state of greater entropy so that we expect a connection between the thermodynamic concept of entropy and the statistical mechanics that the connection is given by the relation

$$S = k \ln w \quad (25-13).$$

Here, k is Boltzmann's constant, S is the entropy of the system, and w is the probability that the system will exist in the state it is in relation to all the possible states it could be in. Hence, Eq. 25-13 connects a thermodynamic or macroscopic quantity, the entropy, with a statistical or microscopic quantity, the probability.⁷

This approach to entropy gives the second law a mathematical rather than an empirical basis. Using quantum physics and Boltzmann's distribution, the second law can be developed on a purely mathematical (statistics) basis completely devoid of empirical observations as presuppositions. "The reason the papers on some desks most frequently seem to be in a disordered state is simply that there are so many combinations of the papers which are disordered, and so few which are ordered."⁸ The same is true of matter and energy.

The information approach is similar to the statistical mechanics approach.

We measured the information content of a message in any given ensemble of messages by the logarithm of the probability of its occurrence. This way of defining information has an earlier precedent in statistical mechanics where the measure of entropy is identical in form with that of information.⁹

Information becomes disordered in interaction just as energy does according to the classical approach. An example of this is the transmission of a television picture down a wire. The picture is reduced to a sequence of electrical impulses which represent highly ordered information. As the impulses of electrical information travel along the wire, the impulses are disordered by the random molecular motion in the wire. If the information were sent through enough wire, it would only produce a completely snowy picture which did not contain the highly ordered information of a clear picture but only random information like noise or static. Information decreases as entropy increases in a system.

A Distinction Between the First and Second Laws

A clear distinction must be made between the first and second laws of thermodynamics. Historically, many misunderstandings would have been prevented, if this distinction had been made. Many have thought the two laws are contradictions.

But soon after Mayer had formulated the principle of energy (conservation of energy), two other scientists, Clausius (1850) and Thomson (1851), laid down a second principle, which did not abolish Mayer's law of energy, as Haeckel mistakenly thought, but amplified and supplemented it particularly in a certain direction. This is the so-called second principle of thermodynamics, or the law of entropy.¹⁰

The usual question is, How can energy be conserved (the first law), if it is degenerating (the second law)? The fact that the amount of energy never alters does not mean that energy is always available. As stated earlier, the first law states that the **quantity** of energy, including the mass equivalent, is conserved, while the second law states that the **quality** of this conserved quantity is continuously degraded.

Likewise evolutionists have tried to attribute the presumed increase of organization, a decrease of entropy, in the supposed upward evolution of living systems to energy supplied by the sun. They point out that the earth is not a closed system and that the sun injects the energy needed for "evolution" from the outside. Blum, for instance, says,

Where must we look for the increase in entropy that would compensate that represented by this increase in organization? We have to go all the way to the sun, which we must include in our isolated system. For the source of the energy utilized in reproducing the microorganisms stems from nuclear reactions in the sun, which have entailed increase in randomness. In all three instances [examples of reversed entropy] the latter of which corresponds very closely to the case of living organisms as a whole, we see increase in total organization only when we view a restricted part of the universe. If we enlarge our system enough to treat it as a thermodynamically isolated one, we find sooner or later an increase in randomness. When we think of high organization of living organisms, we need to remember that we deal with a small part of a much greater whole.¹¹

Blum fails to differentiate the two laws. Quantity can never make up for quality in "evolving" highly organized systems. The sun supplies an influx of energy in waves and particles but the entropic value of this influx is negligible compared to the order needed to synthesize random atoms into living systems. The sun only supplies degradable energy, but it does not supply the agent or order to utilize this energy in producing highly organized life forms. Even Blum admits in the new chapter of his revised edition,

Although the increase in negentropy [negative entropy] is always dependent in one way or another upon the expenditure of energy, the two things are not measurable in the same terms and cannot be equated. For example how would one set about relating number of bits [the degree of complexity in a computer] to energy supplied to the computer? Yet sometimes the terms "entropy" and "negentropy" are confused with "energy" and this may lead to *very wrong conclusions*.¹²

Another evolutionist, Isaac Asimov, admits the need to distinguish between *quantity* (the first law) and *quality* (the second law).

To some cosmic observer, watching the vast increase of entropy represented by the nuclear processes that feed the sun's radiation, the small jiggle of decreasing entropy introduced by life on earth (like a drop of spray shooting upward while Niagara plummets downward) would be completely unnoticeable.

And yet sheer quantity is not all. The complexity and versatility of life enforces a respect that cannot be elicited by raw sun power alone.¹³

Quantity can never make up for quality in any supposed evolution of life. Yet many biologists,

while recognizing that apples and pears cannot be equated, fail to recognize that quantity (the first law) and quality (the second law) cannot be equated, and they still assert that the sun somehow is a force which by its energy drives "evolution" ever onward and upward in complexity.

In conclusion, the relationship between these two laws of thermodynamics is best allegorized by the physicist Somerfeld:

As a student, I read with advantage a small book by F. Wald entitled, "The Mistress of the World and Her Shadow." These meant energy and entropy. In the course of advancing knowledge the two seem to me to have exchanged places. In the huge manufactory of natural processes, the principle of entropy occupies the position of manager, for it dictates the manner and method of the whole business, whilst the principle of energy merely does the bookkeeping, balancing the credits and debits.¹⁴

This difference becomes apparent when a rock is thrown into a lake. The rock, right before it lands in the lake, has energy which is useful and can be used for work. However, it strikes the surface, sends out waves, and settles to the bottom. Eventually the waves die down and the peaceful lake returns to its quiet Walden pond state.

But, what happens to the energy that the rock used to have? It is conserved according to the first law: the energy is dissipated into random motion of the water molecules in the lake. The work energy became heat energy, and the temperature of the lake is slightly higher. The books are balanced (the first law, energy).

Some questions remain: Why cannot the reverse event take place where the water molecules would form into waves, pick up the rock, and throw the rock back at the boy who disturbed its tranquility? Could not the books be balanced in such a reverse event, the "vengeance" of the lake? Yes, they could be balanced for the reverse event (the first law), but the manager (the second law) says, "No, because it would require random energy (heat) to become ordered energy (work)." "No," says the manager, "my bookkeeper must always balance the books, but I have the sole right to dictate how the debits and credits are dispensed; things go my way, in the direction of increasing entropy."

Cosmological Implication of Thermodynamics

As we saw earlier, the amount of energy in the universe is constant, but it is also becoming increasingly less available (See Figures 1 and 2). A superposition of the two graphs reveals two unique points: (1) We may predict that the use-

ful energy will approach zero at some time in the future, and (2) We may deduce that the useful energy equaled the total energy in the universe at some point in the past.

The "scientific" eschatology of the universe

At point (1) on the graph the useful energy in the universe asymptotically approaches zero. In other words, the universe will slowly approach maximum entropy or zero useful energy. What are the implications of this destiny of the universe? Lincoln Barnett, in a popular presentation of modern physics for which Albert Einstein wrote the foreword, states the implications clearly.

The universe is thus progressing toward an ultimate "heat-death," or as it is technically defined, a condition of "maximum entropy." When the universe reaches this state some billions of years from now all the processes of nature will cease. All space will be at the same temperature. No energy can be used because all of it will be uniformly distributed through the cosmos. There will be no light, no life, no warmth—nothing but perpetual and irrevocable stagnation. Time itself will come to an end. For entropy points the direction of time. Entropy is the measure of randomness. When all system and order in the universe have vanished, when randomness is at its maximum, and entropy cannot be increased, when there no longer is any sequence of cause and effect, in short when the universe has run down, there will be no direction to time—there will be no time. And there is no way of avoiding this destiny. For the fateful principle known as the Second Law of Thermodynamics, which stands today as the principal pillar of classical physics left intact by the march of science, proclaims that the fundamental processes of nature are irreversible. Nature moves just one way.¹⁵

The destiny of the universe, then, if left alone by God, would eventually be a slow and irreversible heat-death. We do not know how long it will be before the effect will begin to take place, because we do not know enough about the rate of decay or how far along the process is. Most scientists, however, are presumptuous enough to say, as does Barnett, that it is yet billions of years in the future, but this is based on the assumption that the process has been going on for billions of years and that we are about half way through the process.

Some scientists have tried to get around the implications of the second law.

Mention must be made of the theories recently advanced by Fred Hoyle of Cambridge and others, according to which the expansion of the universe is counteracted by the con-

tinuous creation of new matter. . . . In answer to the question, "Where does this continuously created material come from?" Hoyle rather naively remarks that it does not come from anywhere. "Matter," he says, simply appears. It is created.¹⁶

Hoyle's theory is a violation of the first law of thermodynamics because matter is created and therefore is not conserved. Hoyle, since the time of the above statement, has indeed rejected his own theory.

Such attempts to avoid or annul the "heat-death" amount to nothing less than a denial of either or both of the two laws of thermodynamics. This is a *step of faith* based upon no experimental or theoretical evidence and in fact it is a step of faith contrary to all experimental as well as mathematical formulations of physics. For example, "Everything, indeed everything visible in nature or established in theory, suggests that the universe is implacably progressing toward final darkness and decay."¹⁷

Some other writers and thinkers still see hope, against the heat-death of the universe, in the form of future scientific development of new energy sources.

The accepted theory of yesterday was, that cold, rather than heat, would be the cause of the destruction of life throughout the universe, since it is the tendency of all other forms of energy to change into the form called Heat, which itself gets lost by radiation into space. There being no known cause which could make up for this constant loss of heat from the sun, the radiating center of our solar system, it was inferred that the life which depends upon heat must gradually disappear from our earth. Today it seems likely that this hypothesis will have to be considerably modified in consequence of the recognition of the stores of energy in the chemical elements, and of the varieties of radiant energy to which attention has been prominently directed by the discovery of radium.¹⁸

But unfortunately scientific exploitation of nuclear sources will end because they also are subject to the second law of thermodynamics and will, eventually, no longer contain any useful energy.

Every closed system on earth, excepting only long-lived radio-active matter, reaches this state within observable time. That the course of events on earth continues at all is possible only because there is a constant influx of energy in the rays of the sun—in other words, only because the earth is not a closed system. But given enough time, no structure in the universe should be able to escape heat death! It is conceivable, of course, that cer-

tain forms of energy, such as the energy of atomic nuclei or the kinetic energy of stellar bodies moving in empty space would never be converted into heat at all. But even then, there would be in the end no longer any conversion of energy.¹⁹

Hope in scientific utilization of energy sources is without warrant.

Thus all such attempts to escape heat-death remain futile. The only thing which can delude us into forgetting this dreary prospect is the thought that, if it is a matter of fifty million years away, then the world has still some time to develop and we need not be too much afraid of this prospect. . . . Even the length of time of the reprieve which has been given to the cosmos does not deceive us about the real situation of the universe. It is like the situation of a man condemned to death, who still has a fair interval of time between the verdict and the execution. This by no means alters the real situation, if the forecast made by leading scientists about the future of the world is correct.²⁰

The "scientific" origin of the universe

At point (2) on the graph there is the interesting point at some time in the past when the useful amount of energy in the universe just equaled the total cosmic energy. The universe could not have existed before this point in time under the present laws because the useful energy before this point in time would have been greater than the total energy. This would require the useful energy to be greater than its possible maximum total.

Consequently three possible views exist about the meaning of this temporal point: (1) the universe existed in a perfect state of order and useful energy from eternity past and then a finite time ago began its present downward course, (2) the universe was in a state of total randomness and unuseful energy, then by some means "jumped up" to perfect order and useful energy and then began its downward course to unusefulness and randomness, and (3) the universe came into being a finite time ago and started its present downward course. Each of these views, however, represents a violation of the present scientific laws and, thereby, requires a supernatural event.

In view (1) supernatural intervention is required to maintain the universe in a highly ordered state against statistical disordering or, conversely, a supernatural intervention might have suddenly imposed this law of decay upon a perfect universe (cf. Gen. 3:17-19; Rom. 8:20).

In view (2) a supernatural intervention would be required to take the universe from chaos to order against the second law of thermodynamics.

In view (3) a supernatural intervention would have created the matter and energy *ex nihilo* and then given it the high order and useful energy from which it degraded.

The agent required to bring about these supernatural events in each of these views must have been, according to the second law, (1) able to suspend the physical laws, (2) able to have access to every part of the universe to give each part its order, and (3) more complex than every part of the universe in order to impart order to it.

Most scientific thinkers reject the first two views about the beginning of the universe, and accept the view that the universe came into being a finite time ago and started its present downward course. Sullivan develops this third view and excludes the first two from a more statistical mechanics approach.

But the fact that the energy of the universe will be more disorganized tomorrow than it is today implies, of course, the fact that the energy of the universe is more highly organized today than it will be tomorrow, and that it was more highly organized yesterday than it is today. Following the process backwards we find a more and more highly organized universe. This backward tracing in time cannot be continued indefinitely. Organization cannot, as it were, mount up and up without limit. There is a definite maximum, and this definite maximum must have been in existence a finite time ago. And it is impossible that this state of perfect organization could have been evolved from some less perfect state. Nor is it possible that the universe could have persisted for eternity in that state of perfect organization and then suddenly, a finite time ago, have begun to pursue its present path. Thus the accepted laws of nature lead us to a definite beginning of the universe in time. We are to suppose, on this reasoning, that, at some particular moment in the past, a perfectly organized universe sprang suddenly into being, and has been steadily becoming more and more degraded ever since.²¹

Consequently, scientists who accept the first and second laws of thermodynamics conclude that the universe had an inception in time out of nothing. Any cosmic theory is in direct contradiction to the second law if the upward progress is natural and inherent in the universe. The universe is running down and degrading, not moving upward in complexity. On the cosmic level there is no evidence that, even by divine intervention, things are progressing upward. Also the creationist's, view of a once-for-all inception of the highly ordered universe in time

is strongly supported by non-religious scientific thinkers.

Biological Implications of Thermodynamics

What bearing may physical laws have upon biology? Living matter consists of elements, molecules, and compounds interacting according to chemical equilibria and defined by chemical reactions. A study of biology from a chemical view point is called biochemistry. Chemistry and chemical reactions, however, reduce to physics, the study of mass and energy interactions. Chemical reactions are constrained to take place in accordance with physical laws. Thus, according to the understanding of many scientists of this most fundamental level, biology is essentially a study of physics, defined by physical laws. What constraints, then, does physics place on biology?

Thermodynamics, the basis of physics, limits the possible views of biology about the origin and destiny of life. Life, just as the universe, can only progress in accordance with the laws of physics, excepting of course supernatural interventions.

One of the arguments that life could have come into existence upon the combination of atoms and molecules in spite of the second law is based upon the spark chamber production of amino acids. Elements thought to be in the primordial atmosphere are placed in an enclosed chamber and sparked by an electrical discharge for a week. At the end of this time amino acids are present which demonstrates that ordered organic molecules can be derived upon chance combination of inorganic molecules. Therefore, according to the argument, given enough time and the whole universe, proteins, living cells, and eventually man could evolve by chance.

This whole argument has been explored in some detail by Emmett Williams, Jr., and he makes it quite obvious that the physical chemist can offer no encouragement to the evolutionary biochemist who needs an ocean full of organic compounds to form even lifeless coacervates. As Williams stated in his abstract, "Miller's experiment is an excellent one, scientifically-speaking, and when properly interpreted leads to the conclusion that life could certainly never originate spontaneously."²² In another more recent paper, Emmett Williams, Jr., has shown that life too is subject to the destructive and disordering effects of the principles of thermodynamics.²³

An abundance of quotations can be drawn from the literature that point to the unlikelihood of even one protein molecule arising by chance, let alone life itself. Frank Cousins, for example, has quoted F. B. Salisbury to show mathematically that there is only 1 chance in 10^{515} (under very favorable conditions) that a simple protein

of some 300 amino acid units might arise by chance.²⁴ Earlier, Lecomte Du Nouy carried out the calculations for the chance evolution of only one protein. Statistically, he says, it would be so highly improbable in the age of the universe that it is for all practical purposes an impossible event. And if it did happen he says:

However if this happened and we maintained our confidence in the calculus of probabilities it would be equivalent to admitting a miracle, and the result would be: ONE SINGLE MOLECULE, or at most two or three.

Life itself is not even in question but merely one of the substances which constitute living beings. Now, one molecule is no use. Hundreds of millions of *identical* ones are necessary.²⁵

However, evolutionists have tried to escape the dilemma of this conflict between the second law of thermodynamics and imagined evolution. First of all, as mentioned before, they try to attribute supposed increasing upward complexity to the sun.

The theory of evolution is very much in vogue today, and students and the general public are told over and over that its acceptance as a fact is practically unanimous among men of science. It follows from this that the evolutionists have been able to convince themselves that the theory of evolution is not contrary to this view. They do this by saying that there really is no contradiction because all the energy needed to bring about evolution has been supplied abundantly by an external source, namely the sun.²⁶

However, as pointed out earlier, quantity of energy will not supply quality of energy such as needed to order the complex life forms. After citing a number of cases of increasing complexity in life and nature, such as fertilized eggs becoming complex animals, Davidheiser concludes:

Thus more complex arrangements of matter can be produced from simpler or from random arrangements. In each of the examples given here, the energy required can be traced to an outside source, the sun. But in each case this energy was not enough. Such things as intelligence, skill, instinct, and genetic constitution were also required.²⁷

In other words, not only is an external energy needed but also an agent at least as complex as the system to be produced (the DNA in the case of the egg). The sun alone cannot produce the order needed to produce complex life forms.

A second way sought to "save" natural evolution is by evoking Maxwell's demon, an imaginary character that can sort out atoms and so

reverse the second law. However, Jagjit Singh counters against such magic.

The longish detour we have followed in exorcising Maxwell's demon, rather than denying outright the existence of such a molecular homunculus capable of sorting and ordering, has a purpose. It points to a novel way of reconciling an apparent conflict between the second law of thermodynamics and the process of biological evolution. For the latter, with its continual emergence of ever new forms of life from inanimate matter via the "subvital" autocatalytic particle of protein all the way up to man as an increasingly complex crescendo of self-sustained chemical reactions, does seem to tend towards increasing organization and "Patternedness" of matter. On the other hand, according to the second law of thermodynamics, matter continues to drift toward a state of increasing chaos and "mixed-upness."²⁸

Even if man were able by biochemistry to synthesize life, this would not prove evolution because such laboratory synthesis would not have been by blind chance. Man would have been the ordering agent in such a process. Consequently, neither solar energy, Maxwell demons, nor semantic sabotage of terms provide the evolutionists with a means to resolve conflict between evolution by chance and the second law.

The laws of thermodynamics do not allow for evolution or macromutation to take place by chance. Some highly organized supernatural agent is the only possible explanation for the evolutionary or catastrophic processes. Theistic evolution, macromutationism, and special creationism remain the three possible alternatives according to the second law of thermodynamics alone. All three would involve the supernatural.

However the events by which life actually arose are not a matter of personal speculation. These events occurred only in one way and, as with the whole course of past history, are not subject to change. The biblicist knows by revelation the actual course of events in the Scriptures, and therefore understands by a historical-grammatical approach that creationism is the only choice. The theistic evolutionist and the macromutationist reject or allegorize the biblical account, trying to piece the record of origins together from geology and archeology much as the materialist does.

The science-minded creationist, on the other hand, asserts that the data of biology, geology, and archaeology have better fit with divine, miraculous special creationism than they do with any variation of theistic evolutionism. An understanding of thermodynamics certainly fits with

creationism. Furthermore, an understanding of thermodynamics absolutely eliminates chance or "natural process" as the legitimate agent in the origin of life.

The Destiny of Life

As has been shown earlier, the second law of thermodynamics leads unerringly to a concept of "heat-death" (aside from prophetic revelation in scripture). In this way, the second law leaves no hope for the idealist, the optimist, the existentialist, the evolutionist, or the materialist because life is totally and ultimately subject to vanity and nothingness by this law.

In light of the ultimate destiny of life (i.e., death), man has only two options. "The first is the radical hopelessness of nihilism, for which the whole course of the present world is merely an episode, which appears out of nothingness and disappears again into nothingness, leaving not a trace behind."²⁹ Under this option the only feasible approach to life is hedonism ("let us eat and drink, for tomorrow we die," 1 Cor. 15:32).

At least this first option takes into account the fact that we are doomed to ultimate dissolution and seeks to glean some type of pleasure in the meantime. Unfortunately, it does not stave off death and ultimate meaninglessness. Do-gooders and other optimists are absolutely foolish because they fail to see that good works and progress done solely to produce a better world are doomed by the second law. They make sacrifices to produce these transient, failing ends, and so lose out in the meantime as well as in the future.

A second option is the only option that has any hope, and it is a hope in eternal life based on the resurrection of Christ. Eternal life is the only hope that stands out against a decaying and meaningless cosmos; life has no meaning apart from eternal life.

This hope of eternal life and a transformation of the cosmos is based upon the resurrection of Christ, because through his death our sins are forgiven and through his resurrection we are given eternal life. If Christ did not rise, then this hope is in vain, as Paul explained.

For if the dead are not raised, neither hath Christ been raised; and if Christ hath not been raised, your faith is vain; ye are yet in your sins. Then they also that are fallen asleep in Christ have perished. If we have only hoped in Christ in this life, we are of all men most pitiable. (I Corinthians 15:16-19 A.S.V.)

However Paul points out that this is not just another case of wishful thinking. He bases this hope in Christ's resurrection on the fact that the event was prophesied by the Scriptures, and that

Christ was seen after the resurrection by Peter and the apostles, 500 others, and even by himself.

Without this hope of eternal life through Christ's resurrection we have only the pessimistic option, as Paul explains, "If the dead are not raised, let us eat and drink, for tomorrow we die." (I Corinthians 15:32b A.S.V.) This hope of eternal life presents the only optimistic and meaningful option to life because it is "an inheritance, *incorruptible* and *undefiled*, and that fadeth not away, reserved in heaven for you." (I Peter 1:4) The prophet of old, Isaiah, brings this salvation into sharp contrast with a corrupted fading universe.

Lift up your eyes to the heavens, and look upon the earth beneath; for the heavens shall vanish like smoke, and the earth shall wax old like a garment, and they that dwell therein shall die in like manner; but my salvation shall be forever, and my righteousness shall not be abolished. (Isaiah 51:6)

Nothing else in life is incorruptible, permanent or meaningful because the second law of thermodynamics subjects all life to decay, corruption, and dissolution.

In final conclusion, in natural terms alone, the destiny of life, like the cosmos, is doomed to decay and ultimate dissolution, death. The philosophical options in light of this are (1) a false hope and ignorance of the reality of entropy, (2) a radical hopelessness of nihilism, or (3) a hope in eternal life obtained by personal faith in Jesus Christ.

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THEISTIC EVOLUTION

HENRY M. MORRIS*

Evidence is amassed to demonstrate that theistic evolutionism is objectionable from the standpoints of biblical exegesis and systematic theology. In addition, the concept of "progressive creationism" is identified and discussed. It is asserted that progressive creationism is farther out of keeping with the nature of God than is theistic evolutionism.

Two Opinions

The ancient pagan idolatry and the modern transformist philosophy are fundamentally one. This very identity is currently being stressed by many so-called "ecologists," who are saying that man should return to nature-worship, and that the Christian doctrine of man's God-given dominion over the earth has resulted in pollution and destruction of his environment.

Such a charge is of course fraudulent. It is not this Biblical doctrine, but rather man's perversion and rejection of God's truth, and man's selfish and covert denial of his stewardship that have led to these problems. It is no coincidence that the most aggressive leaders of the environmentalists who supposedly are fighting pollution tend also to be in the vanguard of the new-pagans with their revival of astrology and nature-worship and their militant commitment to social evolution and communism. Fundamentally they are fighting God.

In such a situation as this, it is discouraging to see such a large segment of the professing Christian church unconcerned and ignorant of the true nature of this conflict. Far too often, such apathy has led to dangerous compromises. Unwillingness to face the consequences involved in a clear stand for God leads inevitably to retreat and eventually to capitulation to His enemies. The widespread tendency among even

conservative Christians to adopt some form of theistic evolution as their cosmology is highly dishonoring to God and eventually self-destructive.

A close parallel with this situation existed long ago among God's chosen people, when the pagan Canaanite religion, with its worship of the host of heaven and Baal, the sun-god, was being mixed in with the worship of Jehovah, the true God. This compromising situation came to its climax on Mount Carmel, when Elijah, standing alone against the assembled prophets of Baal, cried out to the people of Israel: "How long halt ye between two opinions? if Jehovah be God, follow Him: but if Baal, then follow him. And the people answered him not a word." (I Kings 18-21)

It is no exaggeration or mere figure-of-speech to suggest that the evolutionary philosophy today is, in all essentials, a revival of Baal-worship. There is no way in which a real and lasting peace can be worked out between evolution and special creation, between Baal and Christ, between Satan and God. Theistic evolution, though a very popular concept, is really nothing but a contradiction in terms and a deadly compromise.

The Biblical Doctrine of Special Creation

According to Scripture all things were specially created by God in six days. Leaving until later the question as to the exact length or nature of these days of creation, is it possible that God's method of "creation" might really have been what the modern evolutionist means by "evolution"? A popular cliché among neo-evangelicals is to the

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effect that God has revealed to us the *fact* of creation, leaving to scientists to work out the *method* of creation. This, of course, is merely a devious way of saying we should accept the fact of evolution and then hope that the scientists will allow us to believe that God is the one controlling the process.

There are various forms of theistic evolution and different terms that have been used. These include "orthogenesis" (goal-directed evolution), "nomogenesis" (evolution according to fixed law), "emergent evolution," "creative evolution," and others. None of these concepts is accepted among the leaders of evolutionary thought and there is thus no need to discuss any of them here, especially since none of them accept the Bible or the God of the Bible, anyhow. The evolutionary scheme which is least objectionable is, of course, simply the idea that Jehovah used the method of evolution to accomplish His purpose in creation, as described in Genesis. This theory might be called Biblical evolution.

Any sound approach to Bible exegesis, however, precludes this interpretation. The Scriptures are very clear in their teaching that God created all things in the way He wanted them, each with its own structure and functions according to His own sovereign purpose for it. The account of creation in Genesis One, for example, indicates that at least 10 major categories of organic life were specially created "after his kind." These categories are, in the plant kingdom: (1) grass; (2) herbs; (3) fruit trees. In the animal kingdom the specific categories mentioned are: (1) sea-monsters; (2) other marine animals; (3) birds; (4) beasts of the earth; (5) cattle; (6) crawling animals. Finally the man "kind" was created as another separate category entirely. The phrase "after his kind" occurs ten times in this chapter.

Even though there may be uncertainty as to what is meant by "kind" (Hebrew *min*), it is obvious that the word does have a definite and fixed meaning. One "kind" could not transform itself into another "kind." There is certainly no thought here of an evolutionary continuity of all forms of life, but rather one of definite and distinct categories.

Furthermore, the sense of the passage is that a great host of different kinds were created in each of the nine major groups (excluding man) that are specifically listed. There is certainly room for variation within the kind, as is obvious from the fact that all the different races and nations of men, with all their wide variety of physical characteristics, are descended from the first man and are therefore all included within the human "kind." The same, must be true for the other kinds, so that many different varieties can emerge within the basic framework of each

kind, but at the same time such variation can never extend beyond that framework.

This clear teaching of the creation chapter is accepted and confirmed in other parts of the Bible. For example, consider I Corinthians 15:38-39: "God giveth—to every seed its own body. All flesh is not the same flesh: but there is one kind of flesh of men, another flesh of beasts, another of fishes, and another of birds."

Not only is this true in the organic realm of plants and animals, but also in the inorganic realm. "There are also celestial bodies and bodies terrestrial: but the glory of the celestial is one and the glory of the terrestrial is another." (I Corinthians 15:40) That is, the earth is quite different from the stars and planets (as has been abundantly confirmed in this age of space exploration), and thus must have been the object of a distinct creative act by God. It was, in fact, created by God, on the first day (Genesis 1:1-5), whereas the heavenly bodies were not made until the fourth day (Genesis 1:14-19).

Furthermore even the stars (and this term in the Bible includes all celestial objects except the sun and moon), were all created with their own particular structures. "There is one glory of the sun, and another glory of the moon, and another glory of the stars: for one star differeth from another star in glory." (I Corinthians 15:41) The tremendous variety of heavenly bodies revealed by modern astronomy—planets, comets, meteors, white dwarfs, red giants, variable stars, star clusters, binary stars, dark nebulae, interstellar dust, radio stars, quasars, neutron stars, etc.—confirms this statement also.

No two stars, out of the innumerable host of heaven, are exactly alike. Each was created with its own structure and purpose (though these matters now are beyond our present knowledge, perhaps awaiting exploration and utilization in the eternal ages to come). Although there are various theories to explain how the various "species" of stars and galaxies may have evolved from one into another, there is obviously no observational evidence of such evolution.

Perhaps the most striking Biblical statement of the absolute uniqueness of each of the foregoing created entities is found in the next passage, I Corinthians 15:42-44, "So also is the resurrection of the dead—There is a natural body, and there is a spiritual body."

That is, the radical difference in kind between man's natural body and his glorified resurrection body (and obviously the one does not by natural processes evolve into the other!) is taken as analagous to the unbridgeable gaps between the created kinds of things in the present universe.

There are numerous other passages in the Bible which clearly prove special creation, but those discussed above should be adequate to demon-

strate that so-called "Biblical evolution" is a semantic confusion, about like "inorganic metabolism" or "theistic atheism." The Bible simply does not permit evolution in its hermeneutical system.

The Contradiction of Theistic Evolution

There are many people, of course, who believe in God without any strong commitment to the Bible as His Word. Therefore, the fact that the plain sense of the Bible cannot be harmonized with evolution is of no particular concern to them since they only accept the inspiration of Scripture in a very loose and generalized way, if at all. They might consider the Bible to be a valuable book in terms of religious insights and ethical values, but not in matters of science and history.

However, even apart from Scripture, there are a number of serious contradictions in theistic evolution, assuming that the God who supposedly created things by this imagined process is really a personal, eternal, omnipotent, omniscient, gracious, loving, purposive God. Most theistic evolutionists (we are not now considering pantheistic evolution, of course) would probably agree with such a concept of God, and of course this is also the type of God who is revealed in the Bible. But if God is like this, it seems completely incongruous that He would use evolution as His method of creation, for the following reasons:

1) Evolution is inconsistent with God's omnipotence; since He has all power, He is capable of creating the universe in an instant, rather than having to stretch it out over aeons of time.

2) Evolution is inconsistent with God's pre-existence from eternity. If slow evolutionary processes were to be the method, why didn't He stretch them out over eternal ages rather than starting them in operation only five billion years ago?

3) Evolution is inconsistent with God's personality. If man in His own image was the goal of the evolutionary process, surely He should not have waited until the very tag-end of geologic time before creating personalities. No personal fellowship was possible with the rocks and seas, or even with the dinosaurs and gliptodons.

4) Evolution is inconsistent with God's omniscience. The history of evolution, as interpreted by evolutionary geologists from the fossil record, is filled with extinctions, misfits, evolutionary cul-de-sacs, and other like evidences of very poor planning. The very essence of evolution, in fact, is random mutation, not scientific progress.

5) Evolution is inconsistent with God's nature of love. The supposed fact of evolution is best evidenced by the fossils, which eloquently speak

of a harsh world, filled with storm and upheaval, disease and famine, struggle for existence and violent death. The accepted mechanism for inducing evolution is overpopulation and a natural selection through extermination of the weak and unfit. A loving God would surely have been more considerate of his creatures than this.

6) Evolution is inconsistent with God's purposiveness. If God's purpose was the creation and redemption of man, as theistic evolutionists presumably believe, it seems incomprehensible that He would waste billions of years in aimless evolutionary meandering before getting to the point. What semblance of purpose could there have been in the hundred-million-year reign and eventual extinction of the dinosaurs, for example?

7) Evolution is inconsistent with the grace of God. Evolution with its theology of struggle for survival in the physical world, fits perfectly with the humanistic theory of works for salvation in the spiritual world. The Christian concept of the grace of God, providing life and salvation in response to faith alone, on the basis of the willing sacrifice of Himself for the unfit and unworthy, is diametrically opposite to the evolutionary concept.

Progressive Creation

A large group of evangelicals, sensitive to the traditional opposition to evolution in their own constituencies, have tried to circumvent this opposition while at the same time embracing the essential framework of the evolutionary system through what they have called "progressive creation." A similar concept is so-called "threshold evolution." Other labels have been suggested for the same general concept, but all of them are nothing but semantic variants of the fundamental system of theistic evolution.

The idea in the progressive creation approach is to suppose that, while life was generally developing over the vast span of geologic time in essentially the way evolutionists have imagined it, there were various occasions at which God intervened to create something new, which the evolutionary process could not accomplish unaided.

For example, God presumably stepped in, early in the Tertiary period, to create *Eohippus*, the small three-toed "dawn horse." He then withdrew to let subsequent horse evolution continue through the stages of *Mesohippus*, *Parahippus*, etc., until finally they developed into the modern *Equus*. Similarly, a long succession of humanoid forms developed from their unknown ape-like ancestor until, at the right moment, God intervened and placed an eternal soul in one of them by special creative power.

Details vary considerably in the exposition of the progressive creation concept by various writers, with greater or lesser numbers of creative acts interspersed in the evolutionary process according to the taste of the writer. However, all accept the basic framework of the evolutionary geologic ages and thus must visualize progressive creation as taking place over five billion years instead of six days.

It is difficult to see any Biblical or theological advantage the progressive creation idea has over a straightforward system of theistic evolution. Exactly the same seven problems as outlined in the preceding section still apply, whether the process is called theistic evolution or progressive creation.

In fact, theistic evolution is more reasonable and God-honoring than progressive creation, if one were forced to choose between the two. It involves one consistent process, always the same,

established by God at the beginning and maintained continually thereafter.

Progressive creation, on the other hand, implies that God's creative forethought was not adequate for the entire evolutionary process at the beginning, and therefore it was necessary that He frequently interfere in the process, setting it back in the right direction and providing enough creative energy to keep it going a while longer until He could get back later for another "shot-in-the-evolutionary-arm."

Theistic evolution is creation by continuous evolutionary processes initiated by God. Progressive creation is creation by discontinuous evolutionary processes initiated by God, but having to be shored up by sporadic injections of non-evolutionary processes. Of the two, theistic evolution is less inconsistent with God's character. However, progressive creation may seem less offensive to college boards of trustees, contributing alumni, and supporting churches.

COMMENTS ON SCIENTIFIC NEWS AND VIEWS

HAROLD ARMSTRONG*

Meteoritic Hydrocarbons

Some scientists claim that identification of organic compounds in certain meteorites lately is evidence of life elsewhere than on the Earth. It is hard to see the reasoning in this; we have believed for a long time that such organic compounds as methane and ammonia were present on the giant planets, and nobody supposed that those compounds were either the remains of life or on their way to becoming alive.

The aromatic hydrocarbons from a meteorite have been analysed, by gas chromatography and mass spectrometry. The results show that the compounds found in the meteorite are "... similar to the pyrolysis of methane ... the aromatic compounds in this meteorite may be the product of an essentially thermal, high-temperature synthesis."¹

It is plain to see, then, that the hydrocarbons likely have nothing to do with life. Maybe they were produced by pyrolysis of methane. Suppose, for instance, that a meteorite happened to pass through some of the atmosphere of Jupiter, and escaped. What better opportunity for pyrolysis of methane could there be than on a meteorite, heated to incandescence as it passed through an atmosphere rich in methane? If such encounters have happened, the meteorites might

tell us something about them; and that is certainly more than they will tell us about the origin of life.

Incidentally, it has been suggested that frozen ammonia, as well as iron and stone, may go to make up many meteorites. If that is so, might the pyrolysis have happened when the meteorite entered the Earth's atmosphere?

Hybrid Inviability

There still appear, in the newspapers and elsewhere from time to time, reports of unlikely crosses between different kinds of animal. Of course, such reports, when investigated, turn out to be either hoaxes or mistakes.

Sheep and goats, for instance, are not such different animals, but they can not cross. Some studies at the Field Station of the Royal Veterinary College, Potters Bar, North London, England, shows that a male goat cannot fertilize a sheep at all.² A ram can fertilize a female goat; but after six weeks of (apparently) normal development the fetus dies, "showing the classical signs of rejection."

Thus there are two kinds of defense, so to speak, against mixing the kinds of animal: they may simply not be fertile, or the fetus, if one starts, may be rejected. It is easy to see that crossing cannot have played any part in the origin of the different kinds.

Is there not another point here? Apparently the theory of macro-mutation, that "a reptile laid

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an egg from which a bird hatched," is sometimes proposed seriously. By the same pattern of thought (if any), it might be proposed that an animal of one kind gave birth to one of a quite different kind. (As far as I know, no one has ever proposed this; but it is hard to see why not, if the same thing in terms of eggs is proposed.) If, however, such a thing should start (and that by itself seems unlikely enough), is it not highly likely that the mother would reject the mutated fetus?

So macro-evolution, whether through eggs or not, is impossible, micro-evolution, we know, is ineffective. Again, Creation of basic kinds remains the only answer.

Bioluminescence and Design

The glow worm is one of the few insects to have a song written about it; and indeed the phenomenon of bio-luminescence is one that always excites our interest.

As well as insects, there are luminous fish, as is well known. Many of these live at great depths, where there may be a real need of a light. But there are at least two luminous shallow-water fish, *Photoblepharon palpebratus* and *Anomalops katoptron*, both from the Banda Sea at the eastern end of Indonesian Archipelago.

The light, which comes from definite organs, seems to be produced by symbiotic luminous bacteria. It seems to be a case of symbiosis, not just parasitism; for the "... light organs ... were especially constructed to provide the bacteria with nutrients and the large amount of oxygen normally required for luminescence."³

Is it not absurd to suppose that this, or any other case of symbiosis, could have evolved? It is admitted that no advantage to the fish is apparent. What, then, would have been the "selection pressure" for the fish to develop the organs to accommodate the bacteria?

By the same argument, since the bacteria do nothing to help the fish, they could just as well have lived as parasites and nothing else. How could their survival have been helped by developing the ability to emit light?

This is a clear case of a design of two things to work together. We may not be able to see why the Designer wanted them to work together. But when we see a clever mechanism, we immediately admit that it was designed, even though we may not know the purpose. And this is just as true when, instead of a physical mechanism, the discussion is involved with two living beings.

Mole Rat Teamwork

It may be commonly thought that assembly lines are a recent invention, but it appears that

the East African mole rat, *Heterocephalus*, knows all about the idea. While most burrowing animals work alone at their burrows, the mole rats work in teams.⁴ The work is divided into three jobs: digging, transportation, and disposal. Several rats work at once in one burrow.

The one in front, whose sole job it is to excavate, bites at the soil ... and clears the loosened soil with fore and hind feet, kicking it to the animal just behind him; this is the first member of the chain of transporters. This animal collects the soil from the excavator, backs up along the passage by crawling under the animals behind him, and finally leaves the load to the mole rat in charge of disposal, who sits at the entrance to the burrow. The transporter then makes his way back to the front by straddling the others ... to a position just behind the excavator and repeats the process. ... Each mole rat takes turns at digging, moving, and disposing of the earth in shifts, so that equal distribution of labour is ensured. ...

Is it necessary to point out the absurdity of thinking that such a system of behavior could have evolved? Like so many other complicated systems of behavior, it had to be nearly perfect before it would be of any use at all; a rudimentary stage of such behavior (whatever might be imagined by that), would have been, if anything, a disadvantage. This kind of behavior shows that these animals were created, and with the habits that they still have.

Phloem and Design

Those of us who live in the northern part of this continent can think, toward the end of each winter, about the rising of the sap, not only as a sign of spring, but also as a sign of maple syrup and maple sugar. Apart from any such special significance, the motion in plants, of water up the stem and sugar solution down, is a very remarkable thing. Indeed, the way in which this transportation is managed is still not understood.

The author of a recent article⁵ discusses what is now known about the matter. Even to summarize it would take much space. But the whole article is well worth reading, for yet another example of the superb design shown in living things.

Creationists may, moreover, be able to find another point of interest. Tall plants (like about everything else), appear rather suddenly in the "fossil record." Now it may reasonably be asked how, starting from algae (or something else small), tall plants could have "evolved." Once they were of some height, they would have needed their transportation system. Microscopic plants, on the other hand, would not need a

system of that sort, and there would have been no "selection" for them to develop it.

Here, as in so many other cases, a feature could not be built up bit by bit, but when it was needed it was needed fully developed. (Does this not remind those of us who can remember of the situation during the Depression, when so many men found that they could not get work without experience, nor experience without work?)

Anyway, I do not believe that evolutionists have given a satisfactory answer to this kind of problem in a single case. But to creationists this is no problem at all.

High Altitudes and Diphosphoglycerate

As is well known, anyone going from low-lying country into high mountains finds himself short of breath for a while. After some days, however, he becomes accustomed to the rarer air, and breathing is easier. What has happened is that his body has produced many more red blood cells, to make better use of what oxygen there is.

It appears that there is also a quick-acting provision, which enables us to adjust to the rarer air, to a certain extent, in a few hours.⁶ What happens is that diphosphoglycerate is produced in the blood, and it helps the hemoglobin in the red cells to function more efficiently.

Surely this provision could not have evolved. There is no evidence that our remote ancestors were always going into high mountains, that those who were "fitter" to do so survived, and that thus the provision involving the diphosphoglycerate evolved.

Furthermore, if we consider the great apes—our supposed ancestors, we know that those animals stay in one kind of surroundings, and do not travel widely. Nor would it make any better sense to say that the diphosphoglycerate came about "by a mutation, somehow." Rather, what we see here is a very ingenious design to meet emergencies, and it reveals the skill of the Designer.

A friend has raised the question, why God should have people suddenly go into high mountains. Of course, we can only guess at the reasons for such arrangements, especially since they go back to before the fall of man.

It should suggest, though, that God's original intention may have been that as men multiplied, they would look after the whole Earth, not just the Garden; but that their manner of looking after it would have been something like the work of a forest ranger. It would have involved traveling, and that up and down as well as horizontally; for there were possibly mountains before the Flood, although they may well not have been as high as the high recent mountains.

Anyway, because of the fall of man, our race never took on such duties, but we still have some of the equipment, so to speak. Even though explanation is conjecture, I think that it is easier to believe than any possible evolutionary explanation.

Genetic Engineering—So Much Talk

There has been much speaking and writing lately about "genetic engineering." Christians might well consider some of the talk to be so presumptuous as to border, at least, on being sinful. The Classical scholar might say that it was hubris, in the Greek fashion; and the plain man would likely at least feel that something was out of place. (They might think something else: that the talk was strangely like the spiel of a medicine peddler, trying to sell his snake oil.)

Similar qualms are being expressed even by scientists. For example,

. . . predictions of the potentialities of new science have outrun the accomplishments . . . speculation about test tube babies is based on a modest accomplishment—that is, fertilizing a human egg in vitro and keeping it alive for a week or so. For many years, biologists have been fertilizing eggs of countless species in vitro . . . the isolation of an operon, a specific piece of DNA . . . is about as meaningful as the isolation of other components of the living system. Biochemists are experts at taking life apart . . . the total system, however, is orders of magnitude more complex than anything they have put together.⁷

Is this attitude not the logical outcome of the evolutionary theory? For that theory, carried to its logical conclusion, maintains that Nothing has brought about all that we see in the world. If Nothing can do it, surely someone can.

But when we admit that the Creator has made these things, well, we never doubted that His powers are greater than ours. So there is no reason why we should expect to be able to duplicate all His work; nay, it would seem likely that there would be many cases in which we could not do so. Here, as elsewhere, the fear of, *i.e.* respect for, God is the beginning of wisdom.

Fossil Dipnoans Were Sea Fish

Authors of many books on biology or geology expound, in great detail, how fish, left in ponds from which the oxygen was depleted, gradually developed lungs. Sometimes the lungfish of the present times are cited as relics of that process. At best all this is conjecture, and should be labeled as such: In fact, there is now some evidence that such a thing never happened at all.

This involves fossil Dipnoans and Arthrodires. These are commonly supposed to have lived in ponds or small lakes, partly (as is admitted),

because that would fit in with evolution.

Now a direct test has been made. In addition to calcium, the fish, and hence the fossils, incorporate strontium, which is chemically very similar. As is well known, there are several isotopes of strontium. (It will be recalled that it is the chemical similarity of radioactive strontium to calcium that is the reason for concern about the presence of radioactive strontium from nuclear explosions.)

The ratio of the isotopes is different in lakes or streams from what it is in the ocean. Thus a chemical analysis can indicate the kind of water in which these ancient fish lived. The results show that they were sea fish.⁸

Now surely nobody will maintain that it is likely that there was once a shortage of oxygen in the whole ocean. Hence these fish had no need to develop lungs. So another alleged mechanism of evolution is challenged.

Evidence for Permian Ice Melts

It has been pointed out, in the *Creation Research Society Quarterly* and elsewhere, that Creationistic biology and geology can explain many things which the uniformitarian theory either ignores or passes off with a vague comment to the effect that in enough time anything can happen.

Yet we should be the last to deny that we have some problems which we are not able to answer at present. Indeed, any scientist who does not admit as much should stand self-condemned for his arrogance. One of these problems is where the ice ages fit in chronologically. They presumably came after the Flood, and before there was much history of the regions affected.

There seems to be independent evidence that the ice ages were by no means as long as is sometimes supposed, and, moreover, that some of the things supposed to have been caused by the ice could have been caused by water, perhaps during the Flood.

One problem which we might have anticipated may be no problem at all. It is often maintained that there was a previous ice age, in the Permian. (I am using these geological names as I use the pagan names of the days of the week: for convenience in understanding but without any belief in the world-view behind them.) Now it has been argued that that earlier ice age never happened, and, in particular, that "... at no time during, the Carboniferous and Permian did a large ice sheet occupy any part of the southern continents—with the single possible exception of Antarctica."^{9,10}

If we can come down to one, rather short ice age not all that extensive, we should be able to place it in relation to the Flood.

Thermoluminescence and Dating

We have often discussed the methods to ascertain supposedly the ages of archaeological and paleontological samples. The best known method is probably that of radioactive carbon, but there are others. A method which has been tried quite recently is that of thermoluminescence, which has been applied to ancient pottery,¹¹ and recently to fossil material.¹²

In the original experiments on thermoluminescence (which had nothing to do with archaeology or paleontology), the sample is irradiated, perhaps with gamma rays. These leave excited states, which may last for very long times, in the material. Then the sample is heated slowly.

At the higher temperatures, the excited states return to their normal condition, and in so doing emit light. The light is detected by a suitable photocell. Usually the amount of light emitted is plotted vs. the temperature at which it was emitted; the result is called a "glow curve." This kind of study is now of considerable importance in solid-state physics.

Obviously, other things being equal, the more irradiation, the more light is emitted. Now archaeological and other such samples will have been irradiated by cosmic rays, natural radioactivity, etc. The total "dose," of course, depends on the time involved, hence the notion of using this method for dating.

This matter is mentioned here mainly as something of which creationists may hear more, and about which they might do some thinking, since "forewarned is forearmed." For the present, many uncertainties should be noticed in this method. For instance, variations in the intensity of cosmic rays, and in the amount of natural radioactivity, could affect it. Like the other methods, those who interpret results can only say "... other things being equal ..." when there is no assurance that other things were, in fact, equal.

Another point might be mentioned, although perhaps well known, that thermoluminescence has been applied successfully to dosimeters, for the protection of those working with radioactive materials. But there the conditions are carefully controlled; while attempts to apply it to e.g. archaeology necessarily have to do with very uncertain conditions.

Potassium Argon Dates "Unreal"

We have often pointed out reasons for taking the ages quoted for materials, on the basis of such methods as that of potassium and argon, "with a grain of salt," to say the least. The application of these methods to alkaline basalt containing large phenocrysts of plagioclase feldspars, and comprising one of the numerous Tertiary—Quaternary plugs of the Benue Trough

Province in Nigeria, led to the conclusion. that: "... the age obtained ... is geologically unrealistic."¹³ As often happens, the method gave far too great an age.

The method involving uranium and helium was also tried, but gave results that were "totally unreal," being about eight times the other ages, which, as has been mentioned, were already too great. The age was also estimated by fission tracks; the results, while still too large (we believe), were much smaller than those resulting from the other methods.

An estimate of the age of some material depends on the ratio of the amounts of potassium and argon. The author stated that the samples appear not to have lost potassium, but rather to have too much argon. Now if one sample can have too much argon, so can another.

On the other hand, clearly some samples could have lost potassium, some of which might have been dissolved out in the course of time. Thus the method could be doubly unreliable. It is concluded, in fact, that: "... clearly K-Ar dates on other whole rock basalts must be accepted with caution. ..."

Evidence Wanes for Life on Mars

At one time scientists thought that there was clear evidence that vegetation, at least, was living on Mars, because the color seemed to change with the seasons. Lately, however, it seems more and more likely that the changes seen have nothing to do with vegetation. It is proposed that pulverized rocks adsorb water to supply ice fogs, which aggregate and disperse.¹⁴

It might be noted that we get a somewhat biased view of Mars, or of any other planet, because we see it only when and where it is day time there. Thus daily changes may escape us, but yearly ones can be seen. A writer in *The New Scientist* comments on these investigations, "... it seems clear that the fluctuations in Mars features are not due to advancing and retreating vegetation. ..."¹⁵

Generally, creationists have doubted whether there is life (of the kind being considered here), outside the Earth. In introducing the collection of Creationistic writings, *Why Not Creation?*, Dr. W. E. Lammerts, writing on 21 July, 1969, when the Apollo 11 flight had been concluded but no information from the study of the samples brought back had yet been released, predicted (1) that no traces of life, or former life, on the Moon, would be found; and (2) that neither would there be found the vast amounts of meteors that should have landed on the Moon, if it be as old as the uniformitarian theory supposes.¹⁶ We know now, of course, that both of these predictions proved to be correct. It would

appear that we might reasonably make a similar prediction about Mars.

One reason why life is sought elsewhere in the universe seems to be the hope that to do so would supply some evidence for evolution. Creationists grant that God could have put living things on Mars, or elsewhere for that matter. But we think that it is highly likely that, in fact, He did not.

From the Scriptural viewpoint, the planets, etc., are just adjuncts to the Earth. They could serve that purpose as well without being inhabited.

Again, the Scriptural viewpoint would seem to be that a creation of living beings without some rational beings would be something incomplete. But nobody believes now that rational beings will be found on Mars. So we think it unlikely that there will be any irrational beings either.

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BOOK REVIEW

Biochemical Predestination by Dean H. Kenyon and Gary Steinman. 1969. McGraw-Hill Book Company, New York, 301 pp.

Review by Duane T. Gish.*

The title of this book, which is concerned with speculations and laboratory experiments allegedly related to the origin of life, is based upon the authors' theory of *Biochemical Predestination*. According to this theory (page 265), "the association of units toward the ultimate development of the living cell is determined by the physicochemical properties possessed by the simplest starting compounds from which these systems evolved." Later on (page 268), the authors say,

This theory suggests that all of the steps ultimately leading to biogenesis were subject to known physical and chemical phenomena, and that the ultimate character of the organisms produced was a direct function of the inherent nature of the simplest materials from which the earliest stages of chemical evolution began.

The basis of this theory is the authors' belief that such simple organic compounds as amino acids, pyrimidine and purines (the precursors to the complex macromolecules—the proteins and nucleic acids—found in the living cell) form spontaneously under plausible primitive earth conditions. They cite other studies which show, they claim, that this inherent tendency toward organization is observed on many levels of biological order. They cite as examples, the interaction of antibody with antigen, the spontaneous reconstruction of viruses from protein and nucleic acid subunits, and the spontaneous reassociation of the subunits of complex enzymes.

Basic Flaws Noted

The basic flaw in the first line of evidence, as will be detailed later, is that in every origin of life experiment designed to show the formation of biological precursors under so-called primitive earth conditions, such as amino acids, the investigator has introduced artificial conditions which would never have existed on a primitive earth, conditions that are essential to the success of his experiment. The flaw in the second line of evidence, cited above, is the fact that the spontaneous interactions of antigen-antibody, of viral components, and of complex enzymes, occur only because of the high degree of specificity built into these macromolecules. The question remains

unanswered: how did this high degree of specificity arise spontaneously from disorder?

These authors would have their readers believe that the origin of life was not a highly unlikely event, but that it was almost inevitable under the conditions postulated for the primitive earth. Thus, they state (page 264), "... with any one of a variety of conditions which we now think could have occurred on the primitive Earth, the appearance of living systems as we know them today would seem to have been a very likely occurrence, *in fact, one which may have been rather difficult to prevent.*" (Emphasis in the original) Improbability piled upon improbability equals impossibility, however, and that applies to the spontaneous origin of life.

However, Kenyon and Steinman's review of speculations and experiments related to the spontaneous origin of life is one of the best among those available. The book is divided into seven chapters: the nature of the origin of life problem, the antiquity of terrestrial life, reconstructing the primitive scenario, synthesis of biomonomers, dehydration condensation and polymerization, development of morphological complexity and dynamic organization, and conclusions and prospectus.

The authors assume, as do all other investigators on the origin of life, that no supernatural agency was involved in the origin of life. They thus state on page 30:

If our problem is to find out as much as possible about those physical and chemical processes occurring on the primitive Earth which were directly involved in the origin of life, then we must assume that it is possible to duplicate, at least to some extent, those processes in the laboratory. Implicit in this assumption is the requirement that no supernatural agency "entered nature" at the time of the origin, was crucial to it, and then withdrew from history.

Later on page 31 they state:

It must be assumed that the origin of life on the primitive Earth involved a series of relatively probable chemical and physical events and did not crucially depend on the chance occurrence of very rare events. Special, very rare, or miraculous events may actually have been crucially involved, but if they were, we cannot hope to reproduce them in the laboratory. *The above assumption is required if the problem is to be subject to investigation by the scientific method.* (Emphasis added)

The authors thus have not only stated their conviction that no supernatural agency was in-

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volved in the origin of life (non-intervention in the origin of higher forms is further assumed, of course), but also that if such intervention actually did occur, then the problem would not be subject to scientific investigation.

It seems apparent to me that the authors are correct in this conclusion: if a supernatural agency was involved in the origin of life, then the origin of life lies outside the scientific domain. *Thus no one who believes that God was involved in the origin of life should contend that the origin of life is in any way subject to scientific investigation.*

Uniformitarian Faith Stated

In Chapter 1, the authors state their implicit faith in the doctrine of uniformitarianism. In regards to the origin of life, however, all evolutionists must deny this doctrine. If present conditions and processes are extrapolated back into the past, the origin of life would have been a thermodynamic impossibility. The type of compounds found in living things could not have arisen abiogenically in an oxidizing atmosphere (presence of free oxygen and oxidized compounds, such as carbon dioxide). It is thus postulated, out of necessity, that the earth at one time had a reducing atmosphere. There is good evidence, however, that the earth never had any other except an oxidizing atmosphere.^{1,2}

The authors state (page 29) that an important assumption in any origin of life experiment is that one can more or less accurately simulate the relevant primitive earth conditions in a laboratory apparatus. That is quite an assumption! As a matter of fact what has been done is that someone has decided what kind of gaseous mixture would be necessary for the abiogenic formation of biological precursors, and then has assumed that this constituted the primitive earth atmosphere. This sort of approach assures one the maximum chance for success, of course, but is open to severe criticism, to say the least.

It is of interest to note the discussion concerning the laws of thermodynamics. The authors state on page 265 that "The proposed increase in order through chemical evolution might seem to be contrary to the laws of thermodynamics, which require that any process taking place in nature must go toward a random state." A few sentences later on they say, "However, when one is discussing entropy using classical thermodynamics, he is talking about a *closed* system. On the other hand, living cells are open systems by their interaction with the environment through mass and energy exchange." The authors are discussing the origin of life and the laws of thermodynamics, and then all of sudden they are talking about living cells!

The relationships of the living cell to the laws of thermodynamics have no relevance whatsoever to the origin of life, where a very high degree of complexity and specificity supposedly arose out of chaos before the living cell existed. Whether this sleight of hand on the part of the authors was intentional or not, it renders their line of reasoning completely invalid. Regardless of all the oratory of evolutionists, the laws of thermodynamics remain an insuperable barrier to a naturalistic origin of life.

Three Objections to Experiments

In their introduction to Chapter 5, the authors state that the discussion in the preceding chapter "has shown us that essentially all of the classes of required monomers could have appeared under the conditions that were believed to have existed on the primitive earth." We might mention just a few reasons why we believe the experiments designed to demonstrate the origin of even simple organic molecules are invalid.

In the first place, every apparatus used to show the origin of organic compounds from a simple gaseous mixture employs some sort of trap to remove the products of the reaction. (See pp. 125, 132, 133, 135, 137) The reason for this is rather obvious. A high energy source is used to convert the gases to organic compounds.

If these organic compounds, once formed, were subjected to this same energy source, they would break down more readily than they form, and no significant amount of product could ever be isolated. The organic chemist circumvents this difficulty by inserting a trap of some kind in his apparatus.

Unfortunately, there were no organic chemists on the primitive earth and no traps, so these compounds, once formed, would be subjected to the destructive action of ultraviolet light, electrical discharges, etc., and their concentration would never have exceeded an insignificant amount.

Because of the above consideration, and the fact that a spontaneously reacting mixture would give rise to a tremendous diversity of organic compounds, no particular organic compound would ever have reached a significant concentration in a primordial ocean. Yet in all the experiments described, a relatively high concentration of reactants (0.001 molar to 1.0 molar) are used. This is necessary in order to obtain even very small yields.

All of the nitrogen in the present atmosphere would have to be concentrated in a single compound to obtain a 0.2 molar concentration in the present oceanic system. Thus, under even the most favorable thermodynamic conditions, if this nitrogen were divided among thousands of

different compounds, none could ever have reached a concentration sufficient for the origin of life.

We might mention a third objection to the relevancy of the experiments described in this book. Conditions and reactants vary from experiment to experiment, depending upon the type of product desired. Thus, a mixture of amino acids may be heated (but for only a precisely limited time!) by one investigator in order to obtain a protein-like polymer. Another investigator may try a mixture of purines, sugars and phosphoric acid in an attempt to obtain nucleotides. If each meets with success, then it is triumphantly proclaimed that plausible conditions have been devised for the abiogenic formation of proteins and nucleotides.

But, of course, on the primitive earth there would have been no organic chemists to carefully compartmentalize the various reactants present—all would have been one big *gemisch*. Then why don't some of these investigators see what happens when both sugars and amino acids are included in the same reaction mixture? Simply because the results are easily predictable—total failure. Amino acids and sugars interact to produce non-biological precursors, thus both are destroyed as far as origin of life experiments are concerned.

The above problems are a few of those that are ignored in origin of life experiments. In spite of the very optimistic statements of Kenyon and Steinman, the assertion of Hull is most appropriate: "The physical chemist, guided by the proved principles of chemical thermodynamics and kinetics, cannot offer any hope to the biochemist, who needs an ocean full of organic compounds to form even lifeless coacervates."³

Inconsistencies Noted

In Chapter 5 the authors discuss condensation and polymerization of biomonomers (such as amino acids and nucleotides) into complex polymers, such as the proteins and nucleic acids. They point out some of the factors that would tend to prevent the formation of these polymers from the monomers. They mention the fact that such formation is a thermodynamically unfavorable event. In other words, the tendency is always to go from polymer to monomers, and not the reverse.

After discussing some of the methods used in origin of life experiments to overcome this thermodynamic barrier, the authors proceed on page 180 to criticize these methods, pointing out reasons why they would be implausible (I believe there is no question at all that they must be excluded as a possibility leading to any significant quantity of product under reasonably plau-

sible conditions). In the very next paragraph they then go on to say,

In conclusion, we may note that various explanations are presented in this chapter to elucidate the course of prebiotic polymerizations. The results of these different approaches suggest to us that these reactions could have taken place on the primitive Earth under a variety of conditions, all leading to the same essential products. This was one of the main themes of Chap. 4. In the present chapter as well, it is not really necessary for us to ascertain which particular approach best resolves the problems under consideration. Rather, it is more important to realize that these necessary polymers most probably did appear in any case, as also concluded in Chap. 4 with respect to the biomonomers.

Thus, in one breath the authors emphasize the implausibility of certain approaches to the abiogenic formation of organic polymers, and then in the next breath the authors are saying that in any case they almost certainly did form somehow. They seem to be saying that if a sufficiently large number of solutions are offered, no matter how improbable each may be, it is a virtual certainty that one will be right!

Throughout the book, the authors repeatedly offer these optimistic statements in the face of even the most obvious difficulties. Such an approach no doubt will convince many and will serve to strengthen the faith of the believers, but will in no way expose the weaknesses of the theory.

In discussing the molecule-to-cell transition in Chapter 6, the authors point out some of the difficulties that lie in the way of understanding how this may have occurred. They discuss a variety of solutions that have been suggested, and then, once again, end on a most optimistic note.

On page 254 they state, "Given the set or variety of sets of conditions that are believed to have existed on the young Earth, the appearance of protocells would appear to have been a likely event." On page 255 the authors say, "These experiments would suggest that given any of a large variety of possible primitive Earth conditions, the production of protocells seems to have been a likely event." Sandwiched in the very brief space between these two practically identical statements are three other statements saying about the same thing. They apparently are following the thesis that if a statement is repeated often enough, it will come to be accepted as fact.

There are many, many sound reasons to totally reject the idea that the extremely complex and highly organized living cell could have arisen naturalistically out of a random mixture of molecules. Space does not permit further discussion,

and we wish merely to quote Green and Goldberger who said, "... the macromolecule-to-cell transition is a jump of fantastic dimensions, which lies beyond the range of testable hypothesis. In this area all is conjecture. The available facts do not provide a basis for postulating that cells arose on this planet."⁴

Conclusion

Kenyon and Steinman have presented in rather comprehensive fashion the thinking and laboratory endeavors of evolutionists on the origin of life. Since the origin of life was not observed by man nor can this event be repeated, the origin

of life is not subject to scientific investigation if the usual criteria for scientific studies are accepted. And, if as we believe to be certain, life was the result of a direct creative act of God, no valid scientific inquiries whatever can be brought to bear on its origin.

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ECOLOGY: THE ABOLITION OF MAN?

JOHN W. ROBBINS*

What is man, that thou art mindful of him?
and the son of man, that thou visitest him?
For thou hast made him a little lower than
the angels, and hast crowned him with glory
and honor. Thou madest him to have dominion
over the works of thy hands; thou hast put
all things under his feet: All sheep and oxen,
yea, and the beasts of the field; The fowl of
the air, and the fish of the sea, and whatsoever
passeth through the paths of the seas.

Psalm VIII; Genesis I

Conservationism as an effective socialist political movement has existed since the turn of the century, but it did not come into its own until the late 1960's, rechristened "ecology."¹ Ecology bears the same relation to conservationism that Marxism bears to socialism: both ecology and Marxism claim to furnish a "scientific" basis for their antecedent movements, and both claims are equally specious.

It was the monist Ernst Haeckel, known to the readers of the *Creation Research Society Quarterly* as a principal proponent of the "ontogeny recapitulates phylogeny" argument, who in 1869

Ye are of more value than many sparrows.

Jesus of Nazareth, Matthew X, 31

I see around me no danger of Deism but much of an immoral, naive and sentimental pantheism. I have often found that it was in fact the chief obstacle to conversion.

*C. S. Lewis, Rejoinder to
Dr. Pittenger*

coined the word "oecology." For Haeckel, an individual is the product of cooperation between organismal heredity and its environment, this cooperation or relationship being called "oecology."

Haeckel viewed oecology as one of the ten "general laws of Biology, upon which this comprehensive law of development [i.e., evolution] is firmly based."² An author in the *Encyclopedia Britannica* has written:

Haeckel's oecology was more or less forgotten in the activity that resulted from publications of Charles Darwin's theory of natural selection in 1859. This is a strange turn of events, since Darwin's theory was primarily an ecological theory of evolution, stressing the environment as a selection agent over long periods of time.³

Ecology as Ideology

Today "ecology" is used as an argument for socialism, just as in the past it has been used as an argument for the doctrine of evolution. Paul Ehrlich of Stanford University has written in *The Population Bomb*: "We must move from an economic system based on growth, production,

†EDITOR'S NOTE: Although the concepts presented in this paper by Mr. Robbins are somewhat political in nature, we entered the arena of politics as soon as we began to discuss ecology. Mr. Robbins purports to answer certain suppose political implications of Dr. John Klotz's paper, "Creationism an Our Ecological Crisis," *Creation Research Society Quarterly*, 8(1):13-15ff; June, 1971.

This article by Mr. Robbins is followed by a reply from Dr. Klotz so that the reader has the benefit of both viewpoints on a highly controversial issue—controversial even among creationists.

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consumption and waste to one that emphasizes stability, quality of capital goods, recycling of resources." Ehrlich, one of the national figures in the ecology movement, helped organize Zero Population Growth⁴, a group which advocates (a) legalized abortion (abortion is justifiable homicide if one can thereby "save the environment"); (b) a maximum of two children per family; (c) government "support" of birth control; (d) tax incentives for smaller families.

Ehrlich writes, "Even if we prevented all unwanted children . . . we would still have a severe population problem." Ergo, "we" (meaning Ehrlich and his fellow planners) must "prevent" *wanted* children: which means, an elite must have power over the life and death of human beings to save the environment.

The socialists of old advocated the nationalization of the means of production; the ecologists⁵ advocate nationalization of the means of reproduction. Indeed, as Ayn Rand notes, pollution is not really the issue at all: power is the goal of the ecologists:

Their immediate, but not ultimate goal, is the destruction of the last remnants of freedom, that is, of capitalism in our mixed economy, and the establishment of a global dictatorship in order to protect our natural environment. This means: to enslave mankind in order to protect weeds, birds and reptiles. Their ultimate goal is the destruction of man's mind, and its product, technology.⁶

The ecologists, to put it quite simply and unmistakably, do not wish to have dominion over the earth and subdue it: they wish to have dominion over men and subdue them.

Ecology as Pseudo-science

I reproduce here an extended quotation from the January 26, 1970, issue of *Newsweek* magazine⁷ as a typical example of the conclusions of the "science" of ecology.

. . . some scientists like to play with the notion that global disaster may result if environmental pollution continues unchecked. According to one scenario, the planet is already well advanced toward a phenomenon called "the greenhouse effect." Concentrations of carbon dioxide are building up in the atmosphere, it is said, as the world's vegetation, which feeds on CO₂, is progressively chopped down. Hanging in the atmosphere, it forms a barrier trapping the planet's heat. As a result, the greenhouse theorists contend, the world is threatened with a rise in average temperature which, if it reached 4 or 5 degrees, could melt the polar ice caps, raise sea level by as much as 300 feet and cause

a worldwide flood. Other scientists [sic] see an opposite peril: that the polar ice will expand, sending glaciers down to the temperate zone once again. This theory assumes that the earth's cloud cover will continue to thicken as more dust, fumes and water vapor are belched into the atmosphere by industrial smokestacks and jet planes. Screened from the sun's heat, the planet will cool, the water vapor will fall and freeze, and a new Ice Age will be born.

This genre of "scientific" thinking is adequately described by Mark Twain⁸: "There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact."

It would indeed be quite surprising if the ecologists were in possession of any facts. The readers of *C. R. S. Quarterly* read both an article on ecology and a new book announcement of *Ecology Crisis* by Dr. John W. Klotz in the June, 1971, issue. Dr. Klotz tries to reconcile Christianity and ecology.⁹ In so doing he demurs from White's ascription of guilt to Christianity (see below) for our "ecology crisis," but accepts Moncrief's attack¹⁰ on capitalism:

. . . the American development of a society made up of small landowners in which decisions to degrade [sic] the environment are made by millions of landowners¹¹ and not by a few (*nota bene*) [is] much more responsible for our problems than any set of religious beliefs.

Ergo, we must substitute an elite for small landowners to protect our environment. The Communists call such a process collectivization.

Both Moncrief and Dr. Klotz ignore (or fail to understand) the fact that a given socioeconomic system is not self-existent, but is the product of ideas, the order of private property being the logical consequent of Christianity. To imply that the social order is not such a consequent (which implication is in the ascription of "guilt" to capitalism but not to Christianity) is to endorse a crude Marxian materialism.

Perhaps both Moncrief and Klotz wish to say (and it is certainly implicit in what they have said) that Christianity and private property are incompatible. If that be their position, then Moncrief and Klotz have failed to understand Christianity or capitalism or both.

Dr. Klotz, as all ecologists do, speaks of an "ecology crisis," of "serious problems" in "our deteriorating environment" caused by people who "exploit the environment, waste our (*nota bene*, the collective possessive) resources and cheat future generations of their legacy."¹² The socialists were once wont to say that the greedy capitalists exploited the workers; when it became

manifestly obvious that they didn't, the socialists changed the tune: the capitalists now exploit Mother Nature.

Words like "exploit," "waste," "cheat" are nothing but pejoratives whose usefulness in a rational discussion is zero and the use of which prohibits rational discussion. Dr. Klotz writes that "Man can hardly claim to own anything,"¹³ a statement which confuses theological, political, juristic, and economic concepts of ownership, and treats the abstract noun "man" as equivalent to "men." The argument for the elimination of small landowners rests on such an equation—and this to be done in the name of God, who owns everything. It is not apparent to me what merit there is in introducing another definition of ownership to an issue already totally confused, unless one wished to use such an equivocation to undermine any Christian opposition to the elitist control (in the name of God) of the land.

Furthermore, there is no "ecology crisis." The entire thesis of the ecologists is the unproved asseveration that local pollution is threatening global catastrophe. Not one bit of evidence has been offered in support of (let alone proof of) such a thesis. Talk about an "ecology crisis" is sheer irresponsibility.

Air pollution: The National Science Foundation has reported¹⁴ that the oxygen content of the air is exactly what it was in 1910: 20.95%. In the years 1930-31 the Public Health Service took particulate measurements in 14 of the largest U.S. cities; the Department of Health, Education and Welfare in 1957 began monitoring the air in 55 cities. In those 25 intervening years particulate contamination had fallen to less than 25% of the 1930-31 level.¹⁵ By 1969 the H.E.W. figures indicated that the contamination had declined to less than 20% of the 1930-31 level, which the ecologists like to view as a "clean-air" era, being the Great Depression.¹⁶

In two-thirds of U.S. cities tested (20 out of 30) during the period 1964-1969, the sulphur dioxide contamination of the air declined (17 cities) or remained the same (3 cities).¹⁷ The SO₂ contamination rose in New York City, for example, where the ecologists have prevented Consolidated Edison from using pollution-free nuclear power, forcing Con Ed to provide power from overworked (hence, blackouts), SO₂ producing, coal-burning plants.

Water pollution: The "mercury contamination" of our waters was much greater in years past than it is now: "Fish caught 44 years ago and just analyzed contain twice as much mercury as any fish processed this year." (1971)¹⁸ In 1793 an epidemic killed 20% of the residents of Philadelphia, which did not happen to be suffering from industrial wastes in the water.¹⁹ The ecologists confuse aesthetic quality and purity: not

everything that "looks good" is good to drink; nor is everything that "looks bad" bad to drink.

Pesticides: Nobel Prize winner Dr. Norman E. Borlaug says:

I have dedicated myself to finding better methods of feeding the world's starving populations. Without DDT and other important agricultural chemicals, our goals are simply unattainable, and starvation and world chaos will result. . . . Science without common sense is worthless and environmentalists are not using common sense when they examine DDT and its effects on wildlife in this country. . . . There has not been one shred of reliable evidence that DDT has put any species of wildlife in danger. . . . The argument that pesticides are upsetting the balance of nature is utter nonsense.²⁰

Dr. Lloyd E. Rozeboom, Professor of Medical Entomology at The Johns Hopkins School of Hygiene and Public Health, has further documented that statement.²¹ Lack of space prevents me from quoting from his article, so I will generalize by saying that not only have the ecologists forced residents of New York City to breathe dirtier air, they have caused a massive resurgence of malaria in Ceylon, for instance, through a ban on the use of DDT. "Estimates of the number of subsequent cases [of malaria] are as high as two-million."²²

Industrialization: If indeed it were true that heavy and concentrated industrialization is inimicable to human life, one would expect to find the life expectancy declining in the most advanced countries. In the U.S. the life expectancy in 1900 was 47.3 years; in 1968, 70.2 years.²³

In pre-industrial times the life expectancy was 30-35 years. In England the population quadrupled during the 19th century (11 to 44 millions) not only when the pollution would have been worst, but when (allegedly) the capitalists were grinding the workers into the dust. Those who would destroy industry must destroy nearly all human life on this planet.

Ecology as Religion

If we are to understand the ecology movement, it is necessary to recognize its philosophical roots. In *The Four Changes*, Clifford Humphrey writes:

It seems evident that there are throughout the world certain social and religious forces which have worked through history toward an ecologically and culturally enlightened state of affairs. Let these be encouraged: Gnostics, hip Marxists, Teilhard de Chardin Catholics, Druids, Taoists, Biologists, Witches, Yogins, Bhikkus, Quakers, Sufis, Tibetans, Zens, Shamans, Bushmen, American Indians, Polynesians, Anarchists, Alchemists . . . the

list is long. All primitive cultures, all communal and ashram movements.²⁴

No doubt the reader has noticed the omission of scriptural Christianity from the list, for the ecology movement and Christianity are diametrically opposed. "Christian ecology" is as much a contradiction in terms as "Christian existentialist" or "Christian Marxist."

Writing in *The Environmental Handbook*, Lynn White of U.C.L.A. explores the "Historical Roots of Our Ecologic Crisis":

What we do about ecology depends on our ideas of the man-nature relationship. More science and more technology are not going to get us out of the present ecologic crisis until we find a new religion, or rethink our old one. The beatniks, who are the basic revolutionaries of our time, show a sound instinct in their affinity for Zen Buddhism. . . .

Hence we shall continue to have a worsening ecologic crisis until we reject the Christian axiom that nature has no reason for existence save to serve man.²⁵

Ecology or "environmentalism" is obviously a form of nature-worship. The continual use of the pagan concept "Mother Nature" by the ecologists is indicative of their substitution of "Mother Nature" for "God the Father." "Christian ecologists" who try to reconcile pantheism with transcendental monotheism always piously refer to nature as "the creation of God."

But if one reads them closely, one will find that man, the king of the earth, the most divine of terrestrial creation, is regarded as unnatural, as subnatural. Redwood trees are "God's creation"; man is not. If one reads the ecologists, one will immediately sense this hatred for man: man disrupts the "natural order of things"; man is "a messy animal," as a *Newsweek* writer put it.

Ecologists regard man as radically evil, not because he has sinned against God, but because he has and is now sinning against another god: Nature. But perhaps more importantly, they regard man as an intruder in the universe, an intruder who cannot be tolerated, for he upsets "Nature's ecological balance" (in theological terms, he disobeys God's commands). Man is metaphysically unimportant.

The ecologists agree with their fellow pantheists of the East that man is able "to enter the water and leave no ripple." No doctrine could be more opposed to Christianity.

Conclusion

I find it quite incredible that Christians should be concerned about "pollution" of the environment in 1972. Mass murderers like the Communists who, at this moment, are martyring Christians for their faith, appear to me to be a

much more ominous and diabolical threat than any amount of pollution.

I find it quite difficult to believe that human beings, and *a fortiori*, Christians, are entirely sane when they choose to crusade in behalf of birds and fish and ignore the terror and slaughter of human beings that surrounds us and is abetted by "our" government.

We are enjoined as Christians to "remember them that are in bonds" (Hebrews 13:3) and not "to love thy flora and thy fauna," for human beings are of more value than many sparrows.

References

- ¹Today the central government owns 40% of the land in the United States.
- ²Haeckel, Ernest. 1876. *History of creation*. Volume II. Henry S. King and Co., London, p. 353ff.
- ³Encyclopedia britannica. 1965. Volume 7, p. 913.
- ⁴See Rousas J. Rushdoony. 1968. *The myth of over-population*. Craig Press, Nutley, New Jersey.
- ⁵Rhymes with "astrologers." See "Ecology as Pseudoscience" in next section.
- ⁶In an appearance May 2, 1971 on NBC's COMMENT! Transcript of the program may be purchased from Merkle Press, Inc., Box 4556, Washington, D. C. 20017, for 10¢.
- ⁷Cited in Ayn Rand. 1971. *The new left: The anti-industrial revolution*. Signet, New York, pp. 135-136.
- ⁸Twain, Mark. 1961. *Life on the Mississippi*. Chap. xxvii, p. 120. New American Library, New York.
- ⁹I wish to forestall any criticism about my use of the word "ecology." Perhaps a science of ecology can be developed, but there is none at present. Science books are not entitled *Ecology Crisis*; political tracts are. Compare White's use of the word in the quotation I present from him in "Ecology as Religion."
- ¹⁰*Creation Research Society Quarterly*, June 1971, p. 14.
- ¹¹For the matter of private property and land use, see C. E. M. Hardin. 1952. *The politics of agriculture: soil conservation and the struggle for power in rural America*. Glencoe, Illinois; Friedrich von Hayek. 1960. *The constitution of liberty*, p. 366ff. Chicago, University of Chicago Press; Rousas J. Rushdoony. 1964. *This independent republic*, pp. 48-49. Craig Press, New Jersey; Ludwig von Mises. 1966. *Human action*, pp. 637ff. and 654ff. Henry Regnery Co., Chicago.
- ¹²*C.R.S. Quarterly, Ibid.*, p. 15. The ecologists' concern is for anything except existing human beings. If irrational and inanimate nature is not most important, non-existent human beings are. Existing human beings are to be sacrificed so "future generations" can have their "legacy," whatever that is.
- ¹³*Loc. cit.*, p. 15.
- ¹⁴Shepard, Thomas R., Jr. *The disaster lobby*, *The Freeman*, August, 1971, pp. 477-487.
- ¹⁵Boehme, Lillian R. *Propaganda and poison air*, *The Review of the News*, August 25, 1971, p. 27.
- ¹⁶*Ibid.* Since they advocate homicide to protect the environment, it is quite reasonable to them that they should advocate depressions to maintain clean air.
- ¹⁷*Ibid.*, p. 30.
- ¹⁸Shepard. *Op. cit.*, p. 479.

¹⁹Shepard, *Ibid.*, p. 473.

²⁰*The Review of the News*, October 20, 1971, pp. 14-15.

²¹Rozeboom, Lloyd E. 1971. DDT: the life-saving poison, *The Johns Hopkins Magazine*, Spring, 1971, pp. 28-32.

²²*Ibid.* p. 31.

²³Rand, *Op. cit.*

²⁴As cited by Gary Allen. 1970. Ecology: government control of the environment, *American Opinion*, May, 1970, p. 10.

²⁵*The Environmental Handbook*, pp. 24-25, as cited by Allen, *Ibid.*, p. 6.

A REPLY BY DR. KLOTZ*

I am somewhat bewildered by Mr. Robbins' reaction to my paper. I do not view either the conservation movement or the present environmental movement as a "socialist political movement" or for that matter any kind of political movement. The environmentalists I am acquainted with are largely biologists, and one of their complaints is that they are not sufficiently political in their orientation: they fear that it is for this reason that they have been ineffective.

Mr. Robbins is of course correct in what he says about the origin of the term "ecology": it was coined by Ernst Haeckel. But I would not want to think that we cannot use it for that reason or that it is in some way tainted as a result of a sort of "guilt by association."

As I have indicated, I do not agree with Mr. Robbins that ecology must be identified with a particular political system, and I certainly do not agree that Christianity must be allied with a particular economic system. If capitalism is indeed the logical consequence of Christianity as Mr. Robbins seems to imply, then I wonder why God did not set up a capitalistic system under the Old Testament theocracy.

I believe that Christianity can operate under any economic system, and I do not believe that capitalism is its logical consequence; in fact, I do not think that any economic system is its logical consequence.

Capitalism Is Effective System

I personally believe that capitalism is the most effective economic system and probably the most effective system so far as the cure of our environmental ills is concerned. Abelson points out that the U.S.S.R. is suffering from a shortage of caviar because of oil pollution in the Caspian Sea and the Volga River. He also quotes from *Izvestia* which criticizes the failure of a factory to install purification installations:

The Voskresensky Chemical Combine managed not to spend one kopeck on this construction, although the money had been allocated. They explained how, waving their arms, the

design organization did not turn over the drawings on schedule. But why did the combine director, Comrade Doktorov, instead of trying to obtain the designs, begin to fuss about to have himself relieved of all these unnecessary headaches, the installation of all kinds of filters and sediment traps?" (Abelson, Philip H., "Shortage of Caviar," *Science*, 168 (1970):199)

In the same journal, Goldman says, "Comparing pollution in the United States and in the U.S.S.R. is something like a game. Any depressing story that can be told about an incident in the United States can be matched by a horror story from the U.S.S.R." (Goldman, Marshall I. "The Convergence of Environmental disruption," *Science*, 170 (1970:37-42)

The Soviets like to claim to be first, and he goes on to point out that the Soviets have a right to claim at least one "first," for the first river to catch fire was the Iset in the Ukraine which ignited when a careless smoker threw his cigarette into the water in 1965. It was not until July, 1969, that a river caught fire in the United States, the Cuyahoga, which ignited under similar circumstances.

Also Goldman points out that while there are some advantages to the Soviet system so far as control of pollution is concerned (they do not put ethyl lead into any of their gasolines and have not permitted as much emphasis on consumer goods so there is less waste to discard), there are some reasons for polluting which seem to be peculiar to a country such as the Soviet Union. Officials are judged almost entirely by how much they are able to increase their region's economic growth, and are not likely to be promoted if they decide to act as impartial referees between contending factions on questions of pollution. There is almost a political as well as an economic imperative to devour idle resources.

Moreover industrialization has come relatively recently to the U.S.S.R. and the Russians continue to emphasize increases in productivity. Pollution control, however, generally appears to be non-productive. In addition, until July, 1967, all raw materials in the ground were treated as free goods: as a result there were very low re-

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covery rates, and much salvageable material was discarded. Because there is no private property there are no private property owners to protest the abuse of various resources. Finally Goldman points out that economic growth in the U.S.S.R. has been even more unbalanced than in the U.S.

Communitic System Ineffective

It stands to reason that a capitalistic system is better able to deal with pollution problems than a communitic system, because in our system there are a number of powerful groups: labor, government, industry, and the general public. In a communist country, government and industry are one, and this combined power is so great that it is difficult to oppose. People cannot seek government aid against an industrial polluter, for the government is the industrial polluter.

So I favor capitalism not because of my Christian faith but because I believe it has the best potential for solving our environmental problems. We need awareness, we need research, we need laws. I believe we can solve our problems here in the United States. Mr. Robbins may be right when he says, "... 'ecology' is used as an argument for socialism," but those who use it (and my impression is that this is a decided minority) are suggesting a system which is unlikely to bring about what they are seeking to accomplish. Most of the environmentalists I know are anxious to work within the capitalistic system because they feel, as I do, that it is probably the best system to accomplish the goal, even though it is indeed an imperfect system.

There are some things on which I find myself agreeing with Dr. Ehrlich. I favor "quality of capital goods": I think many of our economic problems are due to the shoddy goods we have produced, though I think shoddiness is far more likely to occur in a socialistic or communitic economy than in a capitalistic economy. I do not see any particular virtue in growth: uncontrolled growth is the "ideology" of a cancer cell. I favor recycling of resources, as does Dr. Ehrlich: I take this position because that is the way God handles waste materials in the world He has created and I am humble enough to believe we can learn from Him. I do not favor unrestricted legalized abortion because that is contrary to God's laws.

I could go on, but really I do not need Dr. Ehrlich to speak for me. I'd rather speak for myself, because there are some matters on which I share Dr. Ehrlich's point of view, and on others I disagree.

Mr. Robbins' quotation from *Newsweek* is a good example of how little we know. As I have pointed out repeatedly, we badly need more research. To me the greatest hazard to the environmental movement is that we will have a great number of dire predictions from well

meaning people that turn out to be wrong and lead people to believe that environmentalists are crying, "Wolf, wolf."

It never occurred to me that I was attacking the capitalistic system and the idea of private property when I quoted favorably Moncrief's analysis. I believe Moncrief is correct, but I don't regard this as an argument for collectivization: rather I believe it suggests the necessity of providing better environmental education to these private land owners (which we haven't done) so that their private property and their private interests are protected. I happen to agree with Goldman that where there is no private property there are no private property owners to protest the abuse of various resources. In my judgment, what Mr. Robbins says is a *non-sequiter*.

Ecological Crisis Is Real

I happen to think there is a serious ecological crisis. As I look at it, we've consistently abused God's creation. He is a good God who seeks to protect us against the consequences of both our folly and our sin, and so He has provided mechanisms in the environment for undoing much of the damage we inflict on the environment.

But there comes a time when His patience wears thin with our sin and also with our arrogance. The people of the Fertile Crescent abused His bounty, and their lands are largely desert. The land of Israel, for instance, was a land flowing with milk and honey: by no stretch of the imagination can it be considered that today. Babylonia and Assyria were fertile lands: today less than 20% of their national income is derived from agriculture.

It is of course true that we have survived abuse of the environment in the past, but it is just possible that we will add "the straw which breaks the camel's back." On November 9 and 10, 1965, a tremendous power failure struck seven of our northeastern states and Ontario. About 30 million people were affected: this was the result of the failure of a single electrical relay. What frightens me is the possibility of an insignificant environmental abuse triggering a comparable catastrophe.

What Mr. Robbins refers to as evidence there is no ecology crisis I look on as evidence of God's mercy. We have abused His gifts, and instead of letting us experience the consequences of our folly and sin He has provided mechanisms for undoing the damage. I am concerned that His patience may fail, that He may tire of our repeated sinning and of our arrogance. I happen to think that one of the characteristics of 20th century man is his arrogance, and I'm afraid God

will let us suffer the consequences of our stupidity to show us how little our arrogance is justified.

Mr. Robbins feels I confuse theological, political, juristic and economic concepts of ownership. I certainly recognize private property, but not as a human right, rather as a gift of God. And I suppose I do think theologically: as I pointed out, Scripture claims that God owns everything and it's for that reason that I wrote man can claim to own nothing.

Disagreement on DDT

Mr. Robbins quotes Dr. Borlaug for whom I have the highest regard: he's a committed Christian activist who has done something to solve the world's problems instead of spending his time in cataloging them and bemoaning them. But Dr. Borlaug is wrong. The evidence that DDT is harming wildlife is overwhelming. Let me quote a few paragraphs from an article by Faith McNulty which is typical of hundreds of published articles:

For the past three years reports from the California coast have been increasingly ominous. In one instance after another there are signals that birds, and perhaps even fish and mammals, that inhabit these waters are in serious trouble. It is possible—though as yet unproven—that these are the early symptoms of a coming catastrophe. But even if things become no worse than they are at present, there is enough to mourn.

This year, and for the past several years, brown pelicans and cormorants have failed to reproduce. On the off-shore islands, where thousands of these birds annually gather in noisy, busy, breeding communities, biologists have found almost no young; only abandoned nests and scattered eggshells.

On the Farallon Islands, 30 miles west of San Francisco, where thousands of murres and ashly petrels nest, eggshells are measurably thinner than normal, giving warning that like the pelicans and cormorants, these birds, too, may reach the point where reproduction is impossible.

The peregrine falcon is already a ghost. It has virtually disappeared from California. Where there were once more than 200 known nesting sites, a search in 1970 found only two breeding pairs. Four young peregrines were fledged; no more. Bald eagles and ospreys have likewise vanished from the Southern California coast. The great blue herons and common egrets that nest in a canyon near Point Reyes have abnormally thin eggshells and are showing some symptoms of reproductive failure.

All along the coast the sea lion nurseries held less than the usual complement of young.

A biologist reported that on one of the major sea lion islands, San Miguel in the Channel Islands off Santa Barbara County, he had found 348 dead pups and only 20 pups alive during the spring. Many of these seemed weak and unlikely to survive. There has been an extraordinary rise in the rate of premature birth, or abortion, in sea lions. A biologist who counted 135 such aborted young on San Nicolas Island off Ventura County during the spring of 1969 found 442 in 1970, an increase of more than 200 percent in one year.

Hundreds of miles south, on the rocky islands off Baja, California, birds and mammals are having the same reproductive difficulties; there are fewer young than normal of either kind. Besides the fact that they are in difficulty, there are other significant factors common to all these different species. First, they are fish-eaters. Second, the fish they eat inhabit waters that are among the most pesticide-laden in the world.

In fact, it is through analysis of the bodies of these seabirds and mammals that we get an inkling of the extent to which the coastal waters for thousands of miles carry such contaminants as pesticides, mercury, and polychlorinated biphenyl (PCB). PCB is a DDT-like compound used in industry whose persistence and danger to the environment has only recently been identified. That certain persistent pesticides cause reproductive failure in birds has now been firmly established. There has been less research on sea lions and seals to prove, or disprove, a connection between these pesticides and increased mortality or abortion. But very recent evidence strongly suggests such a link. (McNulty, Faith. "The Silent Shore," *Audubon* 73 (Nov. 1971), 5-11.

I believe that if there were as much evidence that a bridge was unsafe as there is that DDT is harming birdlife, the bridge would be closed within minutes. I regret that we cannot use DDT on any extensive scale: its discovery was one of the gifts of God. But any abuse of His gifts may harm and that, I am afraid, is what has happened.

I would like to see men like Dr. Borlaug continue their research and I would like to see other men research biological control mechanisms. That's the way harmful insects are controlled in nature and I have a hunch we may find that these controls God created are even more effective than the artificial controls He permits us to discover.

Mr. Robbins quotes figures on life expectancy: these are truly impressive. But what has happened is that we have extended the life expect-

ancy by decreasing the infant mortality rate and the death rate from infectious diseases. Pollutants are likely to have their effect in old age: they are believed to cause a variety of degenerative diseases such as cancer.

A more meaningful figure would be to compare the life expectancy of a man of 60 in 1900 with the life expectancy of a man of 60 today. In 1900 according to the *Information Please Almanac for 1958*, a man of 60 could expect to live 13.9 years longer; in 1968 he could expect to live 17.1 years longer, according to the *World Almanac for 1971*. Thus while 22.9 years have been added to the average life expectancy, only 3.2 years have been added to the life of a man who is already 60.

When we look at the cancer death rate we find it has steadily increased in this century. In 1900 cancer killed 67.6 per hundred thousand according to *Information Please Almanac for 1958*. By 1940, the death rate from cancer was 123.2 per hundred thousand, and by 1969, according to *World Almanac for 1971*, it had increased to 160.1 per hundred thousand. Figures such as these lead me to disagree with Mr. Robbins and to believe that industrialization may be inimicable to human life.

Conclusions

As I pointed out in my article, the environmental movement has been seized upon by an assorted variety of people who do not share my Christian commitment, and I find this ironic. For I believe that the ethic that is needed to solve our environmental problems is the Christian environmental ethic.

I find it equally ironic that men like Mr. Robbins, who share my Christian commitment, should be so concerned about the environmental movement. It is my conviction that the world which God created is good, that in His creation He showed Himself to be a wise God and that He also shows His wisdom in the way in which He preserves the world. I believe our problems have arisen because of man's sin. Instead of loving God and his neighbor, man seeks to exploit for his selfish benefit.

Man's arrogance also plays a part. He seeks to improve on the world that God has created and finds that he is not wise enough to anticipate the consequences of his actions. I believe that man is a special creature of God: I also believe that plants and animals were created by Him and that He cares for and about them. (Ps. 145: 15f) Man is not an intruder, but he is a sinner and an arrogant fool. And the whole creation suffers from his sin and his stupidity. (Rom. 8:22f)

Obviously man has a responsibility as a manager of God's creation: that obligation was laid on him in Gen. 1:28. But in managing, he is to care for God's creation. (Gen. 2:15) No responsible environmentalist suggests a return to "natural" conditions when the buffalo roamed the prairies and deciduous forests covered the eastern part of the United States: we must have our farmlands to feed our millions. But we must recognize that we have changed the created world; we must be responsible in our management; and we must seek to find answers to our problems by trying to learn more of the natural balances which God in His wisdom has developed.

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