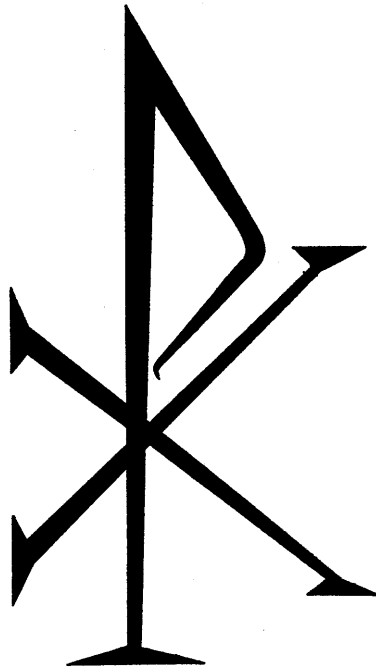


CREATION RESEARCH SOCIETY

1965 ANNUAL



Haec credimus:

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

VOLUME 2

MAY 1965

NUMBER 1

Our Society of research scientists representing various fields of successful scientific accomplishment is 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. Beginning in 1964, we are publishing an annual yearbook of articles by various members of the Society and thereafter a, quarterly review of scientific literature. Our eventual goal is the realignment of science based on theistic creation concepts and the publication of textbooks for high school and college use.

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.

Dues are \$5.00 per year and may be sent to Wilbert H. Rusch, Sr., Treasurer, 4090 Geddes Road, Ann Arbor, Michigan. Active membership at present is limited scientists having an M.S. (or equivalent in experience), Ph.D., D.Sc., Ed.D., or M.D. Degrees. Sustaining non-voting membership is open to those who subscribe to the above statement of belief at \$5.00 per year and includes subscription to annual and quarterlies.

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INTRODUCTION

A year has passed since the organization of our society and publication of our first Annual. The response to our invitations to membership and published statement of belief has been truly heartening. We now have 225 active scientist members with an M.S. degree or better in the way of training and experience. The response of those trained in such fields as the ministry, teaching, technology and the various arts is even more enthusiastic in that we have over 450 sustaining members. Our correspondence has been so heavy that our secretary, William J. Tinkle, treasurer, Wilbert Rusch, Sr. and I, have hardly been able to keep up with it. Many of our steering committee members have given freely of their time answering letters, lecturing, and otherwise publicizing the objectives of our society.

We have already achieved one of our goals. No longer can our evolution-minded colleagues claim that *all* scientists accept the so-called "fact" of evolution. Obviously, at least 225 scientists of recognized achievement believe it has for some time outlived its usefulness even as a theory.

Our main objective, namely, the complete re-evaluation of science from the creation viewpoint, has also been at least outlined and a few foundation stones carefully laid. Actually, though, we have no use for the evolution theory, our main thrust is toward the development of a new framework of reference in science, based on a whole-hearted conviction that the universe and the world in which we live is but the expression of God's creative wisdom and design constantly being maintained by His power. For as Saint John, the much beloved apostle of our Lord says, "All things were made by Him; and without Him was not anything made that was made." And again as Saint Paul says, "For in Him we live, and move, and have our being" (Acts 17:28).

The so-called "laws" of nature are then our sensible impression of God at work. Since we who are created in God's image have been given the task of "replenishing the earth and subduing it," all research should be undertaken prayerfully with the objective of helping one's fellow man to better understand, enjoy, and thankfully appreciate the Glory of God as shown by the ever increasing evidence of the intricacy of His creations.

One of my professors, Dr. Mark N. Christensen, who teaches structural geology at the University of California, Berkeley, correctly stated during his introduction to his course, "The selection of data in structural geology is 90% of the task. You see in observing nature what you expect to see!" Small wonder then that modern science, dedicated to the concept of absolute uniformitarianism, sees little or no evidence of or need for God.

Our correspondence during the year has indicated a considerable amount of confusion as to our viewpoint on such propositions as the "gap theory" and "progressive creation" involving long periods of

time. Accordingly, we have invited one of our distinguished sustaining members, Dr. John C. Whitcomb, to show that there simply is no justification for the "gap theory" from the viewpoint of sound scriptural exegesis.

We have also asked Dr. Arthur F. Williams to write an article in popular style, clearly setting forth the reasons why "Progressive creationism" is not sound Biblical scholarship.

Personally, I am always rather amused at our good friends the theologians who labor so hard to prove that the word "day" really doesn't mean day! I doubt if a single Christian layman in the days when my father was young, or even many now, ever thought that the word "day" could mean anything other than a solar one of about 24 hours. As Shakespeare said, "Verily much learning hath made thee mad!" After reading so much nonsense on this subject, it is refreshing to have such clear-cut discussions from two of our eminent theologians.

Though, of course, we make no attempt to give the *exact* date of creation, since we were not there and the Bible is silent on this matter, it is quite obvious that it does not give any room for concepts involving millions or even hundreds of thousands of years. We are convinced from careful study of all the facts that there is simply no objective validity to the so-called "geologic column." Radioactivity estimates involve so many assumptions they are simply not credible evidence *unless* tied up with the validity of the "geologic column." Samples of various pegmatites, for example, give so many "anomalous" ages along with the "consistent" ones that only by establishing a "norm" of age range based on "other geological considerations" is it possible to "date" stratified rocks.

We plan to continue publishing papers on this fascinating subject showing just how many "anomalous" dates occur. As one of the research men in the Earth Sciences Building of the University of California recently told me, "We often get ridiculous ages of only a few thousand years, and *obviously* something has gone wrong in these experiments."

In addition to the "guidepost" articles so kindly contributed by Whitcomb and Williams, we are also fortunate in having five research articles and two reviews of the literature. The study on Micraster presented by Rita Rhodes Ward was of special interest to me since this classic on evolution was one of two references given as evidence in my recent course in invertebrate paleontology. It is surprising how "hard up" our colleagues really are for support of their theory, when so little change actually occurred in this group of "species" in their assumed 20 million years of time.

The paper by P. W. Davis on "the origin of the Tetrapod limb" is a classic in its revelation of how

impossible it really is to even **imagine** how our arms and legs would ever have evolved from fish fins.

Dr. George Howe's article on creative interchange of basic component organ structures is fascinating in that it gives a far more plausible explanation of the almost infinite number of analogous structures found in plants and animals as well as so-called "convergent" and "parallel" evolution.

The article on remarkable adaptations by Dr. E. V. Shute presents examples of many adaptations so ingeniously devised as to challenge our ability to thoroughly understand the mechanisms involved. The idea that these could ever evolve by natural selection of mutations is so incredible as to hardly merit the consideration of any serious student. Especially fascinating is the story of how young devil fish steal enough stinging cells from the Portuguese man-of-war to cover all eight rows of their own suckers and then proceed to use these stolen weapons for paralysis of the animals needed for food. Modern industrial technology might well profit from a careful functional study of all these mechanisms, and biologists would indeed be wise to quit wasting their time in a vain attempt to explain these from the viewpoint of evolutionary theory. A frank recognition of these as God's remarkable creative design would no doubt be a great stimulus to increasing our own creative ability.

I have been asked to publish my own continued research on the remarkable effects of neutron radiation as a potent tool for effecting mutations in roses in the American Rose Society Annual and several radiation genetics journals. However, in hopes of encouraging other members of our Society to submit *original* reports of their research, I have decided to publish this paper in our own magazine even though it would be read more widely elsewhere. If **enough** of us publish in Creation Research, our agnostic and atheistically minded colleagues will **have** to read our publication in order to keep informed of progress.

We have decided to publish a high school text book and laboratory manual challenging the evolutionary bias of the BSCS series now being adopted by many school boards. This will be no small task, Dr. Thomas G. Barnes has kindly consented to act

as chairman of the committee heading up this activity.

Also, we are vitally interested in building up funds for exploration of the Pre-Cambrian strata of the Grand Canyon in order to get a clearer picture of the range of fossils in the lowermost and presumably "oldest" layer of water deposited rock. A thoroughgoing investigation of the many reports of fossil human footprints in what is called the Cretaceous strata is much needed. The converse of this, a detailed exploration of the so-called overthrust faults presumably accounting for strata containing relatively primitive forms of life now lying on top of strata with more complex form of life, is equally important. Thousands of examples of these exist and need careful study from the viewpoint of Flood geology.

Toward this end funds are herewith earnestly solicited which will be set aside especially for this purpose.

It should be quite clear by now that we haven't the slightest interest in harmonizing our thinking and basic concepts with what for the time being is considered the "consensus" of modern scholarship. As we move deeper into our re-evaluation of science, facts obscured by the prejudice of almost 100 years of evolutionary thinking will be discovered. This clearer understanding of natural phenomena will result in both a better appreciation of the glory of God's handiwork, and also an increased ability to use it wisely.

We solicit your continued and dedicated support for the many tasks ahead. Our Lord and Saviour clearly prophesied that because of our inherent sinfulness we will never be able to build "The Great Society." But we as Christian men of science can at least reorient it so that our journey as pilgrims here on earth, though obscured by the work of Satan, will be guided by the light of God's power and glory as shown in His still marvelous creation.

Sincerely,

Walter E. Lammerts
Chairman

THE RUIN-RECONSTRUCTION THEORY OF GENESIS 1:2

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Students of the Bible have long debated the question of whether the original creation of the heavens and the earth is to be understood as an event within the first “day” of creation, or whether a vast period of time could have elapsed between the original creation of Genesis 1:1 and the “waste and void” condition described in Genesis 1:2. Most theologians who favor a time gap between these two verses believe that the original earth was populated with plants and animals (and perhaps even men), and because of the fall of Satan it was destroyed by God. The vast ages of the geologic time-table are thought to have occurred during this interval, so that the fossil plants and animals which are found in the crust of the earth today are relics of the original world which was destroyed before the six literal days of creation (or, rather, re-creation) recorded in Genesis 1:3-31.

The “ruin-reconstruction theory,” or “gap theory,” has been widely accepted among Christians who interpret the Book of Genesis in the traditional historical-grammatical method, especially since the early 19th century when Thomas Chalmers of England advocated this interpretation as a means of harmonizing the Genesis account of creation with the vast time periods of earth history demanded by uniformitarian geologists.¹ The differences between the “gap theory” and the traditional view of a recent creation of the earth within six literal days are quite profound, and may be outlined as follows: (1) The gap theory permits Christians to accept without question the complete validity of the time-table of uniformitarian geologists. (2) The gap theory leaves us with no clear word from God as to the original world — the time involved in its creation, the arrangement of its features, or its pre-judgment history —; for instead of having the entire first chapter on this important subject, we have only the first verse. (3) Because all the animals of the first world were destroyed and fossilized, they have no relation to the animals of the present world, in spite of the fact that many of them appear to be identical in form to modern types. Likewise, those who would place human fossils into the “gap” are forced to the conclusion that such pre-Adamic “men” did not possess an eternal soul.² (4) The gap theory redefines the “very good” of Genesis 1:31 (“God saw every thing that he had made, and, behold, it was very good”), for Adam would have been placed as a very late arrival into a world that had just been destroyed, so that he was literally walking upon a graveyard of billions of creatures over which he would never

exercise dominion (1 :26). Furthermore, the earth would already have become the domain of a fallen and wicked angel who is described elsewhere in Scripture as “the god of this world” (II Cor. 4:4).

Obviously, then, the gap theory is not a minor deviation from the traditional interpretation of the Genesis creation account. For this reason, the Biblical evidences that have been set forth in its defense need to be carefully examined. The four most frequently used evidences are these: (1) The verb translated “was” in Genesis 1:2 (Heb. *hayetha*) can just as well be translated “became,” and thus the idea of a profound change in the earth’s condition is permitted. (2) The phrase “waste and void” (Heb. *tohu wa-bohu*) appears elsewhere only in Isaiah 34:11 and Jeremiah 4:23, and the context of those passages speaks clearly of judgment and destruction. Furthermore, the word *tohu* by itself frequently has an evil connotation. (3) It is highly improbable that God, the author of light, would have originally created the world in darkness, which is generally used in Scripture as a symbol of evil. (4) There seems to be a definite distinction in the first chapter of Genesis between “created” and “made,” thus permitting us to assume that many of the things mentioned in this chapter were simply re-created.

“WAS” OR “BECAME”?

The first supporting argument for the gap theory is that the Hebrew verb *hayetha* in Genesis 1:2 may be translated “became,” thus implying a tremendous transition from perfection to judgment and destruction. It is true that there are six instances in the Pentateuch where this verb is translated “became” (Gen. 3:22, 19:26, 21:20, Exod. 7:19, 8:17, 9:10). In each of these cases, however, the context clearly shows that a change of state has occurred. The same verb appears 258 other times in the Pentateuch and in each case is to be translated “was.” Because Genesis 1:2 lacks contextual support for translating this verb “became,” no English version of Genesis has ever translated it this way. One graduate student questioned twenty of the leading Hebrew scholars of America concerning the exegetical evidence for a gap in Genesis 1:2. They unanimously replied that there was no such evidence.³ The clearest way to have conveyed the idea of a change of state would be to follow the verb *hayetha* with the preposition “to” (*lamedh*), as was done in Genesis 2:7 (“and man *became* a living soul”) and in twenty-five other verses in the Pentateuch. But this preposition does not appear after the verb in Genesis 1:2.

Furthermore, the sentence structure suggests that.

the earth's condition in verse 2 is just as God created it in verse 1, for we have an exact grammatical parallel in Jonah 3:3 ("Jonah arose, and went into Nineveh . . . Now Nineveh was an exceeding great city"). Obviously, Nineveh did not *become* a great city after Jonah entered it. Dr. F. F. Bruce points out that if verse 2 indicated an event subsequent to the creation of verse 1, we might have expected in verse 2 a "waw consecutive" with the imperfect tense instead of a "waw copulative" with the perfect (i.e., *wattehi ha-arets* instead of *we-ha-arets hayethah*).⁴ In the light of this evidence, it appears that the passage is not speaking of a change in the earth's condition due to a catastrophe, but is simply describing the earth as it came into existence through God's creative word.

"EMPTY" OR "CHAOTIC"?

This brings us to the second important argument in support of the gap theory. If Genesis 1:2 describes the earth's condition at the time of creation, how do we explain the phrase "waste and void" (*tohu wa-bohu*)? Would an infinitely wise and powerful God have created the earth in such a chaotic condition? The only other places in the Bible where the two words *tohu* and *bohu* appear together (Isa. 34:11 and Jer. 4:23) are passages that speak of divine judgment upon Gentile nations and upon Israel. Does not this indicate that these words must refer to judgment and destruction in Genesis 1:2? Even the word *tohu* (translated "without form" in the K.J.V. and "waste" in the A.S.V.), in the twenty verses where it appears without *bohu* in the Old Testament, is sometimes used in an evil sense.

This is admittedly an impressive argument, for one of the most dependable ways to ascertain the meaning of Hebrew words and phrases is to compare their usage in other passages. Thus, if *tohu* always refers to something evil when used elsewhere in the Old Testament, it would probably have this connotation in Genesis 1:2. But a careful examination of the usage of this word does not support such a meaning. For example, in Job 26:7 we read that God "stretcheth out the north over *empty space* (*tohu*), and hangeth the earth upon nothing" (ASV). Certainly we are not to find in this verse any suggestion that outer space is basically evil. In some passages the word refers to the wilderness or desert, which is conspicuous for its absence of life (Deut. 32:10, Job 6:18, 12:24, Psa. 107:40). In most of the places where the word appears in Isaiah, it is paralleled with such words as "nothing" and "nought."

Of particular interest in this connection is Isaiah 45:18; which has been used as an important proof text for the gap theory. The verse tells us of "the God that formed the earth and made it, that established it and created it not a waste (*tohu*), that formed it to be inhabited." It has been claimed that the "tohu" condition of the earth in Gen. 1:2

could not have been its original condition, because Isa. 45:18 says it was *not* created a "tohu." Consequently, God must have originally created an earth replete with living things, and later destroyed it, causing it to *become* "tohu." However, such an interpretation overlooks the true significance of the final phrase in this verse: "formed it to be inhabited." The real point of the passage seems to be that God did not ultimately intend that the world should be devoid of life, but rather that it should be filled with living things. Thus, He did not allow it to *remain* in the empty and formless condition in which He first created it, but in six creative days filled it with living things and fashioned it as a beautiful home for man. The verse thus speaks of God's ultimate purpose in creation, and the contrast in this verse between "tohu" and "inhabited" shows clearly that "tohu" means empty or *uninhabited*, rather than judged, destroyed, or chaotic.

To be sure, the only passages besides Genesis 1:2 where *tohu* and *bohu* appear together — Isaiah 34:11 and Jeremiah 4:23 — are placed in contexts which emphasize divine judgment. But even here the basic meaning of *empty* or *uninhabited* fits well. Since God's ultimate purpose for the earth, and particularly the Holy Land, was that it might be *filled with people* (Isa. 45:18, 49:19-20, Zech. 8:5), it would be a clear evidence of His wrath and displeasure for the promised land to become *empty* and *uninhabited* again. The concept of emptiness, therefore, implies divine judgment only when it speaks of the removal of something that is good. On the other hand, when emptiness follows something that is evil, it can be a comparative blessing! An example of this may be found in Christ's work of casting demons out of people (Luke 8 :35; cf. Matt. 12:44— "*empty, swept, and garnished*").

In spite of the fact that the phrase *tohu wa-bohu* appears elsewhere in judgment contexts and thus takes on an evil connotation in those passages, the same phrase may have a very different connotation when it appears in a different context. Even advocates of the gap theory admit that a context of divine judgment seems to be missing in the opening verses of Genesis.⁵ It is true that the earth was *empty* as far as living things are concerned, and it was devoid of many of the interesting features it later possessed, such as continents, mountains, rivers, and seas; but it was certainly not chaotic, ruined, or judged. Edward J. Young feels that "it would probably be wise to abandon the term 'chaos' as a designation of the conditions set forth in verse two. The threefold statement of circumstances in itself seems to imply order. The material of which this earth consists was at that time covered with water, and darkness was all about. Over the water, however, brooded God's Spirit."⁶

WAS THE DARKNESS EVIL?

The third major argument used in support of

the gap theory concerns the darkness of Genesis 1:2. Since darkness is almost always used as a symbol of sin and judgment in the Scriptures (John 3:19, Jude 13, etc.), and since God did not say that the darkness was “good” (as He did concerning the light — Gen. 1:4), we must assume that God originally created the world in light (Psa. 104:2, I Tim. 6:16) and only later plunged it into darkness because of the sin of angels and Satan.

This, again, is an impressive argument. But all of the Biblical evidences need to be taken into consideration. Psalm 104:19-24, for example, makes it quite clear that *physical* darkness (absence of visible light) is not to be considered as inherently evil or as the effect of divine judgment. Speaking of the wonders of the day-night cycle, the Psalmist states: “The sun knowest his going down. *Thou makest darkness*, and it is night, wherein all the beasts of the forest creep forth. The young lions roar after their prey, and seek their food from God . . . O Jehovah, how manifold are thy works! In wisdom hast thou made them all: the earth is full of thy riches.” If the making of darkness is a revelation of God’s wisdom and riches, how can it be inherently evil?

In discussing the opening verses of Genesis, Dr. Young points out the true significance of the term “darkness.”

“God gives a name to the darkness, just as he does to the light. Both are therefore good and well-pleasing to him; both are created, although the express creation of the darkness, as of other objects in verse two, is not stated, and both serve his purpose of forming the day . . . Darkness is recognized in this chapter as a positive good for man. Whatever the precise connotation of the ‘evening’ of each day, it certainly included darkness, and that darkness was for man’s good. At times, therefore, darkness may typify evil and death; at other times it is to be looked upon as a positive blessing.”⁷

It would seem reasonable to assume that the reason why God did not see that the darkness was good is that darkness is not a specific entity, or a thing, but it is rather an absence of something, namely, light. Perhaps it is for this same reason that God did not see that the “firmament” (expanse) of the second creative day was good. It, too, was a rather negative entity, being the empty space between the upper and lower waters. The fact that physical darkness is not incompatible with the presence and blessing of God is evidenced by the statement that “the Spirit of God moved upon the face of the waters” in the midst of this primeval darkness. In the words of the Psalmist, “Even the darkness hideth not from thee, but the night shineth as the day: the darkness and the light are both alike to thee” (Psa. 139:12).

HOW MANY CREATIVE ACTS IN GENESIS ONE?

The fourth major supporting argument for the gap theory is built upon a supposed distinction between the verbs “created” (*bara*) and “made” (*asah*). For example, the second footnote in the Scofield Reference Bible states: “But three *creative* acts of God are recorded in this chapter: (1) the heavens and the earth, v. 1; (2) animal life, v. 21; and (3) human life, vs. 26, 27. The first creative act refers to the dateless past, and gives scope for all the geologic ages.” Thus, the vegetation of Genesis 1:11 was not *created* on the third day, but was simply “brought forth” from the earth again following the catastrophic judgment of Genesis 1:2. Likewise, the sun, moon, and stars of Genesis 1:16 were not actually *created* on the fourth day, but were simply “made to appear” through the thick, dark clouds that covered the earth following its devastation.

It is true that the verb “made” (*asah*) in Genesis 1:16 (“God made the two great lights”) is not the same as the verb “created” in Genesis 1:1. Nevertheless, it seems rather obvious that these two verbs are used synonymously throughout the chapter, for God “created” (*bara*) the great sea-monsters (vs. 21), and He “made” (*asah*) the beasts of the field (vs. 25). Surely we are not to find any significant difference here. The sea-monsters were created supernaturally by God, and so were the beasts of the earth. Likewise, in 1:26 God said, “Let us *make* man in our image.” But in the next verse we read that God “*created* man in his own image.” Once again the verb seems to be used synonymously. Therefore, 1:16 must refer to the *original* creation of the sun, moon, and stars. If God had intended to convey to us the idea that these heavenly bodies were created on the first day, or earlier, but only “appeared” on the fourth day (presumably by a removal of clouds), The verb “to appear” could easily have been used (see vs. 9). Similarly, when we read that God commanded the earth to “put forth” grass, herbs, and fruit trees, we are to understand this as referring to their supernatural creation; even as God’s command to the waters to “swarm with swarms of living creatures” (vs. 20) is explained in the following verse to mean that “God *created* (*bara*) . . . every living creature that moved, wherewith the waters swarmed.” For the sake of variety and fullness of expression, then, different verbs are used to convey the concept of supernatural creation. The context makes it clear that these verbs are used synonymously throughout the chapter, so that not only animal life and human life, but also plant life and the heavenly bodies were created by God in their appropriate days.

OTHER ARGUMENTS

In addition to the four major arguments for the

gap theory discussed above, one frequently hears the claim that the phrase “replenish the earth” in Genesis 1:28 implies that the earth was once filled but now had to be filled *again* (re-plenished, or re-filled). But the verb in the Hebrew text (*maleh*) simply means “to fill,” with no suggestion of repetition.

It is also frequently claimed that Ezekiel 28:13-14 demands an originally glorious world before the “waste and void” of Genesis 1:2, for it speaks of Satan as dwelling in “Eden, the garden of God . . . the holy mountain of God” and walking “up and down in the midst of the stones of fire” before his rebellion against God. But it seems clear from a comparison with Daniel 2:45 and Isaiah 14:13 that “the holy mountain of God” must refer to the third heaven of God’s immediate presence and not to an earthly domain. It should be noted that Satan was “cast . . . out of the mountain of God . . . to the ground” (Ezek. 28:16-17; cf. Isa. 14:12). Apparently the Lord Jesus Christ spoke of this event when He said: “I beheld Satan *fallen* as lightning from heaven” (Luke 10:18). It should also be noted that “Eden, the garden of God” was not a garden with trees, flowers, and streams. It was composed of precious stones and “stones of fire” (Ezek. 28:13, 14, 16). When we compare this with the description of the Holy City of Revelation 21:10-21, with its various precious stones, we must conclude that Ezekiel’s “garden of God” refers not to an earthly Eden back in Genesis 1:1, but to a heavenly one, from which Satan was cast down to the earth. When God created the “heavens” at the beginning of the first day of creation week, He apparently created all the angelic beings (including the unfallen Satan), who were thus on hand to sing together and shout for joy at the creation of the earth (Job 38:7). Sometime after creation week and before the temptation of Eve, Satan rebelled against his Creator. The visible earthly effect of his fall would thus not have been a catastrophe in Genesis 1:2, but the Edenic Curse of Genesis 3, which God inflicted upon the entire earth because Adam and Eve chose to believe and obey Satan rather than God (Rom. 8:20-23).

SIX DAYS OF CREATION

One clear Biblical proof that creation week was not preceded by a divine judgment is found in Exodus 20:11. In this fourth commandment, God said to Israel: “Six days shalt thou labor, and do all thy work . . . for in six days Jehovah made heaven and earth, the sea, and all that in them is.” The gap theory holds that the heavens, the earth, and the sea were created *before* the six days of Genesis 1. But this passage asserts that *everything* was made by God *in six days*. The fact that the verb “made” (*asah*) is used here does not mean that the earth was “refashioned” in six days, for

we have already seen that this verb is synonymous with *bara* when used in a creation context.

We would agree with advocates of the gap theory that “the earth has undergone a cataclysmic change as a result of a divine judgment. The face of the earth bears everywhere the marks of such a catastrophe.”⁸ But we would identify this catastrophe with the great universal Flood of Noah’s day, which not only occupies three entire chapters of Genesis, but also is referred to by David (Psa. 29:10), Isaiah (Isa. 54:9), Christ (Matt. 25:39), and Peter (I Pet. 3:20, II Pet. 2:5, 3:6). It was through the vast and complex current patterns of this year-long deluge that the living creatures of the entire world were buried forever in the great fossil strata that encircle the globe.⁹ It is *this* catastrophe that provides for us the God-given answer to the false uniformitarianism of these last days (II Pet. 3:4) and thus effectively foreshadows the final universal destruction of all things by fire at the climax of the day of the Lord.

References:

- ¹As early as 1814, Dr. Thomas Chalmers of Edinburgh University was promoting the views of George Cuvier, and became the first great popularizer of the “gap theory.” See *The Works of Thomas Chalmers on Natural Theology*, Glasgow: Wm. Collins & Co., n.d. See also Francis C. Haber, *The Age of the World: Moses to Darwin* (Baltimore: The Johns Hopkins Press, 1959), pp. 201-204.
- ²For a recent defense of the pre-Adamic race view, see Gleason L. Archer, *A Survey of Old Testament Introduction* (Chicago: Moody Press, 1964), pp. 188-189.
- ³Milford Henkel, “Fundamental Christianity and Evolution” (Th.M. thesis for the Winona Lake School of Theology, 1948), cited by Edwin K. Gedney, “Geology and the Bible,” Chapter III in *Modern Science and Christian Faith*, Wheaton, Ill.: Van Kampen Press, 2nd ed. rev., 1950, p. 49.
- ⁴F. F. Bruce, “And the Earth Was Without Form and Void,” *Journal of the Transactions of the Victoria Institute*, Vol. 78 (1946), pp. 21-23.
- ⁵J. H. Kurtz, *Manual of Sacred History*, 1888, p. xxvi. Cited by Curtis C. Mitchell, “A Biblical and Theological Study of the Gap Theory” (B.D. thesis for Talbot Theological Seminary, 1962), p. 45.
- ⁶Edward J. Young, *Studies in Genesis One* (Nutley, N.J.: Presbyterian and Reformed Pub. Co., 1964), p. 13.
- ⁷*Ibid.*, pp. 21, 35.
- ⁸*Scofield Reference Bible* (New York: Oxford University Press, 1917), Footnote No. 3 on Genesis 1:2.
- ⁹For a recent discussion of the implications of the Biblical doctrine of the Flood, see Whitcomb and Morris, *The Genesis Flood* (Nutley, N. J.: Presbyterian & Reformed Pub. Co., 1961). See also John W. Klotz, *Genes, Genesis, and Evolution* (St. Louis: Concordia Pub. House, 1955; Paul A. Zimmerman (ed.), *Darwin, Evolution, and Creation* (St. Louis: Concordia Pub. House, 1959); and Henry M. Morns, *The Twilight of Evolution* (Grand Rapids: Baker Book House, 1963).

THE GENESIS ACCOUNT OF CREATION

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Current theories—far-reaching in their effects—call for fresh consideration of this subject

There are certain areas of Biblical interpretation in which Christians find themselves in serious disagreement. One of these is the Genesis account of creation. Some interpret the record *literally*, believing each of the six days to have been cycles of 24 hours, on the sixth of which God created man in His own image by divine fiat from the dust of the earth. They believe that God breathed into man's nostrils the breath of life and he became a living soul. They, likewise, believe that this occurred at a time not longer than a few thousand years ago. Others interpret the entire record of creation "parabolically," and insist that the six days represent a vast period of time, extending into millions or billions of years. The evidence for these opposing views will be examined together with the theological implications involved.

DOES IT MAKE ANY DIFFERENCE?

Some regard the issue as peripheral and of such trivial importance as to be unworthy of debate. Others regard the day-age theory as merely an attempt to accommodate the Word of God to the prevailing scientific philosophy. They believe that it opens the door to further compromises with the world in its antagonism to the credibility of Scripture. This article presents evidence in support of the literal interpretation of the Genesis account of creation which requires us to believe each of the six days was comparable to our own. The day-age theory, though espoused by some men who are sincere Christians, is fraught with dangerous consequences to the Christian faith. This question is not merely academic, as some assert, but it directly affects Biblical theology.

For instance, if there is textual justification for interpreting each of the six days of Genesis parabolically or figuratively, what defense can be offered for not doing the same with the language descriptive of God's creation of man in Genesis 2:7? Are we to understand that there was a literal garden in which God planted "the tree of life" and the "tree of the knowledge of good and evil," or is this to be understood figuratively? And what about the record of God's creation of woman? Did God literally cause a deep sleep to fall upon Adam, and did He literally take one of his ribs from which He made woman, or is this too, to be regarded as figurative? Are we to understand that a literal serpent was the diabolical instrument in the temptation of Eve, or should this also be interpreted parabolically? And further, what are we to understand from the language concerning the curse which God is said to have pronounced upon

the serpent? Was this literal, and did it affect the posture of the serpent, or are we to take this figuratively, too? Such questions demand an answer. Where does the figurative or parabolic end and sober history begin? Or are we at liberty to treat the entire record as "mythological" as neo-orthodoxy does? In the light of the confusion which presently prevails in Christendom concerning origins, it is not surprising that some young people who were students at a certain Christian college asked their pastor, "Don't you think we could just forget the first eleven chapters of Genesis and still be Christians?" The issue is not so peripheral as some would lead us to believe. The first chapters of Genesis must be regarded as the seed plot of the entire Bible, and if we err here, there is reason to believe that those who come under false interpretations of the Genesis account of creation will sooner or later become involved in error in other areas of divine revelation. It is our conviction that once the interpretation of the six days of creation which makes them extended periods of perhaps millions of years in duration is accepted, the door is opened for the entire evolutionary philosophy. In saying this, we do not mean to imply that all who hold to the day-age theory are evolutionists. We do insist, however, that such a view can only be maintained by an acceptance of the mental construct known as the geologic column, which is based upon the assumption of evolution.

WHY SUCH DIVERGENT CONCLUSIONS?

How is it that men who claim to believe the Bible to be the very Word of God can arrive at such contradictory conclusions? Why is it that some believe in a relatively recent creation fully accomplished in six solar days while others believe the earth with life upon it is billions of years old, and that each of the six days was of undetermined duration? The answer is to be found in the method of Bible interpretation employed. There is no more important discipline for the Bible exegete than a painstaking study of sound principles of Biblical hermeneutics.

BY WHAT METHOD IS SCRIPTURE TO BE INTERPRETED?

One of the first and most important steps in any exegesis of Scripture is to determine the purpose of the writer and the literary nature of the book. Some books of the Bible are historical; some are poetic; others are prophetic in character. Figures of speech abound in poetic literature, but they are recognized as such and the reader is mentally prepared to adjust his thinking to the real concept so beautifully expressed in figurative terms. Our Lord made much use of the parable as a means of conveying truth

more understandingly to the minds of those whose hearts were open to receive divine instruction. When He did use this method of communication, however, He always made it clear that it was parabolic and not to be understood literally.

The exegete must decide if the text of Genesis is poetic, prophetic, or historical. It is my contention as a professional student of hermeneutics that the five books of Moses must be classified as historical. The first three chapters of Genesis are just as truly historical as the remainder of the book. Therefore, we are not prepared to find parables in such a record of sober history.

One of the recognized dangers of Bible interpretation is that of "eisegesis," or reading into the texts of Scripture meanings which they did not originally possess. There are certain important rules of hermeneutics which must be faithfully observed if one is to be preserved from error. Consideration must be given to the cultural context in which the Word of God was communicated. We endeavor to discover what the words which the Holy Spirit prompted the writer to employ meant, both to the writer and also to the people to whom this revelation was to be given. With this rule in mind let us consider the record of creation as given through Moses to the nation Israel.

What did the word *yom* (day) mean to Moses and to Israel in the day in which the books of Moses were written? I am sure that all will agree that neither Moses nor the people of his day had any knowledge of the science of geology or of the theories which have been advanced to account for geological phenomena. Therefore, we are not justified in attributing to Moses a meaning of the word "day" which later use may have given to the word in an entirely different context.

The word "day" in our English Bibles occurs a total of 396 times in the five books of Moses. They are distributed as follows: 72 times in Genesis; 76 in Exodus; 64 in Leviticus; 81 in Numbers, and 103 in Deuteronomy. In every instance, with the exception of Genesis 32:24, the word "day" is a translation of the Hebrew word *yore*. Since this is true, it becomes necessary to find out what the word *yom* meant to Moses and to the people of Israel, to whom this revelation was given. Let us not be guilty of reading into the word a meaning which later use may have given to it in an entirely different context.

In the Genesis account of creation the word "day" occurs 14 times, always a translation of the Hebrew word *yore*. Those who hold to the day-age theory ask us to give to the word "day" a meaning which it has nowhere else in the five books of Moses. Such a meaning (that of an indefinite period of time), we are told, has for its justification the cultural significance of the word *yom* in the thinking of Moses and that of the children of Israel. One might very properly inquire why the cultural meaning of the word *yom* should be so very different in the Genesis ac-

count of creation from that which it obviously had in all of the other writings of Moses.

As if the consistent significance of the word *yom* throughout the writings of Moses were not enough to establish the meaning of the English word "day," God added statements which are difficult to interpret otherwise. ". . . God divided the *light* from the *darkness*. And God called the light *Day*, and the darkness he called *Night*. And the *evening* and the *morning* were the first day." In the light of cultural considerations of hermeneutics, can anyone honestly believe that these terms as used in the Genesis account of creation had a meaning almost infinitely removed from the meaning which they had elsewhere in the writings of Moses? The word "day," would have had no meaning to Moses or to his contemporaries other than that which was limited by reference to the sun. It would be impossible to prove from Scripture that the Israelites in the days of Moses had any concept of a "day" in terms of millions or billions of years. The evidence arising from serious consideration of the cultural meaning of the word *yom* as used by Moses and understood by the Israelites is wholly on the side of a 24-hour day in the Genesis account of creation. Such a view is consistent with its meaning as used by Moses throughout his writings.

In the twentieth chapter of Exodus we read, beginning at verse 8, "Remember the sabbath day to keep it holy. Six days shalt thou labour, and do all thy work: But the seventh day is the sabbath of the Lord thy God: in it thou shalt not do any work . . . For in six days the Lord made heaven and earth, the sea, and all that in them is, and rested the seventh day: wherefore the Lord blessed the sabbath day, and hallowed it." An examination of this passage and also another similar passage in Exodus 31:17 must be considered in any interpretation of the Genesis account of creation. Did Moses enjoin upon Israel the observance of the seventh day, attaching to it the concept of from sunset to sunset, while-at the same time; wishing to convey the idea that the six days in which God created were periods of one million years or more? Did Moses mean that the six days are to correspond with the geological column of the evolutionary paleontologist? Such an interpretation would require a rendering such as the following: "Six days shalt thou labour and do thy work: But the seventh day is the sabbath of the Lord thy God . . . For in six million years the Lord made heaven and earth, the sea, and all that in them is . . ."

THE MEANING OF THE WORD "DAY"

The root meaning of the Hebrew word *yore*, translated "day" throughout the writings of Moses, according to Strong, is " 'to be hot,' a day (as the warm hours) whether literally from sunrise to sunset, or from one sunset to the next." That the word is also used figuratively is readily acknowledged, but when so used Strong says, "It is defined by an associated term." An illustration of this would be "the

day of the Lord.” Those who insist that the six days of Genesis I should be interpreted parabolically claim “proof” for this method of interpretation on the basis of its use in Genesis 2:4, which reads, “These are the generations of the heavens and of the earth when they were created, in *the day* that the Lord God made the earth and the heavens . . .” Since the word “day” is used in Genesis 2:4 with obvious reference to all time involved in creation we are told, “Thus *incontestably* the usage of ‘day’ in Genesis 2:4 is parabolic.”

Now every student of Scripture recognizes the fact that the word “day” is used to designate a period of time of varying lengths. When Zephaniah speaks of “the day of the Lord” (1:7) we have no reason to think of his use of the word “day” as a period limited to 24 hours. Nor when Peter speaks of the same period are we justified in concluding that “the day of the Lord” is to be limited to 24 hours. But we are not justified in assuming that because Peter tells us “one day is with the Lord as a thousand years, and a thousand years as one day” that the word “day” has no time signification. The duration of time indicated by the use of the word “day” must be determined by the context in which it is found.

Now those who hold to the day-age theory of creation insist that the use of the word “day” in Genesis 2:4 proves that the use of the same word in Genesis I must refer to a period of undetermined length. That such “proof” is open to question we shall endeavor to demonstrate. Not all Hebrew scholars agree with this conclusion. Regarding the day-age interpretation, Dr. Bernard Ramm says, “The problem of the meaning of *yom* is not fully decided as to whether it can mean period or not. The word is one which has many uses as we have already indicated. We are not presently persuaded that it can be stretched so as to mean *period* or epoch or *age* as such terms are used in geology. Though not closing the door on the age-day interpretation of the word *yore*, we do not feel that lexicography of the Hebrew language will as yet permit it.”

Leupold, a recognized Hebrew scholar, says:

“In the interest of accuracy it should be noted that within the confines of this one verse, Genesis 1:5, the word “day” is used in two different senses. “Day” (*yore*) over against “night” (*layelah*) must refer to the light part of the day, roughly, a twelve hour period. When the verse concludes with the statement that the first “day” (*yore*) is concluded, the term must mean a twenty-four hour period . . . to make this statement refer to two parts of a long geologic period; the first part of a kind of evening; the second a kind of morning; both together a kind of long period, runs afoul of three things: first, that “evening” nowhere in the Scripture bears this meaning; secondly, neither does “morning”; thirdly, “day” never means “period” . . . There ought to be no need of refuting the idea that *yom* means period. Reputable dictionaries like Buhl, B D B or K W

know nothing of this notion. Hebrew dictionaries are our primary source of reliable information concerning Hebrew words. Commentaries with critical leanings utter statements that are very decided in this instance. Says Skinner: “The interpretation of *yom* as aeon, a favorite resource of harmonists of science and revelation, is opposed to the plain sense of the passage and has no warrant in Hebrew usage.” Dillman remarks: “The reasons advanced by ancient and modern writers for construing these days to be longer periods of time are inadequate.” If it is claimed that some works can with difficulty be compressed within twenty-four hours, like those of the third day or the sixth, that claim may well be described as a purely subjective opinion. He that desires to reason it out as possible can assemble fully as many arguments as he who holds the opposite opinion. Or if it be claimed that “the duration of the seventh day determines the rest” let it be noted that nothing is stated about the duration of the seventh. This happens to be an argument from silence, and therefore it is exceptionally weak. Or again, if it be claimed that “the argument of the fourth (our third) commandment confirms this probability” we find in this commandment even stronger confirmation of our contention. Six twenty-four hour days followed by one such day of rest alone can furnish a proper analogy for our laboring six days and resting on the seventh day; *periods* furnish a poor analogy for *days*. Finally, it is contended that our conception contradicts one school of thought in the field of geology. But this is a school of thought which we are convinced is hopelessly entangled in misconceptions which grow out of attempts to co-ordinate the actual findings of geology with an evolutionistic conception of what geology should be, and so is for the present thrown into a complete misreading of the available evidence, even as history, anthropology, Old Testament studies and many other sciences have been derailed and mired by the same attempt.”

It is interesting to note that even Dr. Edward John Carnell admits that the “Genesis account implies an act of immediate creation, but the same account implies that God made the world in *six literal days*.” But having this admission he then proceeds to state what he cannot prove: “And since orthodoxy has given up the literal-day theory out of respect for geology, it would certainly forfeit no principle if it gave up the immediate-creation theory out of respect for paleontology. The two seem to be quite parallel.” This statement in its entirety is most significant. First, it tells us that Dr. Carnell and others like him who still want to be regarded as orthodox *have given up the literal-day theory out of respect for geology*, not out of respect for the text of God’s Word. Secondly, it tells us what logically follows from an abandonment of sound Biblical exegesis, namely, *the giving up of the immediate-creation theory out of respect for paleontology*. Nor have we any reason to conclude that this is the end of “giving up” out of

respect for the intellectual world of our day. Consistency makes certain demands of us, either for the truth or against it. What Dr. Carnell has failed to prove is that "orthodoxy has given up the literal-day theory." He does not, and cannot speak for "orthodoxy." He is a representative of that school of thought which Dr. Harold John Ockenga of Park Street Congregational Church in Boston designates as "neo-evangelicalism." These men have surrendered the plain teachings of God's Word "out of respect for geology and paleontology." One cannot help wondering what the final outcome of such a surrender may be. There is not a miracle in the entire Bible which can be substantiated by the empirical methods of modern science. Will such men, or their children, find it necessary to surrender the doctrine of the virgin birth and the bodily resurrection of Christ out of respect for biology and physics? That evangelical scholars are increasingly surrendering to the theory of evolution should become evident from a quotation in an article in the *Journal of the American Scientific Affiliation* entitled, "The Evolution of Evangelical Thinking on Evolution," by J. Frank Cassel, a recent president of the ASA (Dec. 1959, p. 27) :

"Thus, in 15 years we have seen develop in the A. S. A. a spectrum of belief in evolution that would have shocked all of us at the inception of this organization. Many still reserve judgment, but few, I believe, are able to meet Dr. Mixer's challenge of, 'Show me a better explanation.' "

When once an attempt is made to harmonize the Word of God with "the consensus of modern scholarship" it is difficult to terminate the compromise of Scripture which such accommodation requires.

It is our conviction that we have a parallel; use of the word "day" in the seventh chapter of Numbers to that in Genesis 1 and 2. In Numbers 7:1, 2 we read, "And it came to pass on the day that Moses had fully set up the tabernacle, and had anointed it, and sanctified it . . . That the princes of Israel . . . offered." In verse 10 we read, "And the princes offered for dedication of the altar *in the day* that it was anointed, even the princes offered their offering before the altar." In the verses which follow we read what Nahshon offered on "the first day" (v. 12) ; what Nethaneel offered "on the second day" (v. 18) ; and what Eliab offered on "the third day" (v. 24) . Each of the twelve princes offered, one on each of twelve days. Then in verse 84 we read, "This was the dedication of the altar, *in the day* when it was anointed, by the princes of Israel." There appears to be no more justification for the idea that the word in Genesis 2:4 is used parabolically than in Numbers 7:84. In both instances we have first a record of details which occurred in "days" of 24 hours' duration, and then we have the same word used *comprehensively* of what has been previously set forth in detail. Such a use of the word "day" is not peculiar to the Hebrews; we use the word similarly today

without confusion. A biographer of Lincoln may state the day of his birth and the day of his marriage, the day of his inauguration and the day of his death, etc., and then when summing up the details of his life may say, "Now in Lincoln's *day* there were no automobiles, radios, or television." No one would think such a biographer was using the word "parabolically." Rather, he would be using it *comprehensively*. And this is exactly what we find in Genesis 2:4. After the writer has informed us as to what transpired on each of six days, he sums up God's creative acts by saying, "These are the generations of the heavens and of the earth when they were created, *in the day* that the Lord God made the earth and the heavens."

To insist that the word "day" is used parabolically in Genesis 1 and 2 is implicit with danger in the exegesis of Scripture. Parabolic interpretation is not justified by the language and it opens the door for parabolic interpretation of other details in the early chapters of Genesis. This would rob Genesis of all historical significance and leave the reader uncertain as to where the parabolic ends and sober history begins. When we read such expressions as "light" and "darkness," "night" and "day," "evening" and "morning" in connection with the six days of Genesis 1, we would very naturally conclude that such days were similar to our own. We have failed to find a single example of the use of the word "day" in the entire Scriptures where it means other than a period of 24 hours when modified by the use of a numerical adjective. Doctors Morris and Whitcomb state, "Therefore, we must approach a study of the work of the six days of creation strictly from the perspective of scriptural revelation, and not at all from that of a projection of present natural processes into the past. It is precisely this sort of illegitimate projection which has led to the theory of evolution and to the various theological devices that have been conceived for harmonizing it with the Biblical revelation. Since God's revealed Word describes this creation as taking place in six 'days' and since there apparently is no contextual basis for understanding these days in any symbolic sense, it is an act of both faith and reason to accept them, literally, as real days."

THE APPEAL TO SCIENCE

Those who argue for the day-age theory of creation appeal to the science of geology for confirmation. We are told that sedimentary rocks have been laid down in certain areas to depths of seven miles or more. Of necessity, this would require millions of years for their formation. I do not profess to be an authority on geology, but I do favor a literal interpretation of the Biblical record over that of current scientific opinion to the contrary. Is there any place on God's footstool where sedimentary rocks can be found for a depth of seven miles? Is it not true that this claim is based upon a method of *correlation which assumes evolution as the starting point?*

We are told that "in 1815 William Smith observed that each layer had a characteristic *assemblage of fossils, and by comparing the fossils in various strata* in England he could establish the relative sequence of these strata. The subsequent refinement of this technique has become one of the most powerful tools for dating which the modern geologist has." There is no doubt but that this last statement is true. Now if this method of dating the rocks is "one of the most powerful tools for dating which the modern geologist has," it will not be necessary to examine his weaker ones. It is strange that anyone who repudiates the theory of evolution should place any confidence in such a method of dating. It is based in its entirety upon the assumption of evolution. Modern geology is based upon the assumption that sedimentary rocks in which the prevailing fossils are primitive must have been deposited earlier than rocks with fossil remains of higher forms of life. Rocks are examined in various parts of the world and classified as to their age, not on the basis of their relation to layers above and beneath, but on the basis of their predominant fossil enclosures. "The refinement" of a method of dating which is basically false does not enhance its validity!

No one should form conclusions as to the age of the earth or life by quoting from the pen of fallible men. It is interesting to note, however, that not all "scholarship" is on the side of the day-age theory or "progressive creation."

Dr. Walter E. Lammerts, for example, received his Ph.D. from the University of California, taught at UCLA and is now Director of Research at the Germain Seed Company, Livermore, Calif. Along with more than 200 other scientists, many listed in American Men of Science, he is a member of the Creation Research Society. Some months ago the editor of "The Progress Summary" became interested in the evasion of some neo-evangelical scholars as to the age of man. He stated that the maximum age of man, Biblically, is not more than 10,000 years and asked Dr. Lammerts for his opinion from the standpoint of his scientific research. His answer, as quoted below, is the most responsible and fascinating statement we have ever read on this subject for it goes far beyond the mere question of the age of man.

"Regarding the question you asked in your second paragraph, I am in complete accord with Dr. Henry Morris, particularly as regards not only the age of man, but the earth, our stellar system, and in fact, the universe. As a matter of fact, were it not for my belief in the truth and literal interpretation of the Genesis account, I would have great difficulty in believing that the earth was even 6,000 years old! However, there seems to be no doubt but that people would live for vastly longer periods of time, i.e., almost a thousand years in the days before the Flood. Accordingly, I am willing to grant this extreme age for the earth and universe. Actually from the strictly scientific point of view, most of the surface features

of the earth give the appearance of being far younger. The reason for this, I presume, is that as the number of years from the time of the Flood increase, the amount of erosion and other geological actions decrease. Accordingly, most of our rivers, mountains, and other features of the earth give the impression of being quite young, geologically speaking."

The prevailing uniformitarian concept in scientific circles is that the processes now operative in the world are the same as have been active from time immemorial. I believe this to be purely an assumption. There is abundant evidence of great cataclysms in past ages, which cannot possibly be accounted for in the theory of uniformity. It is incredible on the theory of uniformity that fossil forms of tropical plant and animal life could have been formed in such a state of preservation and on such a scale as those which have been found in northern Siberia. What convulsions of nature account for such phenomena we may not yet fully know, but that such have occurred cannot be honestly denied. The theory that the earth must be billions of years old is based in part upon the method of determining the age of rocks by the evidence supplied in the decay of Uranium 238 to form lead. Since this rate of decay is so measurably slow, it is assumed that the formation of lead has required billions of years. But is it not pure assumption to insist that this is the only way lead has come into existence? Is it not possible, and even probable, that God created quantities of lead at the same time that He created Uranium 238? It has also been argued that since some distant stars are millions of light years removed from the earth, it has required an almost incredible period of time for their light to become visible. But this, too, is an assumption. God Who created the stars could cause their light to become visible on earth at the instant of their creation. It is my conviction that the creative acts of God were instantaneous, and created organisms were mature. God did not create Adam as an infant, but as a mature man. I am not willing, on the basis of the currently accepted geological column or on the basis of radioactive dating, to accept the conclusions that the earth is billions of years old and that life upon it has existed for a vast period of time.

DO THE ROCKS PROVE "PROGRESSIVE EVOLUTION" ?

The fact remains that sedimentary rocks do not exhibit such an orderly sequence as the evolutionary geologist would have us believe. There are vast areas of the earth's crust in which the fossil record is embarrassing to the evolutionist. Rocks with relatively primitive fossil forms are found on top of rocks with fossil remains of higher forms of life. In the face of such evidence the evolutionist resorts to a marvelous explanation. He tells us that the rocks on top (with fossil forms of primitive life) are really older than those beneath them, and their present location is due to immense lateral thrusts! Great areas of rock of earlier deposition allegedly were upraised and then.

moved laterally over more recent sedimentary deposits. Such areas have been examined which cover thousands of square miles! Now the credulous are asked to believe the above explanation since the **rocks must exhibit** evolutionary development from the simple to the more complex. The entire theory upon which evolutionary geology is built rests upon the assumption that the age of the rocks must be determined on the basis of the state of life development as exhibited by their fossil remains. Thus the geologic column which originated with William Smith and was refined by evolutionary scholars has become "one of the most powerful tools for dating which the modern geologist has."

EVOLUTION THEORISTS AND THE GENESIS FLOOD

All evolutionists insist that the earth and the universe came into being millions, if not billions of years ago. The geological column is predicated upon the theory of uniformitarianism. It makes no provisions for cataclysms, which might produce in a relatively short period of time what the evolutionary geologist can only account for on the basis of millions of years. Evolutionary geologists repudiate the literal interpretation of the Genesis account of creation and rather than accepting the plain statements of Scripture, some writers attempt to disprove the universality of the flood by appealing to evolutionary geology. Everyone who believes that the Bible is the very Word of God must decide for himself whether he will interpret the phenomena of nature by the simple statements of Scripture, or interpret Holy Scripture by the theories of modern scientists.

UNACCEPTABLE ALTERNATIVES

Now if one is to accept this method of dating, there are only two possible conclusions which can be drawn. One must accept the evolutionary concept of creation, either naturalistic or theistic, or what some scholars call "progressive creation." Unlike evolution, progressive creation credits God with creating by divine fiat something new on each of the six "days" --some new forms of life unrelated biologically to preceding forms of life. Now if "progressive creation" is to be accepted it would seem that more than six days would be required. The evolutionary geological column is divided into major eras designated by such terms as Archeozoic, Proterozoic, mesozoic, and cenozoic, each of which is subdivided into vast periods of time. If we were to accept the day-age theory of creation it could seem that the Genesis record has ceased to have any historic sig-

nificance. Genesis covers not more than a few hours of the billions of years which the theory seeks to establish.

THE QUESTION OF AUTHORITY

An interpretation is not necessarily substantiated just because it is approved by a long list of eminent scholars. With all due respect to such scholarship it still is our very basic statement of faith that the Bible is our sole authority in all matters of faith and practice. The careful student will not allow himself to be persuaded by a long list of illustrious names. The Bible repeatedly refers to the record of creation, and invariably speaks of it as the work of God accomplished in "six days." Agnostic scientists work on the *a priori* assumption that all phenomena of nature are to be explained, in terms of present day observable physico-chemical laws. Either consciously or subconsciously, they are prejudiced in favor of this viewpoint.

In contrast we work on the *a priori* assumption that all the phenomena of nature are to be explained in terms of God's creative power and design. The so-called "laws" of nature are God at work providentially maintaining His original creation.

IMPLICATIONS OF THE GENESIS FLOOD

The language of Scripture represents the flood of Noah as both anthropologically and geologically universal. Yet, even within the ranks of professing Christians are many who appear to be more disposed to accept the conclusions of evolutionary scientists than they are to believe the plain statement of God's Word. I believe that many of the geological phenomena observable in the world today have had their origin in the Genesis flood. Some argue, however, that the flood was only local or at best only "anthropologically" universal. It is my contention that if the Genesis flood was only local, several deductions are logically inevitable. First, we must conclude that the language of Scripture is susceptible to meanings which are not obvious to average intelligence. Secondly, God's bow in the cloud has ceased to have the significance which He attached to it when He said, "I do set my bow in the cloud, and it shall be for a token of a covenant between me and the earth." By this covenant God promised never again to destroy the earth with a flood. It cannot be denied that local floods have devastated vast areas of the earth from the days of Noah until today, but there has been no universal flood since Noah's day. Thirdly, the warning which God has given to the world through the Apostle Peter has ceased to have any significant meaning if the flood was local in character. Peter refers to it as of such universal destructiveness as to foreshadow the universal judgment of

God upon an unrepentant world in the day of the Lord's wrath.

THE INTELLECTUAL TREND OF OUR DAY

It is not within our province to judge the motives of men, but it appears to us that in our day there are those who disdain to be called "fundamentalists" and who brand all who are willing to be identified by such a designation as *naive*, *unscientific*, and *reactionary*. There are some who insist that one's views with reference to the "days" of creation should not be made a test of *spirituality*, but they do not seem to object to its being made a test of *mentality*. Regardless of how he may be evaluated by the so-called "intellectual world" of our day, one must rest upon the statement of Holy Scriptures, interpreting them *literally*, unless the context requires otherwise. So-called "conclusions of scholarship" should not be regarded as infallible. The statements of God's Holy Word should be accepted with a reverence not grant-

ed to the writings of any man, however learned he may be. In the future, the discrepancies between "science" and the Bible will be completely resolved. Those who have placed implicit confidence in the theories of scientists will regret that they have tried to make the Bible "acceptable" to unregenerate intellectuals.

BIBLIOGRAPHY

- Cooper, David L., *The God of Israel*.
 Carnell, Edward J., *The Case for Orthodox Theology*.
 (Philadelphia: The Westminster Press, 1959).
 Leupold, H. C., *Exposition of Genesis* (Columbus: The Wartburg Press, 1942).
 Morris, Henry M. and Whitcomb, John C., *The Genesis Flood* (Nutley, N. J.: The Presbyterian & Reformed Pub. Co., 1961).
 Strong, James, *The Exhaustive Concordance of the Bible* (New York: Abingdon-Cokesbury Press, 1890). See page 48, No. 3117, under "Hebrew and Chaldee Dictionary."

"If I profess with the loudest voice and clearest exposition every portion of the truth of God except precisely that little point which the world and the Devil are at the moment attacking, I am not confessing Christ, however boldly I may be professing Christ. Where the battle rages, there the loyalty of the soldier is proved, and to be steady on all the battlefield besides is merely flight and disgrace if he flinches at that point."

-MARTIN LUTHER

HOMOLOGY, ANALOGY, AND CREATIVE COMPONENTS IN PLANTS

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Evolutionary theory assumes that biological likeness necessarily implies kinship. Yet brothers sometimes differ more from each other than from unrelated men. Some particular cases of similarity do indeed indicate relatedness such as the blue-eyed children found in a human family from blue-eye parents. These limited illustrations, however, give us no reason to assume that similarities between the kinds of plants and animals must point toward organic descent. Although likeness *may* derive from kinship, it can likewise stem from the activity of a common originator or creator. Various models of automobiles produced by the same firm resemble each other. Similarity here indicates a common creator rather than a common ancestry. Likewise, parallelism between models of Chrysler, General Motors, and Ford indicates that all three manufacturers respond to customer needs by use of the same designs and materials.

Evolutionary biologists have decided that some similarities are meaningful and indicate close relationship (homology), while others do not (analogy). For example, the underlying bony similarities between man's fingers and a bat's wing bones are thought to demonstrate a very close relationship. But the superficial similarity between an insect wing and a bat wing is assumed to illustrate evolutionary convergence (analogy) between widely different groups. Such an arbitrary choice between the "true" similarities and "apparent" ones is open to question since it rests partially on the subjective bias of the investigator. If evolutionists are so certain that analogy is a "false teacher" when it comes to demonstrating phylogeny, perhaps much of what is called homology is really analogical (consult 1, p. 109). Some of the so-called analogous similarities are just as striking and as close as others that are classed as homologies.

Biblical Creation of distinct and non-related "kinds" is a scientific model in which the artificial distinction between homology and analogy disappears. All homologous and analogous resemblances are accordingly attributable to what could be called "creative interchange of components." In the field of automobile manufacturing such widespread interchangeability is clear evidence for design. Distribution of similar tissues, organs, and organ systems throughout widely diverse plant forms likewise speaks for the creation of distinct kinds. There is no need then to postulate great evolutionary divergences followed by incredible convergence. Only one postulate is essential to the creation system — the originating God. He worked by obvious

outline (homology) but integrated various patterns in the distinct kinds as He chose (analogy). A catalog of analogous similarities in plants will demonstrate the great faith required to attribute all such parallelism to chance evolutionary convergence.

Parallelisms in Bacteria:

Bacteria of the order Myxobacterales have a life cycle that is plainly similar to that of the slime molds (Myxomycophyta — members of an entirely different botanical division). In both groups there is a swarming amoeboid stage followed by formation of a fruiting body which produces spore-like reproductive cells.

Other bacteria (such as Streptomycetaceae and the Actinoplanaceae) have a tubular shape (hypha) that resembles the hyphal strands of true molds. Likewise the reproductive spores and spore cases (sporangia) formed by these bacteria are similar to those of the fungi.

The "trichome" or thread-like colony of the Caryophanales bacteria clearly parallels the pattern of the blue-green algae (e.g. *Oscillatoria* sp.). The Beggiatoales (a sulfur metabolizing bacterial group) closely resemble the blue-green algae in their colony structure also.

Parallelisms in Fungi:

The common bread mold reproduces across a tube that unites two parent strands. This process emulates the conjugation between cells of *Spirogym* (green alga) although exact nuclear details vary.

The large egg enclosed in the oogonium (egg sac) and the male nuclei enclosed in a smaller tubular antheridium (sperm sac) in the Peronosporales order of the Phycomycetes fungi closely approximates the reproduction by oogonium and antheridium in the golden-brown alga *Vaucheria* sp.

Some fungi (mycorrhizae) invade the roots of other plants and thereby enhance their nutrient absorption and growth. At the same time the fungus supposedly receives food and shelter from the root. Many distant groups show such a mutualistic union between fungus and green plant. It occurs in the gametophytes of certain lycopods, the root of the fern *Ophioglossum*, and in the roots of many woody seed plants. In fact, mycorrhizae are coming to be recognized as very important and extensive in the plant world.

Parallelisms in Algae:

It has been assumed that phloem sieve tubes (food conducting elements) are the evolutionary hallmark of the vascular plants. It is interesting to discover that there is a phloem-like tissue in the stipes of brown algae and in certain mosses (2, p.

96). Since most evolutionists regard brown algae, mosses, and vascular plants as distant branches of the evolutionary tree, it must be assumed that phloem tubes arose independently at least three times. To attribute such an amazing amount of parallel structure to evolutionary convergence demands a stretching of the scientific imagination.

Algae of the diatom group and unicellular Radiolarian animal types independently show complex silicon cell wall formation. Certain separate groups of multicellular vascular plants also incorporate silicon into walls of the outer cells — *Equisetum*, ferns, grasses, Cyperaceae, palms, and some dicot flowering plants (3, p. 31) (4). Has the ability to build glass cell walls been the product of chance evolution in more than three different instances?

Parallel Life Cycle Patterns:

Some plants have two distinct generations that alternate with each other. One generation (gametophyte) has haploid cells and bears gametes that unite forming a diploid zygote. The other generation which results from the growth of the zygote (sporophyte) is diploid and eventually produces reproductive spores. It is sometimes argued that an alternation of two equal generations in one life cycle is a "primitive" evolutionary characteristic in plants. It is also argued that the dominance of the spore-bearing generation over the gametophyte is a more "advanced" status. This assumption is made because the sporophyte generally is larger in "higher plants." There is likewise a decreasing size of the gametophyte generations in ascending representatives of the supposed evolutionary series (algae — mosses — ferns — pines — etc.) Within the same group (green algae) however, there is a full spectrum or typical life cycles with no indication of which type is most "primitive." Some have a gamete-forming generation only— *Spirogyra* sp. Other green algae have only one generation but it is the diploid sporophyte — *Cladophora* sp. Still others exist with a complete alternation of independent sporophyte and gametophyte generations — *Cladophora* sp. (8, p. 363). In the brown alga *Fucus* the gametophytic generation is greatly reduced. Haploid spores are retained in the parent sporophyte and directly produce gametes. Such reduction and retention of the gametophyte generation clearly resembles the life cycle of the flowering seed plants. Such a scramble of supposedly primitive and advanced life cycle patterns within the algae themselves is further evidence in support of creation with interchangeable systems.

Evolutionary Problems with Bryophytes:

(mosses, liverworts, hornworts)

It is frequently assumed that the delicate leafy-liverworts arose from a leafless flat thalloid liverwort like *Marchantia*. But it is also assumed that the most advanced sporophyte among bryophytes is the type found in the hornworts. This complex

cylindrical stalk has growing tissue which continually produces new spores from below. In the hornworts the most advanced sporophyte grows out of a typically primitive thalloid gametophyte — this of course presents a great problem to any theory of evolution.

Parallelism in Vascular Plants:

All plants which have water conducting tissues (xylem) and food conducting tissues (phloem) can be classed as "vascular plants." Some authorities however believe that the category is artificial and that there are several distinct groups of vascular plants that have arisen independently from the algae by parallel evolution. Within paragraphs that follow, convergence and parallelisms between the different kinds of vessel-bearing plants will be considered.

Most vascular plants grow in length as the rapidly-dividing regions at the tips of stems and roots form new cells. Some vascular plants can also grow wider as cambial growth layers produce whole new sheets of cells around the entire girth of the stem. Such growth in width is called "secondary growth." The following lists demonstrate the widespread distribution of secondary growth in a few groups that are otherwise quite distinct:

Groups Showing Secondary or Woody Stem Tissues:

1. Anomalous fossil Pentoxylaceae (6, p. 50)
2. Fossil Lycopphyta (Lepidodendrales and Sigillariaceae) (7, pp. 187, 220)
3. Some living Lycopphyta (Isaetaceae—quillworts)
4. Some fossil Sphenophyta (Calamites) (7, p. 248)
5. Some fossil ferns (Zygopteridaceae) (7, p. 275)
6. Some fossil Gymnospermae (Cordaitales, Voltziaceae) (8, p. 151)
7. Living Gymnospermae (Coniferales)
8. Living Angiospermae (Dicotyledonae)

Groups Showing Secondary Bark:

1. Fossil Lycopphyta (Lepidodendrales, Pleuromeiaceae of Isoetales) (7, pp. 213, 222)
2. Fossil Sphenophyta (Sphenophyllales and Calamites) (7, pp. 243, 249)
3. Fossil Gymnospermae (Cordaitales) (8, p. 151)
4. Living Gymnospermae (Coniferales generally)
5. Living Angiospermae (Dicotyledonae generally)

The term "stele" is applied to the total mass of xylem and phloem tissue in a plant stem. The pattern and arrangement of xylem in relation to phloem varies and several stele patterns exist. In a "protostele" a central solid mass of xylem tissue is surrounded in some fashion by the phloem regions (see Diagram 1). If, however, the center of the stem is composed of soft-walled non-xylem cells (pith) with the xylem and phloem arranged around this central region, the stele is classed as a "siphonostele." Various subcategories of siphonosteles exist. If the xylem and phloem tissue are-

arranged in discreet parallel bundles in a peripheral ring (with the phloem cells outside the xylem) or in a cylinder with phloem outside, the stem is called an "ectophloic siphonostele." If the phloem of each vascular bundle lines both the inside and the outside of the xylem regions of the bundle or cylinder, the stele is classed as an "amphiphloic siphonostele." If there is more than one ring of vascular bundles (many sets of bundle rings or cylinders) the stem is a polycyclic siphonostele. Since protosteles are frequently encountered in the simpler fossil vascular plants and since various siphonostelic types are common in gymnosperms and dicot angiosperm flowering plant stems, it is generally postulated that steles with a pith probably evolved from the solid protostelic stem type. This theory leads to the preposterous conclusion that carrot stems (which are siphonostelic) may be more "advanced" than carrot roots (which are protostelic). It also makes the improbable assertion that various siphonosteles evolved from protosteles not once, but several times in different parallel plant lines.

Some plant groups previously judged to be "primitive" in the light of evolution theory show wide and diverse stele arrangements. In the Selaginella family (little club mosses) for example, several stele patterns are known: protosteles, siphonosteles, and polycyclic siphonosteles. The polycyclic siphonosteles of the Selaginellaceae are quite complex. There may be as many as 16 different stele cylinders in one particular cross sectional region of the stem (7, p. 197).

A study of different vascular plant groups shows that the various stele types are present throughout most of the categories with no indication of which arrangement is actually "ancestral." The following documented lists will illustrate the wide distribution of stele types regardless of supposed "phylogenetic" or evolutionary family trees.

Groups with Protostelic Members:

1. Fossil Psilophyta (*Rhynia*) (7, p. 161)
2. Living Psilophyta (*Psilotum*) (7, p. 170)
3. Living Lycopphyta (*Lycopodium phlegmaria* "ground pine" in which the stele resembles that of flowering plant root) (7, p. 187)
4. Fossil tree-like Lycopphyta (Bothrodendraceae—smaller stems protostelic, larger siphonostelic) (7, p. 2218)
5. Fossil Sphenophyta (Calamites — roots protostelic, but stem siphonostelic) (7, p. 249)
6. Living Sphenophyta (*Equisetum*— roots protostelic, stem siphonostelic) (7, p. 256)
7. Fossil Filicinae (ferns) (Protopteridales and Coenopteridales) (7, pp. 272, 275)
8. Living Filicinae (many fern groups—Marattiales, Osmundaceae, Matoniaceae, Dipteridaceae, Cyatheaceae, and *Ophioglossum* roots and lower stem—upper stem siphonostelic) (7, p. 285 ff)

9. Fossil Gymnospermae (Cordaitales—roots protostelic, stem siphonostelic) (8, p. 152)
10. Living Gymnospermae (roots generally, while stems are siphonostelic)
11. Fossil and living Angiospermae (Dicotyledonae) (roots, while stems are generally siphonosteles)

Likewise the wide distribution of siphonosteles in nearly all the vascular plant categories means that there is no basis for the statement that siphonosteles are necessarily more "advanced."

Groups with Siphonostelic Members:

1. Living Psilophyta (*Tmesipteris tannensis*) (7, p. 170)
2. Fossil Lycopphyta (Bothrodendraceae — larger stems siphonostelic, smaller ones protostelic) (7, p. 218)
3. Fossil Sphenophyta (Calamites—stems siphonostelic, roots protostelic—Calamophyton) (7, pp. 241, 248)
4. Living Sphenophyta (*Equisetum* or horsetail)—stems siphonostelic, roots protostelic) (7, pp. 254, 255)
5. Living Filicinae (ferns—stems frequently siphonostelic, roots or lower stems protostelic—*Ophioglossum*, Marattiales, Osmundaceae, Cyatheaceae, Polypodiaceae, etc.) (7, p. 285 ff)
6. Fossil Gymnospermae (Cordaitales, Voltziaceae) (8, p. 152)
7. Living Gymnospermae (stems generally)
8. Living Angiospermae (Dicotyledonae — stems generally)

Groups with Ectophloic Siphonostelic Members:

1. Living Filicinae (such ferns as *Schizaeae molleceana* and *Ophioglossum* sp.) (7, pp. 314, 282-285)
2. Living Gymnospermae (stems generally)
3. Living Angiospermae (Dicotyledonae — stems generally)

Groups with Amphiphloic Siphonostelic Members:

1. Living Filicinae (ferns—species of *Marsilea*, *Matonia*, *Dipteria*, *Cibotium*, *Pteris*, *Lindsaya*, *Polypodium*, *Gleichenia*, *Jamesonia*, and *Loxsonia*) (7, pp. 328-329, 302, 345) (9, p. 312)
2. Living Angiospermae (Dicotyledonae—Curcubitaceae or Cucumber family)

Groups with Polycyclic Siphonostelic Members:

1. Living Lycopphyta (Selaginellaceae) (7, p. 197)
2. Fossil Pteridospermales (seed ferns—Medullosaceae) (6, p. 26)
3. Anomalous fossil group Pentoxylales (8, p. 143)
4. Fossil Filicinae (Cladoxylaceae) (7, p. 273)
5. Living Filicinae (ferns — Matoniaceae and Polypodiaceae) (7)

Within ferns, lycopods, sphenophytes, gymnosperms, and angiosperms are protosteles and all sorts of siphonosteles. How much convergence will be permitted before neo-Darwinianism is considered

inadequate as a working model in origin studies? Far from being guides to evolutionary family trees, the stele types appear to be components which the Creator used in various scattered segments of His creative outline.

Origin of Vascular Elements:

Much evolutionary discussion has centered upon the supposed origin of the various water conducting elements in the xylem. Briefly, there are two distinct water conducting units in the xylem—the tracheid, and the vessel member. Tracheids are cells that elongate and become spindle shaped. During their differentiation, tracheid cell walls are thickened excepting in small patches (pits) which do not become covered with cellulose and lignin (the thickening chemicals). Usually a number of such pits connect one tracheid to each neighboring tracheid. When the cell matures, it usually dies and thus a hollow water-containing element results. Sometimes tracheids have a scalariform (ladder-shaped), spiral, or ringed pattern of wall thickening rather than the pitted pattern. Vessel members, on the other hand, elongate but eventually lose the top and bottom end walls. This means that a vertical column of vessel member cells will eventually lose the end walls that separate them (or else the end walls become extensively perforated) and a hollow-conducting vessel many cells in length results because the protoplasm of each cell dies. Such multi-cellular vessels may have cell walls thickened in a pitted, scalariform, spiral, or ringed pattern. Katherine Esau (3, p. 232) and others express the belief that the tracheid is the most primitive xylem element and that xylem vessels have evolved from tracheids of ancestors. Such a decision, however, is not necessarily confirmed by comparative plant anatomy. Vessels occur independently in five separate plant groups as Katherine Esau points out: (1) gymnosperm Gnetales (*Ephedra*), (2) most dicot angiosperm, (3) monocot angiosperm, (4) in certain ferns (*Pteridium aquilinum*, and roots of *Nephrodium felix-mas*) (7, p. 141) (10) and (5) in the genus *Selaginella* of the Lycopphyta. She interprets these results as follows: "Vessels arose independently, through parallel evolution, in the five groups of plants named above . . ." (3, p. 232). It would tax the idea of natural selection to produce vessels from tracheids in just one evolutionary line during the supposed ages. To suggest that vessels arose five times by chance is not a scientific deduction from data but an evolutionary afterthought. Evidently God used whichever types of steles or xylem were most likely to fill the needs of the particular plant He was creating.

Frost, Bailey, Cheadle, and others have performed extensive statistical examinations of the xylem in various stems (2, p. 106). They believe that the anatomical correlations of wood overwhelmingly support the evolution hypothesis. A compelling alternative view would suggest that the formation

of various xylem and phloem elements is controlled by physiological laws within genetic limits originally established by the Creator.

Parallelism in Guard Cells:

Certain paired cylindrical cells in the epidermis of various plants (guard cells) change shape by swelling and thus create a pore (stomate) between them. Gases can readily diffuse through this open portal. Since guard cell pairs are found in such divergent groups as moss sporophytes, hornwort sporophytes, fossil Psilophytes, *Psilotum*, *Tmesipteris*, *Lycopodium*, *Selaginella*, *Equisetum*, ferns, gymnosperms, and flowering plants, evolutionists must again plead that such mechanisms arose by chance several times.

The upper surface of a *Marchantia* (flat or "thalloid" liverwort) thallus is composed of polygonal air chambers whose walls and ceiling are composed of green cells. In the top of each chamber there is a pore surrounded by several cells in concentric rings. (7, pp. 47-48). The pore bears a striking superficial resemblance to the guard cell complex found in other plants. In some liverwort genera the pore has been found to open and close due to imbibitional changes in walls of nearby cells (7, pp. 47-78). Such parallelism fits the Biblical creation view.

Two different kinds of guard cells have a scattered distribution in vascular plants. In some plants, a single mother cell divides yielding two guard cells. Certain nearby epidermal cells then become the subsidiary cells. (Subsidiary cells are oriented epidermal cells surrounding the guard cell apparatus.) Such a stomatal type is called "haplocheilic." Haplocheilic stomates occur in these groups: Nilssoniales (Cycads), Cycadales, Pteridospermales, Coniferales, *Ginkgo*, *Ephedra*, and some angiosperms. In other plants, however, one mother cell divides twice yielding three cells. The middle cell then divides forming two guard cells and the outer cells then form the subsidiary cells—the whole unit having come from just one mother cell. Such stomates are called "syndetocheilic" and are found in the Bennettitales, Pentoxylales, Cycadeoidales, *Gnetum*, *Welwitschia*, and some angiosperms (8, p. 136). It appears that the stomatal apparatus is likewise a widely distributed creation component. Stomates in *Lycopodium phlegmaria* "have been shown to be identical in structure with those of certain angiosperms." (7, p. 186)

The Problem of Pentoxylales:

If there ever existed a vascular plant group that strained the theory of evolutionary convergence, it is the Pentoxylales. Delevoryas states that their stems are like coniferous gymnosperms, yet they are polystelic like the seed ferns. They have leaves like cycads but their stems resemble those of *Ginkgo*. Their microspore structures are unlike any others (8, p. 145).

Other Anatomical Parallelisms:

Endodermis: Since an endodermis is characteristically present in many of the simpler vascular plants and in angiosperm roots but not in angiosperm stems generally, some investigators have suggested that the presence of an endodermis is a "primitive" condition. However, some Psilophyta such as *Rhynia* (7, p. 161) and *Tmesipteris tannensis* (which evolutionists call "primitive") must then be classed as "advanced" because they too lack an endodermis in their aerial branches. Some herbaceous dicotyledonous angiosperms have an endodermis in the stem (*Trophaeolum majus*- nasturtium) and are thus "primitive" despite their complex and otherwise advanced floral anatomy.

Latex vessels: Another fascinating situation that challenges evolutionary theories is the distribution of latex vessels (lactifers) in various flowering plants. Latex tubes form in two or three distinct and different modes. Sometimes longitudinal chains of cells lose their end walls yielding so-called "lactiferous vessels." In other plant forms single cells grow and develop into much-branched tubes. The single cell thus keeps pace with the growing seedling and the latex tube thus formed is actually a "lactiferous cell." These and other latex vessel types occur scattered in widely different plant families (3, p. 307).

Stem succulence: Some plants manifest greatly thickened stems which contain much water. It would be difficult to suggest the steps by which just one plant family might evolve succulent members. Then when it is seen that several different families such as the Cactaceae, Euphorbiaceae, and the Asclepiadaceae have parallel or convergent types with succulent stems, one is tempted to postulate that there has been definite planning and proportioning. There is just such a direct convergence between the cactus *Astrophytum asterias* and the euphorbiaceous plant *Euphorbia obeasa* (both having a ribbed, balloon-shaped succulent stem). An outside observer would be tempted to entertain the idea that God decided to create such succulent types along entirely different family lines. Accordingly He created various plants according to their kinds and formed succulent members in various segments of the creation outline.

Parallelisms in External Shape or Function:

"Leaves": Some plants that have no leaves as such have either petioles (*Acacia melanoxylon*) or whole side shoots (cladophylls of *Ruscus* spp.) that are flat and act as "leaves." Thus leaflike structures are produced in several distinct anatomical patterns.

"Cones": An apparent parallelism exists between the flower clusters (catkins) of betulaceous trees (birch, alder) and the cones of Redwood trees. They are members of entirely different classes — Angiospermae and Gymnospermae respectively—yet they both bear their seeds in woody "cones." In *Sequoia* the seeds are borne nakedly on scales of a woody

cone (Figure 1) . In *Alnus*, (alder) pistils are borne on a separate female stalk. Because the female flowers lack both sepals and true petals and because the catkins bear the nutlets between persistent woody scales (11, p. 159) the female catkin bears a resemblance to the female cone of *Sequoia* (Figure 1). There are certain differences, of course--the seeds of alder cones are housed in a pistil or ovary whereas those of *Sequoia* rest nakedly on the cone scales. But the apparent similarity that exists is striking and not easily explained by neo-Darwinianism.

"Fruit": The *Ginkgo* tree bears a reproductive organ which outwardly resembles the true drupe fruits of the cherry tree, but which is not really a fruit but simply a seed with one fleshy seed wall. The cherry fruit (Angiospermae) is an entire ripened ovary with the seed deeply encased in an outer fleshy fruit wall and an inner bony "pit." This is another example of two distinct groups with unbelievably similar organs. *Parallelism of Nuclear Disintegration in Female Gamete and/or Spore Formation:*

In mammals three out of four sets of meiotic female chromosomes are shunted into various polar bodies, and only one functional egg is generally formed. In *Ascaris* worm, a similar production of an egg and polar bodies occurs. In flowering plants three out of four sets of meiotic chromosomes disintegrate in the reduction division of the megaspore mother cell, and only one functional megaspore eventually arises. By repeated nuclear division this functional spore gives rise to the egg inside an embryo sac. In the megasporangium (female spore case) of *Selaginella* (Lycopphyta) many megaspore mother cells begin to develop, but all except one of these disintegrates. The one functional megaspore mother cell is nourished in part by the fluid resulting from the degeneration of the others (5, p. 469). In the Coniferales (e.g. pine) one megaspore mother cell forms in the young seed or ovule. This cell undergoes meiosis, yielding four megaspores. Here too, three out of the four chromosomal sets eventually disintegrate. Such amazing parallelism in the development of female gametes, spores, or spore mother cells suggests that there has been the creative repetition of a common feature throughout extremely different forms.

Parallelism Between Beefwood and Horsetail Plants:

A final and arresting morphological similarity concerns the genus of beefwood trees (*Casuarina*). By virtue of its reproductive structures, *Casuarina* is a dicotyledonous flowering plant genus. Female flowers are borne on short dense heads that eventually have the appearance of "cones." Male flowers are borne in slender spikes. *Casuarina stricta* Dry. is therefore a flowering tree of some 10-30 feet in height with drooping branches. Figures 2 and 3 further demonstrate that the branching pattern and the detailed external appearance of the young *Casuarina* stem bears an amazing resemblance to stems

of *Equisetum telmateia* Ehrh. var. *braunii* (Milde) Milde-giant horsetail. The stems of the species *Casuarina equisetifolia* bear an even closer resemblance to *Equisetum* stems in certain aspects (11, p. 141), Figure 4. Figures 5a and 5b show photomicrographs demonstrating that the two stems are not entirely similar internally. They both have sclerenchyma patches at the margin but the placement of vascular tissues and chlorenchyma (darker colored patches of green cells) is somewhat different. They also differ in that *Casuarina* alone is perennial and later forms layers of secondary wood. The main stems of *Equisetum* are hollow, while those of *C. stricta* are solid. The side branches or "verticils" of *E. telmateia* var. *braunii* are solid when very young like the branches of *C. stricta*, however.

Despite the internal differences, one would hardly expect a greater degree of *external* morphological similarity between two plants within the same genus. It is a staggering thought then to realize that these two plants must be placed in different phyla or plant divisions on the basis of reproduction—*Equisetum* sp. in the Sphenophyta (no seeds, only one kind of spore), *Casuarina* sp. in the dicotyledonous Angiospermae of the Pterophyta. Regarding *Casuarina*, Eames says that it *must* be classified as a dicot despite its affinities to *Ephedra* and the stems of *Equisetum* (12, pp. 610-611). Such similtude in appearance and structure of two obviously diverse plants fits very nicely with the idea of creative use of various patterns in different basic plant forms.

There are many unbelievable parallelisms in the botanical world. A study of the work of Berg (13) and Short (14) will reveal numerous other examples of "convergence" in the animal world. It is presently postulated that the principle of creative interchange of components is a more adequate model in the explanation of these numerous parallelisms than is convergent evolution by neo-Darwinian mechanisms of chance mutation and natural selection.

References:

1. Zimmerman, Paul A. (Editor) chapter by Klotz, John W. 1959. Darwin, Evolution and Creation. Concordia Publishing House, Saint Louis, Missouri.
2. Steere, William C. (Editor) chapter by Cheadle, Vernon I. 1958. Fifty Years of Botany. (Golden Jubilee volume of the Botanical Society of America). McGraw-Hill Book Company, Inc., New York.
3. Esau, Katherine. 1953. Plant Anatomy. John Wiley & Sons, Inc., New York.
4. Preston, R. D. (Editor) chapter by Metcalfe, C. R. 1963. Advances in Botanical Research. Vol. I. Academic Press, London and New York.
5. Robbins, Wilfred W., T. Elliot Weier, and C. Ralph Stocking. 1957. Botany. Second Edition. John Wiley & Sons, Inc., New York.
6. Preston, R. D. (Editor) chapter by Wesley, Alan. 1963. Advances in Botanical Research. Volume I. Academic Press, London and New York.
7. Smith, Gilbert M. 1955. Cryptogamic Botany, Volume II. McGraw-Hill Book Company, Inc., New York.
8. Delevoryas, Theodore. 1962. Morphology and Evolution of Fossil Plants. Holt, Rinehart and Winston, New York.
9. Seward, A. C. 1963 (Reprint date) Fossil Plants. Volume II. Hafner Publishing Company, New York and London.
10. MacLeod, Anna M. and L. S. Cogley (Editors) chapter by Wardlaw, C. W. 1961. Contemporary Botanical Thought. Quadrangle Books, Chicago.
11. McMinn, Howard E. and Evelyn Maine. 1935. An Illustrated Manual of Pacific Coast Trees. University of California Press, Berkeley, California.
12. Steere, William C. (Editor) chapter by Eames, Arthur J. 1958. Fifty Years of Botany. (Golden Jubilee Volume of The Botanical Society of America). McGraw-Hill Book Company, Inc., New York.
13. Berg, Leo S. 1926. Nomogenesis or Evolution Determined by Law. Constable & Company Ltd., London.
14. Short, A. Rendle. 1943. Modern Discovery and The Bible. The Inter-Varsity Fellowship of Evangelical Unions, London.

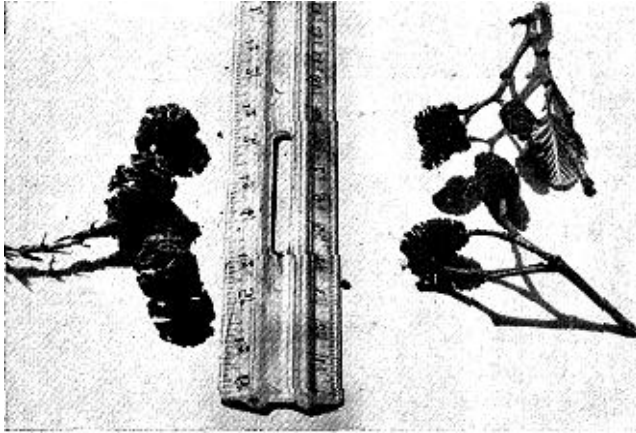


Figure 1. Right, *Alnus rhombifolia* Nutt, female catkin. Left, *Sequoia sempervirens* Endl. female cone. Note similarities.

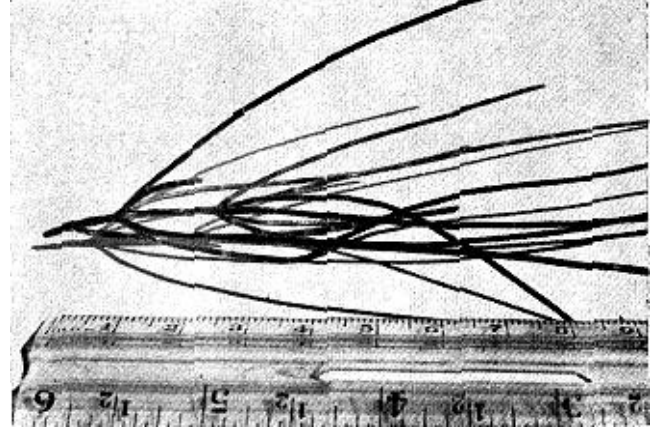


Figure 2. *Casuarina stricta* Dry. young stem. Compare with Figure 3.

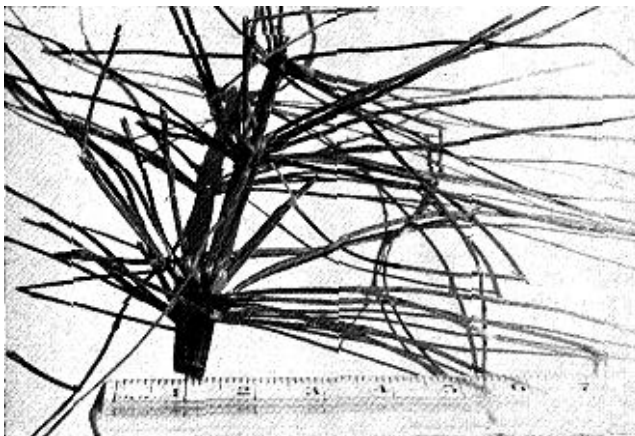


Figure 3. *Equisetum telmateia* Ehrh. var *braunii* (Milde). Milde. young shoot. Compare with Figure 2.

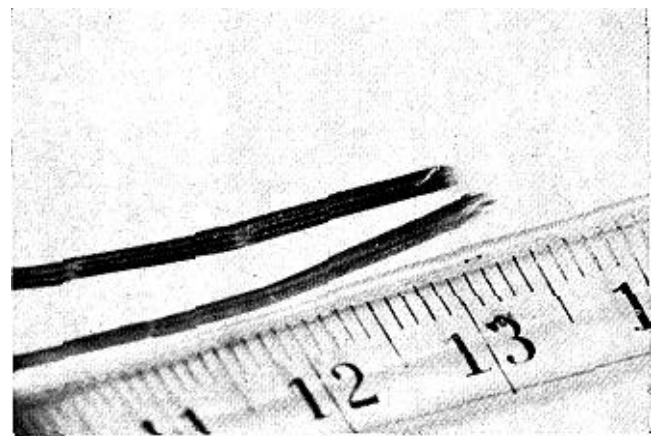


Figure 4. Bottom, *Equisetum telmateia* Ehrh. var *braunii* (milde) Milde. Closeup of young side shoot (verticil). Top, *Casuarina stricta* Dry. closeup of young stem. Note striking similarities.

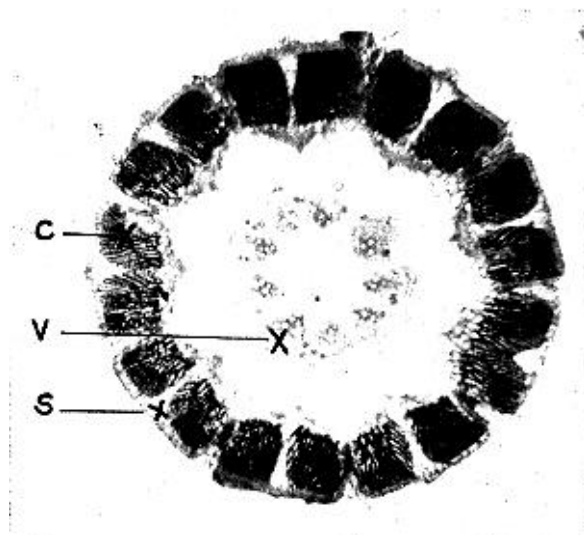


Figure 5a. Photomicrograph (about 80X) fresh cross section of *Casuarina stricta* Dry, young stem. C — chlorenchyma patch, "S"—sclerenchyma (thick walled) patch, "V"—vascular bundle.

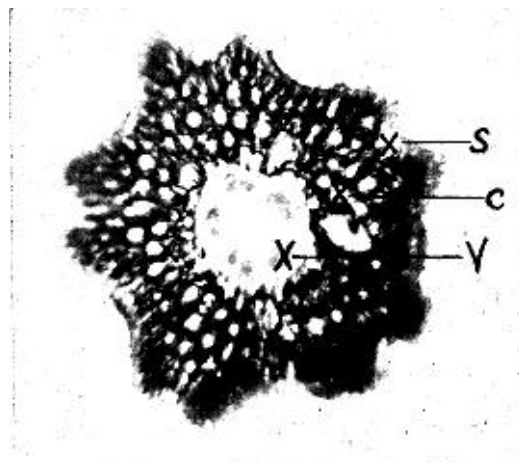


Figure 5b. Photomicrograph (about 80X) fresh cross section of *Equisetum telmateia* Ehrh. var *braunii* (milde) Milde young verticil. Note continuous chlorenchyma region "C," other symbols as in Figure 5.

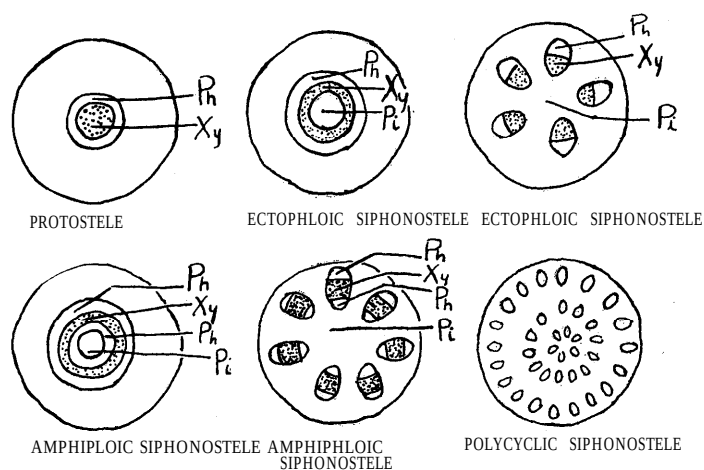


DIAGRAM 1 CROSS SECTIONS OF REPRESENTATIVE STELE TYPES
(Ph--Phloem, Xy--xylem, Pi--Pith)

REMARKABLE ADAPTATIONS

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Plants and animals display a superb series of tight adaptations, so remarkably integrated that a multitude of creatures can fill every environmental and ecological niche in sea, on land or in the air and endure, more or less happily, generation after generation. The evolutionist says this process is the result of mutation and natural selection. The creationist does not discount these natural though negative forces but believes that the directing hand of God plays more than a permissive role in the glorious pageant of fitness to live. If He made living forms at all, presumably He would make them "good."

Are there any examples of adaptation so remarkable that they should snap the elastic credulity of those who believe that natural laws free of any interjection of a purposeful Providence are responsible for all life as we know it? Let me try to provide some samples of this sort for everyone's consideration. All are taken from recent scientific journals and therefore some may not yet have come to the attention of other readers. My preoccupation with this theme has found previous expression in a chapter in my book on evolution.

Respiration

Burton² remarks that some freshwater turtles can submerge for as long as 15 hours because they have accessory breathing organs — in some a vascular lining of the throat, in others an adaptation of the rear end of the gut, these acting as "gills"!

Diving animals are highly adapted³. As soon as the nose of a seal submerges its heart beat falls to a tenth of the normal rate. Bradycardia develops in every diving creature, and in fishes removed from water! But the central blood pressure of the seal remains the same, as the pressure in the peripheral flipper drops to near zero. Muscle circulation is shut off as long as the seal is submerged, even in the mesenteric and renal arteries. Similarly the metabolism of the body is damped down. The heart of the mudskipper in the mudhole in Northern Australia is also very slow. Hibernating animals also show the same kind of metabolic deterioration and peripheral vasoconstriction with bradycardia.

Senses

The Australia Mallee fowl keeps its eggs at constant temperature by burying them under soil and debris. Its thermometer is its sensitive tongue. When it pecks the sand it can decide by this means whether to add or remove soil from its nest⁴.

Pacific salmon return to their own stream, even the same tributary, to spawn. How do they orient themselves at sea and recognize it without landmarks? It is due to odour imprinting. An eel can

detect as little as 2 or 3 molecules of a soluble chemical such as beta-phenylethyl alcohol! A minnow can differentiate between the smell of water from Georges Bank and samples from the Sargasso Sea! Holzman⁵ points out that many fish have electro-receptors to detect obstacles. Each of these species emits waves of a characteristic frequency of 50 to 1600 cycles per second. Such a fish can thus detect the movement of a rubbed comb in front of an aquarium or respond to a magnet there—a sensitivity which will pick up even a change in field in the water of .0003 microvolt per millimetre, a fantastically small change. The rattlesnake has temperature receptors sensitive to a change of 10 to 11 calories (small) in 0.1 seconds, equalling a change in tissue temperature of 0.001 degrees Centigrade. Insects have amazingly accurate smell — and mechano-receptors. Thus the praying mantis integrates all its information about a fly and captures it within 50 milliseconds.

Thorpe and Griffin⁷ found that owls were not only silent but ultrasonically quiet — unless they were very large. However, the Asiatic fishing owl which feeds on fish and crustaceans does not need such silence and is not so adapted. The wings of silent owls have a downy upper surface and fringes of feathers on the lead and trailing edges to act as silencers.

Plants

The red flowers of the lousewort *Pedicularis densiflora*, have purple shades in coastal California where they are pollinated by Anna hummingbirds with gorgets of the same shade. But in the Sierra Nevada, where pollination depends on rufous hummingbirds with orange-red gorgets, the flower is orange-red⁸. The flowers of some tropical trees visited by bats smell like bats. Male hymenopteran visiting the orchid *Ophrys* in the Mediterranean region find the flower is insect-like and are aroused to copulatory activity by the stimulus of its hairs, this activity leading to transfer of pollen. Tropical epiphytic orchids have the most intricate pollination systems, operable only by particular insects. Unfortunately for evolutionists, there is no high degree of correlation of floral "evolution" with the differentiation in these insect visitors. The orchid, *Coryanthes speciosa*, attracts male bees by its fragrance. As the bee lands on its meso-chile it fans its wings vigorously, eventually striking a drop of fluid hanging over its head (which had been secreted by glands at the base of the column). The drop dislodges the bee into the liquid-filled bucket formed by the epichile. The bee struggles but can escape only by pushing up past an anther with two pollinia attached to it. The flower has now lost its fragrance and the bee flies off — till next day the flower becomes fragrant again and bees return to it

to cross-fertilize it. Yet this same bee species is involved in the cross-pollination of an entirely different orchid, *Gongora maculata*, with a very different mechanism—no change appears in the bee designed to fit the two different mechanisms! How could such correlated change have developed gradually? The females of these bees have other tastes, and waste no time on flowers because they lack chemoreceptive hairs on their tarsi.

The fossil record of the bats does not go back beyond the Paleocene, and the flower- and fruit-visiting bats seem to have appeared too late to enter the New World tropics. Here, when the new flowers appeared, nectar-lapping bats were called for immediately from quite a different stock, the insectivorous micro-chiroptera. The tree, *Parkia*, is pantropical and is pollinated by bats everywhere, with the same specialized adaptations everywhere—a real evolutionary problem since the plants were ready for the bats before the bats appeared! A similar problem is presented by the flowering Kapok tree, *Ceiba pentandra*, pollinated by bats in Africa and South America⁹! The evolutionist here has to fall back on “lucky pre-adaptations” by either the flowers or the pollinating agents!

How does sap rise in tall trees⁹, where perhaps at the tip the sap pressure can run at —20 atmospheres? It seems incredible that water can flow upward in this way. It is done by combining capillarity with check-valved compartmentalization. The latter prevents a cut twig from letting air penetrate beyond the wounded area. What happens to northern trees in winter? Are they frozen or supercooled? It appears that nearly all free water in the xylem does freeze at about —6 to —10 C. There is a real puzzle here.

Ocean Fish

Some fish have been caught at 15,000 foot depths where the gas in their swim bladders must have exerted a pressure of more than 7,000 pounds per square inch to withstand sea pressure¹⁰. This gas is largely oxygen, unlike that found in the shallow swimmers. In some mid-ocean fishes fat replaces gas in and about the swim-bladder, and thus constant volume is maintained under varying pressures by a material close to the density of water. Other fishes meet the pressure situation in the deep-sea by having lighter body parts. The cuttlefish has a large bone that serves for buoyancy. It is built up of thin lamellae and pillars forming chambers. This constitutes about 9.3 per cent of the total volume of the fish and its density is only 0.6 that of water. The bone chambers hold varying amounts of gas and water. The fish uses this bone as a submarine uses buoyancy tanks, filling up with water or blowing water out with gas. A yellowish membrane over the rear of the cuttlebone by a complex arrangement sucks fluid from the bone into the bloodstream and so changes its osmotic pressure at various depths in the sea. The bone can withstand severe compression by the sea

by altering the salinity of its fluid. The squid maintains its buoyancy by holding in its coelomic cavity a great deal of low density fluid containing an astonishing concentration of ammonia (9 gms. per litre). Unlike mammals the squid excretes its nitrogen as ammonia rather than urea, and this is diffused into and trapped in the coelomic cavity. The squid can be almost independent of external water pressure and can dive more deeply than the cuttlefish, but its fluid sac is very bulky (200 per cent of the rest of the cranchid squid). It is really a kind of bathyscaph.

The rhizopod protozoan *Arcella* (about 1 mm. in diameter) which is found in shallow fresh water produces gas bubbles of oxygen (?) in its cytoplasm to control its buoyancy. A coastal foraminiferan, *Tretomphalus bulloides*, (size 0.02 mm) lives on the bottom until ready to release its flagellated gametes.. Then it produces a large terminal gas chamber by means of which it floats on the top of the sea. A special gas gland secretes oxygen in the swim-bladders of deep sea fish, involving a *rete mirabile* with the longest capillaries known in Nature, perhaps. 50 times longer than the long capillaries of muscles! Some fish have a valved duct leading to the osophagus through which gas enters the swim bladder. Others have a structure called the oval, which is surrounded by a ring of muscle and this controls the filling of the swim bladder with gas.

Food

The jaws of the ant lion have deep grooves which act as syringes to inject digestive juice into its prey. As soon as its victim's body inside its chitinous covering is dissolved the juices are sucked up by the ant lion. The latter never needs to expel faecal material during its one to two years of life because no undigested material enters its bowel—which has no posterior outlet!

The bees' dance¹¹ is now regarded as a classic of adaptation. The honeybee talks to its mates in the hive with a round dance for near sources of nectar, but with a tail-wagging dance for sources 275 feet or more distant. It tells them the direction and distance more accurately than could any communication system but human speech. When the other bees seek the original source they go to it directly, ignoring other directions or nearby decoys. By means of a built-in chronometer they allow something for the movement of the sun through the sky in the interim. The language is genuinely innate and not learned, as von Frisch has proven. However, the Italian honeybee talks a little differently from the Austrian honeybee and confuses the latter with its instructions. Yet they are of the same species and interbreed. Their offspring are even more confused! The Indian honeybee talks the language of the European bees. The dwarf bee can dance only on a horizontal platform, however, and cannot transpose from sight to gravity. The dung beetle and many others can transpose from

sight to gravity, although only the bees use this ability to speak to their fellows.

Symbiosis

The symbiosis of fungi and insects is often remarkable, as von Frisch points out¹². The biscuit weevil, *Sitodrepa*, excretes its symbiotic yeast cells while laying, thus infecting its eggs as they exit from the rectum. The emerging larvae bite their shells and thus ingest some of this yeast. One kind of leaf bug, *Coptosoma*, has bacterial symbionts which live in a mycetome communicating with the gut. When this insect lays its eggs batches of encapsulated bacteria are also expelled one at a time in between the eggs. As soon as the embryo opens its egg it pierces a capsule with its proboscis and sucks in the bacteria it needs! If it does not get them it usually dies before undergoing metamorphosis because of a lack of vitamin B₁. Similarly other insects lacking vitamins live in symbiosis to get them. Or insects may lack nitrogen for the synthesis of what proteins they need, and require nitrogen-fixing micro-organisms for this, just as the roots of legumes do. Many insects contain three or more different symbionts in their mycetomes. Each passes out on the egg and is then allotted its special area in the mycetome of the young insect.

A typical frog egg¹³ lies encased in gelatin that prevents jostling or overcrowding and is both unpalatable and slippery to predators. It acts like a tiny greenhouse to concentrate the sun's rays. Chinks between the spheres of jelly are taken up by unicellular plants and rotifers which are oxygen-liberating and so help the tadpoles to emerge in 4 to 15 days.

Small fish cleaning the mouths of big or predator fish present a rare problem¹⁴. In the Bahamas the Pederson shrimp (*Periclimenes pedersoni*) waits till passing fish call on it, stop nearby, and present any injured or troublesome part to the shrimp. The shrimp crawls aboard, inspects the client, even makes minor incisions which the client tolerates as it remains motionless. The fish even opens its gill covers seriatim to let the shrimp in to inspect them. Similarly it inspects the mouth (Figure 1). As was said, fish will line up for such inspection, even waiting for it when the shrimp has retired from work! The known cleaners include 26 species of fish, 6 shrimp and Beebe's crab. The little senorita (*Oxyjulis californica*) cleans black sea bass, ocean sunfish, even the bat ray — both bony and cartilaginous fishes! Even distantly related species of cleaners may have analogous specialized cleaning structures — convergent evolution? Senoritas seem never to be eaten, although they enter the mouths of the kelp bass which eats similar-sized fish. Some fish mimic them in colour and conformation, even doing so to become predators! Shrimps clean the mouth of the moray eel — but do get eaten occasionally. All this suggests that nature exhibits much cooperation, rather than merely a bloody tooth-and-claw struggle for existence!

Immature pelagic octopods or devilfish (*Tremoctopus violaceus*) have suckers adapted to holding fragments of tentacles of the coelenterate *Physalia*, the Portuguese man-of-war, using their nematocysts¹⁵ or stinging cells having a trigger-like mechanism discharging barbs and a fluid which paralyzes action of animals penetrated by the barb! These can render fish defenseless with the sting. It is not known if the adult octopod retains this habit. This is a unique use of only parts of a coelenterate as weapons, and may imply the octopod's ability to know when these weapons need to be replaced! Just how the devilfish is able to activate or fire the stinging cells of such an unrelated creature as the Portuguese man-of-war is not too clear, especially since only a part of its tentacle is involved. And how by natural selection was this trick incorporated into the DNA system of the devilfish? The pickpocket type of dexterity required to steal enough tentacle fragments to cover eight rows of suckers would make even a "big-time" operator envious.

Reproduction

Nestless birds such as the murres lay pear-shaped eggs which cannot roll off the ledges and cliffs where they are laid. Other birds, like some of the sandpipers and killdeer, lay eggs on the ground which hatch into youngsters which can run to safety as soon as they hatch and dry.

The female Indochina swift¹⁶ at nesting time has glands under her tongue which begin to swell. She flies to a cave, presses her beak against the rock wall, thus expresses a crystal-clear fluid which she weaves back and forth on the rock wall. When it hardens it provides a glass-like nest for her eggs — and the source of bird's nest soup!

A malarial mosquito in Panama can lay its eggs through the tiniest holes in bamboo internodes by hovering outside the holes and shooting its eggs in with great force and accuracy¹⁷. A species in Ceylon that faces the same problem meets it by laying its eggs on one of its legs, then inserting the tiny leg into the tiny hole. The larvae of these mosquitoes must escape through these tiny holes, of course. It turns out that they are very persistent and can wriggle through almost any tiny aperture, unlike the larvae of other mosquitoes, being able even to penetrate absorbent cotton.

Locomotion

For the first few days after hatching the moorhen chick¹⁸ cannot stand on its legs but gets about by using its legs and a long claw on each thumb — here is a feature shared with the hoatzin chick. It is a remarkable adaptation for a peculiar defect of locomotion and one shared with one very dissimilar bird, which uses such a claw for climbing trees!

Attack and Defense

The giant electric ray¹⁹ (*Torpedo nobiliana*) puts out pulses of 50 amperes at 50 to 60 volts, able to electrocute a large fish. The African catfish (Malap-

terurus) puts out up to 350 volts. The electric eel (*Electrophorus*) puts out more than 500 volts. The evolutionist is puzzled by such a "convergence" in unrelated families, among the "ancient" cartilaginous fish as well as more recent bony fish. Moreover the electric organs are very differently arranged in the various fish possessing them. They may be longitudinal and constitute 40 per cent of the fish's bulk — or be vertical columns mainly in the wings (as in the ray), or be a mantle under the skin of the whole body. Curiously, to the evolutionist, studies on the giant ray, the skate, a southern Atlantic ray and the bony fish *Astroscoptes* found that the electroplaques in all are electrically unexcitable! Moreover, even the weakly electric fishes use their powers for guidance. Indeed the African *Gymnarchus* can detect a potential gradient of about .03 microvolt per mm. It was once thought that stalked electroplaques were to be found only in the African freshwater families, but lately they were found in one of the American knife fishes! The firing mechanism in the brain differs in all types of fishes. In the rays and *Astroscoptes* the skin near the trigger area has much lower electrical resistance than the rest of the skin. In the eel, where the organ can be a metre long, the synapse resistance is so arranged in a gradient that all the electroplaques are fired at the same time. The knife fishes discharge repetitively and have a pace-maker which excites the spinal motoneurons at a rate as high as 1500 pulses per second. Even warm-blooded animals show no such rate of continuous nerve activity. The electric skates remain a puzzle to evolutionists for their electric organs are in their long tails, are weak, and seem to have no obvious adaptive value. Elsewhere the picture is one of strange "convergence."

The mormyrid African fish *Gymnarchus niloticus*²⁰ has a weak electric organ in its tail which emits a continuous stream of discharges. Two other fish do this, too — another mormyrid and a small South American fresh water relative of the electric eel — far removed from the mormyrids. It uses these impulses to dodge objects in the water as small as 2mm. in diameter, even when swimming backward! Skates, which are cartilaginous and not teleosts like the mormyrids and gymnotids, also have a weak electric organ in the tail. All swim rigidly in order not to upset their electrical field unduly. The skin of the mormyrid is made up of many layers of remarkably hexagonal platelike cells. Pores in the skin contain tubes leading to the electric sense organs. These tubes contain a jelly-like substance and widen at their central end into a capsule containing a group of specialized cells. In half these fishes the electric organ emits constant frequency pulses. In the other half of these species the rate varies with the fish's state of excitation. It is interesting to find both types of sensory systems in the two different families, one in South America and one in Africa!

The polydesmid millipede²¹ (*Apheloria corrugata*, Wood) has paired glands in most body seg-

ments. Each of these has two compartments. In one is an undissociated cyanogenic compound and in the other a chemical factor able to trigger hydrogen cyanide production when needed — not before. At the instant of discharge, for example against ants, the two compartments' contents mix and cyanide is generated. Among millipedes this two-compartmented gland may be exclusive to the order Polydesmida. Other millipedes may use quinones and phenols similarly. These do not require chemical activation when discharged.

The Mexican bean beetle (*Apilachna verivestis* Mulsant) displays reflex bleeding when molested or handled²², always bleeding from the tibio-femoral leg joints, considerable loss of blood being tolerated. This blood drop is larger than the volume of the whole leg! The larvae of this species are densely spined on the top and sides; the spines being hollow and brittle, and bleed when broken. They too can tolerate much blood loss in this way. If ants get entangled in this blood they are immobilized for a few minutes. The adaptation is an eminently useful defense against ants.

Burton²³ calls attention to the purple emperor butterfly of England which at every stage of its life closely resembles something else, either a gall, a slug, a young or an old leaf. He adds that this suggests intelligent design and makes the biologist think of many adaptations towards survival. But Burton adds that this species and many another showing such remarkable adaptations are often not successful in the world!

General Comment

It is possible to contend that all special adaptations have arisen in response to need and have developed gradually by natural selection. But there are certain adaptations which are so intricate and complex that it is impossible to imagine a single mutation having achieved so much, and no half-way measure would have helped toward the end desired. We have given many examples of these. Then there are the even more wonderful synchronized and complex adaptations of flower and insect, or of two different families or orders, of which examples have also been given. The world of the parasite is one long instance of this. How could adaptations of such complex inter-action be achieved in one single step or in a series of steps? The snapdragon does not explain this, although we know that in the snapdragon genus, *Antirrhinum*, the usually two-lipped flower can become radially symmetrical by the mutation of a single gene. Whether the reverse occurs is unknowns.

Creation is a much more plausible explanation — the only one, indeed. These are all instances of lock and key or hand and glove adaptations. It is not enough to use any key, but only the right one. Then imagine the simultaneous development of a hand inside a glove inside a suit inside a submarine — which is approximately analogous to what we have in many of the more complex adaptations in Nature!

Why the *remarkable perfection* of the dolphin's or bat's sonar or the rattlesnake's perception of heat the moth's perception of odour? Less would have done quite well.

Bibliography

- ¹ Shute, E. V. — Flaws in the Theory of Evolution. Temside Press, London, Canada, 1962.
- ² Burton, M. — Illustrated London News, March 19, 1960, p. 576.
- ³ Scholander, P. F. — Scientific American, December 1963, p. 92.
- ⁴ Illustrated London News, January 31, 1959, p. 170.
- ⁵ Hasler, A. D. — Science 132:785, 1960.
- ⁶ Holzman, B. G. — Ibid 132:793, 1960.
- ⁷ Thorpe, W. W. and Griffin, D. R. — Scientific American, April 1962, p. 78.
- ⁸ Baker, H. G. — Science 139:877, 1963.
- ⁹ Scholander, P. F., Hemmingsen, E. and Garey, W. — Ibid 134 : 329, 1961.
- ¹⁰ Denton, E. J. — Endeavour 22:3, 1963.
- ¹¹ von Frische, K. — Scientific American, November 1963, p. 110.
- ¹² Idem -- Triangle 4:206, 1960.
- ¹³ M. D. of Canada, May 1960, p. 101.
- ¹⁴ Lembaugh, C. — Scientific American, August 1961, p. 42.
- ¹⁵ Jones, E. C. — Science 139:764, 1963.
- ¹⁶ George, J. — Audubon Magazine, March, April 1961.
- ¹⁷ Burton, M. — Illustrated London News, May 16, 1964, p. 786.
- ¹⁸ Idem — Ibid, September 17, 1960, p. 484.
- ¹⁹ Grundfest, H. — Scientific American, October 1960, p. 115.
- ²⁰ Lissman, H. W. — Ibid, March 1963, p. 50.
- ²¹ Eisner, T., Eisner, H. E., Hurst, J. J., Kafatos, F. G. and Meinwald, J. — Science 139:1218, 1963.
- ²² Happ, G. M. and Eisner, T. — Ibid 134:329, 1961.
- ²³ Burton, M. — Illustrated London News, December 1, 1962, p. 892.

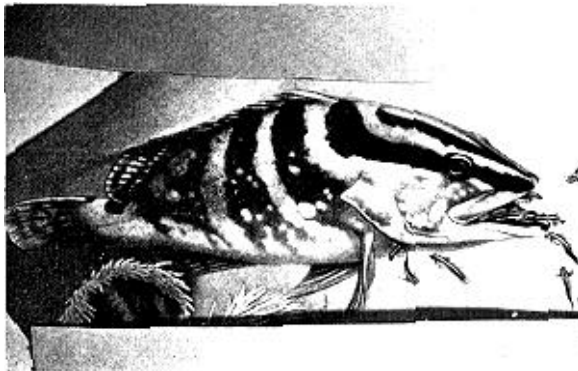


Figure 1. Grouper fish (Epinephelide) and small fish cleaning off parasites.

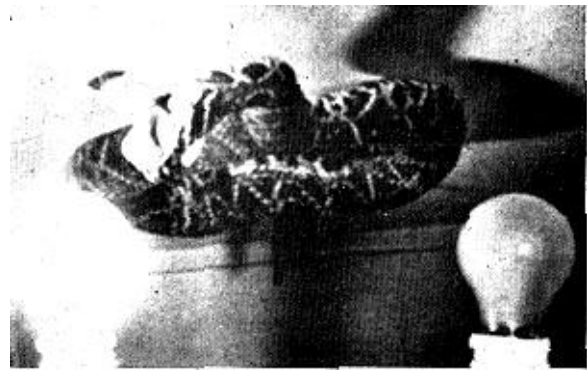


Figure 2. Blindfolded rattlesnake hits light bulb. Courtesy Life Magazine (April 28, 1958).

LAND-DWELLING VERTEBRATES AND THE ORIGIN OF THE TETRAPOD LIMB*

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"Most students become acquainted with many of the current concepts in biology whilst still in school and at an age when most people are, on the whole, uncritical. Then when they come to study the subject in more detail, they have in their minds several half truths and misconceptions which tend to prevent them from coming to a fresh appraisal of the situation. In addition, with a uniform pattern of education most students tend to have the same sort of educational background and so in conversation and discussion they accept common fallacies and agree on matters based on these fallacies.

"The answer (to the quest for the origin of higher categories of organisms) will be found by future experimental work and not by dogmatic assertions that the general theory of evolution must be correct because there is nothing else that will satisfactorily take its place." Kerkut⁶, 1960

Terrestrial and amphibious tetrapods generally locomote with the aid of distinctive paired appendages which we refer to as "limbs," "arms" or "legs." Since the structure of the arm and the leg is basically similar, this discussion will treat them as if they were equivalent.

Fish, on the other hand, employ a fundamentally different form of locomotion. (This is true even when they are locomoting on land, as in the case of the nocturnal excursions of eels or the normal life of the mudskipper, *Periophthalmus* or the African *Clarias lazera* which actually steals millet out of gardens.) The locomotion of the fish is accomplished by serial contractions of the segmentally arranged *myotomal* musculature, producing a resultant force which tends to propel the fish forward by reaction when in water, or by contact when on land. Some fish are able to utilize their limbs, or projections from the opercula of the gills, or other devices to secure a hold on the substrate when not actually swimming. However, such appendages never contain the intrinsic musculature which would enable true walking to be accomplished. Generally they serve as stabilizers or as a point of contact to minimize lateral slippage while wriggling.

In contrast to this, most tetrapods rely little upon the segmental musculature in locomotion. Instead, in order to drag their bodies over obstacles in the terrestrial habitat, they utilize the muscles in the *limbs themselves* or in direct association with them (*par*

ex: the *gluteus maximus* of man). The basic source of power in these animals is not the *trunk* but the *appendicular musculature*. Obvious exceptions to this rule are salamanders, which seem to combine the two modes of locomotion, and snakes which are confirmed wrigglers. In both of these forms and in similar forms the limbs are reduced or entirely absent.

Additionally the tetrapod limb functions to support the body at a distance from the ground. We may compare the typical land vertebrate to a bridge supported by two pairs of trusses. If the trusses are near to the center of the main axis of the bridge they will support it much more effectively than if they are arranged at either side. Similarly, tetrapods which have their limbs joined directly below the body axis do not need to employ great effort to stand up; their construction is essentially stable. On the other hand, those tetrapods whose legs are placed more laterally than ventrally must employ much effort and considerable musculature on the distal surface of the limbs just to lift their bellies off the ground. Most, but not all, of the latter are extinct at the present time.

(The reader is advised at this time to refresh his memory on anatomical terminology which has necessarily been employed in the following section. Any standard textbook of comparative anatomy may be consulted.)

As a generalization, the tetrapod limb is divided into three segments, the *stylopodium*, the *zeugopodium* and the *autopodium*. Their composition is as follows :

Segment	Anterior limb	Posterior limb
Stylopodium	Humerus (upper arm)	Femur (thigh)
Zeugopodium	Radius Ulna (forearm)	Tibia Fibula (shank)
Autopodium	Carpus (wrist) Metacarpus (hand) Phalanges (fingers)	tarsus (ankle) metatarsus (foot) Phalanges (toes)

Please note that this division is not based upon evolutionary presuppositions. It is purely functional. If these functional divisions are the basis for one's thought regarding the comparative anatomy of the limb, it is especially difficult to derive the limb of the tetrapod from the limb of the presumed fish ancestors of the tetrapods. Such divisions are never found in fish fins, ancient or modern, so far as is known. Thus, if one is committed to the thesis that land dwelling tetrapods are derived from a fishlike

*Illustrations to accompany and clarify this discussion may be obtained upon request from the author at Shelton College, Cape May, New Jersey.

ancestry, one is faced with the problem of stating the way in which the transition from an aquatic to a terrestrial animal was accomplished. The ancient Rhipidistian crossopterygian, or lobe-finned fish, appeals to the evolutionists as the most likely ancestor for the terrestrial vertebrates.

These fish had a number of characteristics which might have suited them for the role. Some of them had nostrils communicating with the mouth cavity (which is not the case among sharks and teleosts), and some had ventral air bladders which might have been serviceable as lungs. Most important perhaps is the fact that with sufficient imagination one can present a reasonably plausible scheme for the derivation of the tetrapod limb from their fins. The structure of the fins of all other fish is so remote from that of the tetrapod limb no one has yet appeared with a sufficiently good imagination to make it look plausible.

There is a fundamental difference between the walking and the stabilization functions of the fins. Either the fin is held like a rudder and serves that purpose, or else (rarely) the fin is used as an oar or as a support. The pattern of tetrapod locomotion differs from this, involving an overhand motion with flexion at the wrist and elbow. In order to accomplish such a motion, the crossopterygian would have to bend its fin in a most peculiar and unnatural fashion for a fish. However such a position would be necessitated, since an attempt to preserve the "rowing" motion on land would bring the delicate edge of the fin into contact with the ground, and would probably damage it or wear it away. The natural consequences of this are that the tip of the fin would have to be directed anteriorly, but in such a way that the "flat" of the fin was flat upon the ground. This situation would result in a double flexion of the limb corresponding to the joints of the wrist and elbow, with a corresponding change in the orientation of the bones. Specifically, the elements of the fin which were previously *anterior* (that is, preaxial) now tend to become medial, and those previously *posterior* (postaxial), now tend to become distal.

It is characteristic of the crossopterygian fin that the radial rods of the fin are present only on the anterior side. Hence, these preaxial radii would become medial.

By the above hypothesis, one ray would elongate to form the radius of the limb. Such an intermediate stage is purely hypothetical. No such fossil has ever in fact been found. Other elements are also supposed to elongate and/or change. A point to be emphasized and re-emphasized is that no form intermediate between a rhipidistian crossopterygian and a labyrinthodont, primitive amphibian has ever

been found. The closest known example¹ is not very close*

There is another point to be made in this connection, and that involves fossilized amphibian trackways. Only a very few of these are known, and it might well be argued that tracks left by limbs of an intermediate form might well have remained undiscovered, as have the limbs themselves. However, even the tracks of fairly advanced labyrinthodonts could be expected to show certain characteristics if they were originally derived from fish. As a matter of fact, the labyrinthodont tracks which have been discovered cast considerable doubt upon the above evolutionary theory of tetrapod limb derivation.

In the earlier stages of limb development the leg musculature could not have been very well developed. It is reasonable to suppose that if the above hypothesis were correct, that the animal possessing a moderately well-developed limb would still be relying heavily on the segmental muscles of the trunk for its locomotion. In support of this contention it may be argued as follows: If the evolutionists are correct in their supposition that modern amphibians are derived from labyrinthodont ancestors such as the ones under discussion, then salamanders must be considerably closer to the ancestral form than, for example, the more highly modified frog. The salamander has for the most part well developed leg musculature, although the legs themselves are diminutive. Hence, the salamander is a *more* advanced tetrapod than any really early labyrinthodont is likely to have been, and it *still* relies on trunk-wriggling for the bulk of its locomotion. Therefore, it is reasonable to suppose that its ancestors relied on the trunk at least as much as does the salamander of today.

When one leg of such a wriggling animal is off the ground, the others form a most unstable tripod until the one off the ground has been advanced by a wriggling motion of the body. The other feet (especially the contralateral foot to the one that is off the ground) will tend to rotate, and on a slippery surface would tend to slip rotationally, forming a track in which soft earth or mud would be pushed up in a ridge at the *lateral* edge of the foot.

Now this, or something even more exaggerated, is the kind of track that the labyrinthodont amphibians could be expected to make if they are indeed derived from crossopterygian ancestors in the way which has been discussed. In actual trackways of such labyrinthodonts, however, there is no evidence whatever for rotational slippage. Slippage exists, but it is antero-posterior; that is, it is simply the result of trying to run across a slippery substrate and would appear today in our tracks under similar circumstances. The posterior position of the mud ridge indicates that these animals relied completely upon the musculature of their limbs for locomotion. In summary, there is no fossil

*The hypothesis here advanced was first Presented by T. S. Weston¹⁰ and is discussed in somewhat more detail in the appendix to this paper. The interested reader is referred to Weston's original paper, listed in the bibliography.

evidence for the existence of forms intermediate between crossopterygians and amphibians. Not only this, but what little pertinent fossil evidence exists is inconsistent with such intermediate forms. In view of these facts, the very existence, not to say credence of such an inherently improbable idea is puzzling.

There is certainly no unanimity regarding the evolutionary "motivation" behind this change. The investigator is confronted with a cloud-cuckoo land of fantasy when he begins his inquiry into this area of thought. The writer was impressed forcefully at that time by the fact that this kind of thinking requires great faith — that is, faith that the evolutionary process actually took place. The frame of mind seems to be: "Evolution took place. That is our postulate. Therefore, intermediate forms *must* have existed whether they are known or not and there must have been a reason to produce these intermediate forms." This is an example of blind faith raised to the second power of fantasy. That such forms existed is in the first place a fideistic statement. A discussion of the conditions which may have produced such speculative forms seems to be

at the same level of significance as the more futile scholastic debates of the middle ages.

Limitations of space prohibit a full discussion of this controversy, so a brief summation must suffice. The controversy began, for the purposes of our discussion, with Romer, the noted paleontologist. He argued that at the time the transition from aquatic to terrestrial life was taking place, intermittent droughts made it necessary for crossopterygians to leave drying fresh water pools, stopping along the way perhaps to snack upon a cockroach or other insect. The availability of such food supply eventually gave the fish which spent the most time out of water an adaptive advantage, so that the best walkers among them would come to predominate in the population, and so on. Doubt was cast upon the Romer hypothesis by the seeming discovery that the era in question was not necessarily drought-ridden, but that the geological formations characteristic of it were more likely to have been laid down in a rain forest.

In the following summary I have presented the name of the author, his main arguments and my comments.

Author	Thesis	Comment
Orton, ⁷ 1954	Land locomotion does not require limbs. A drought is a hostile environment. You could not expect a fish to expose itself to dedication by overland journeying. Modern lungfish <i>burrow</i> in drought. The tetrapod limb was originally a burrowing device.	Modern lungfish burrow <i>without</i> legs. This theory would in any case account only for the front legs. The early amphibians and crossopterygians were also probably too large for effective burrowing.
Ewer, ² 1955	Why should a structure be evolved for burrowing and then changed so as to be suitable for walking? What caused this <i>further</i> change? (Ockham's razor). Even amphibians at present, which burrow, migrate in response to <i>population pressure</i> .	By itself, this tells us nothing about what might have brought the limbs about in the first place.
Gunter, ⁴ 1956	In order for limbs to be effective at all in migration, they have to be strong <i>before</i> migration becomes necessary. He thinks the fin became a sort of leg to support the fish halfway out of the water in order to exploit the food value of the shallows and to escape large predators.	Crossopterygians were large, very carnivorous fish with little to fear from predators. They were obviously moderately deep-water fish, and the insects, etc. of the margin would not be enough to support them. Limbs would be a handicap in a generalized ecological niche in competition with fish.
Goin & ³ Goin, 1956	Population pressure was the stimulus for migration. Rainfall and humid conditions occasionally permitted it. Fish could begin to exploit the land environment <i>once the legs were developed</i> .	Why did the legs develop? They are simply not needed for migration under humid conditions! (cf. eels)
Inger, ⁵ 1957	Modern air breathing fish do not migrate to avoid drought or stagnation.	Again, how can a limb be of aid in migration unless it has already

They breathe air so as to be able to stay in stagnant water. They migrate to find food and uncrowded habitats. A continuously humid climate would favor invasion of the land.

come into existence from some other cause?

Romer,⁸
1958

Limbs were developed prior to terrestrialism. Few insects were originally found on land, but some must have inhabited shallow water. Limbs enabled fish to exploit this environment as in Gunter's 1956 theory. In subsequent geological time, drought conditions forced migration with development of insectivorous habits. (Insects were by now abundant.)

See criticism of Gunter's 1956 theory. It is controversial that subsequent (Devonian) time was arid. Inger's 1957 argument still refutes Romer's major thesis.

Warburton⁹
& Denman,
1961

If the crossopterygian *larvae* could exist in the shallows, predators could not get to them. When the pools began to dry up, the larvae might be isolated in mud puddles. In that case, limbs would enable them to walk back to the main body of the pool. These limbs would also enable adults to seek out mud puddles in the first place, which were initially isolated and free from the competition of other fish larvae.

What could the larvae eat in the puddles? Would not limbs initially *handicap* the adults while they were still competing with fish? Since returning larvae would have to be big enough to compete with adults, the puddle they just left would have to be sizeable indeed!

In summary, we may tabulate these theories as follows:

Larva		Warburton & Denman		
Adult	Romer	Goin & Goin Ewer Inger	Gunter Romer	Orton
Ecological motivation	Migration- drought	Migration— Population of pressure	Exploitation of margin	Burrowing

Obviously there are a number of as yet unused combinations, combinations of combinations, or even new ideas. For instance, by combining the two concepts of exploitation of the margin, and larval adaptation we have a most attractive theory which states that the larva exploited the marginal food supply and also thereby avoided the larger predators. Legs would give it an advantage over the ordinary minnow, and the loss of these legs as an adult would remove the handicap of their presence. The larvae might take to spending more and more time on or near land, and eventually get to the point where they become capable of reproduction while retaining their larval form (Paedogenesis). Perhaps one might even propose a *burrowing* larva. It is an entertaining game, and any number, it seems, can play.

In the opinion of this writer, an attempt to press evolutionary thought to its logical conclusion is in

reality a *reductio ad absurdum* and cannot result in anything other than paradoxes, riddles and enigmas. When we survey the wonderful and variegated patterns of living creation, we behold an almost unlimited display of great virtuosity expressed in a great number of variations on a limited number of basic themes. This view of the living universe is more consistent with the facts than the views of the evolutionist.

APPENDIX

The Weston Hypothesis

The basic argument of Weston is as follows: Inasmuch as Rhipidistia primitively possess only pre-axial radii (later, postaxial radii are thought to be geomorphic), and the pre-axial aspect of the fin is directed ventrally in them, an inward turning of the entire limb towards the body axis would cause several of these radii to roughly parallel the median elements. Weston feels that:

A. The most proximal radius became the radius of tetrapods.

B. In its consequent enlargement it interfered with, and suppressed in a manner of speaking, the second radial element.

To shorten an otherwise involved discussion, Westoll believes that he can homologize the structures of the labyrinthodont forelimb with the above considered rhipidistian structures as presented below in the following table:

Rhipidistian fin

1. Median elements
2. "Postaxial processes" of median elements
3. Radial elements
4. No equivalent

Labyrinthodont limb

1. Ulna, intermedium, distal and proximal axial centralia
2. Ulecranon, postocentralia
3. Radius, Precentrale, radiale

4. Supposedly geomorphic phalangeal structures (formed as heterotopic bones in the fin membrane?)

LITERATURE CITED

- ¹ Eaton, T. H., and Stewart, Peggy, L., 1960. A new order of fishlike amphibia from the Pennsylvanian of Kansas. Univ. of Kansas Publs. 12:217-240.
- ² Ewer, D. W., 1955. Tetrapod limb. Science 122:467-468.
- ³ Goin, C. J., and Goin, O. B., 1956. Further comments on the origin of the tetrapods. Evolution 10:440-441.
- ⁴ Gunter, Gordon, 1956. Origin of the tetrapod limb. Science 123:495-496.
- ⁵ Inger, R. F., 1957. Ecological aspects of the origin of the tetrapods. Evolution 11:373-376.
- ⁶ Kerkut, G. A., 1960. *Implications of Evolution*. Pergamon press.
- ⁷ Orton, G. L., 1954. Original adaptive significance of the tetrapod limb. Science 120:1042-1043.
- ⁸ Romer, A. S., 1958. Tetrapod limbs and early tetrapod life. Evolution 12:365-369.
- ⁹ Warburton, F. E., and Denman, N. S., 1961. Larval competition and the origin of tetrapods. Evolution 15:566.
- ¹⁰ Weston, T. S., 1943. The origin of the primitive tetrapod limb. Proc. Roy. Soc. Lond. B 131:373-393.

A STUDY OF ENGLISH MICRASTER RESEARCH

From a Creationist's Point of View

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INTRODUCTION

Because of the great importance attached by evolutionists to the English *Micraster* as an example of fossil evidence of change of species, it was decided to make a study of the major research papers dealing with this genus and relate the material to creationists' concepts. Such evolutionists as K. A. Kermack¹, D. M. S. Watson², and E. R. Truman³, as well as other writers consider the English *Micraster* to represent perhaps the best example known of a gradual change from one species to the next. In this paper the basic research by A. W. Rowe⁴ and that of K. A. Kermack¹ will be given special attention. The third study, that of D. Nichols, is not available to this writer at this time. References to this work, which is of secondary importance to this paper, will be brief.

The Micrasters

The *Micrasters* are sea urchins belonging to the phylum, *Echinodermata*. These spiny skinned animals fall into two subphyla, the *Pelmatozoa* (attached forms) and the *Eleutherozoa* (free-moving forms). The latter subphylum is comprised of five classes one of which is the *Echinoidae* or sea urchins. The *Echinoidae* are made up of two subclasses, the *Regularia* and the *Irregularia*. The *Micrasters* belong to the *Irregularia*.

The test of the sea urchins is very complex and forms fine fossils with the most minute details clearly revealed. This makes the *Echinoids* ideal material for study of presumed successional changes in structure. The size varies from some five or six mm. to as much as fourteen or more cm. in diameter. The shape may be flattened, globular, conical, or heart-shaped.

On the ventral side is found the *peristome*, a ring of plates surrounding the mouth. The peristome may be centrally placed or it may be nearer the anterior margin or *ambitus*. On the dorsal side is the *oculogenital ring* comprised of a circle of ten plates. Five of the plates contain ocular sense organs and five alternate plates contain genital pores. In the *Micrasters* as well as some other species one of the genital pores does not develop. One of the genital plates is modified to form the *madreporite*, a sort of sieve which admits water. The *periproct* is a leathery structure surrounding the anus. In the *Regularia* the periproct is found within the oculogenital ring but in the *Irregularia* the structure is outside the ring. The oculogenital ring with the structures within it are referred to as the *apical system* or *apical disk*.

Radiating from the apical system are five structures called *ambulacra* which consist of double rows of pores. In the *Regularia* these rows extend to the peristome. In many *Irregularia*, including the *Micrasters*, the ambulacra are found on the aboral side only and resemble the petals of a flower. For this reason they are called *petals*.

This very brief and incomplete description of the morphology of the *Echinoids* will help to orient those not familiar with these structures.

The *Micrasters* are heart-shaped members of the *Irregularia*, belonging to the order *Spatangoida*. The periproct is found at the posterior end of the test while the peristome is placed anteriorly.

The Geological Formation

The *Micrasters* which formed the basis of the studies of Rowe and Kermack were found in the White Chalk of Southern England belonging to the Upper Cretaceous. These deposits of soft white limestone are several hundred feet thick. Similar deposits are found in Northern England and Northern Continental Europe, particularly France. Rowe confined his study to five zones comprising the Turonian and most of the Senonian. The zones were the following: *Terebratulina gracilis*, *Holaster planus*, *Micraster cor-testudinarium*, and the lower third of *Micraster cor-anguinum* which he termed low-zonal and the upper two-thirds of *Micraster cor-anguinum* which he called high-zonal. These formations cover about twenty million years in the evolutionary geological column. Kermack's study was based on one portion of Rowe's collection from the *Micraster cor-anguinum* zone.

The softness of the limestone makes removal of fossils quite easy. The tests of the *Micrasters* could be cleaned without damaging the complex ornamentation which served as the basis for much of the study.

THE MAJOR STUDIES OF MICRASTER

Rowe's Research

Rowe⁴ collected two thousand specimens from six areas in Southern England. Each specimen was accurately zoned before being measured and studied. Published in 1899, this study is the only one to date which is based on a population rather than individuals. Rowe based his research on seventeen characters, only part of which will be discussed here. Various factors of size and shape of test were measured. Particular attention was directed to the ambulacra which Rowe considered the most dependable basis of zonal determination. The position

of the peristome and the characteristics of the surrounding structures were studied. Rowe disregarded the structure of the spinal system because it was obscured by deposit in so many specimens, however he did consider its position a character of great importance.

The species used in this study and the zones in which they were found are as follows:(p. 542)

High-zonal Series	
Zone	Species
M. cor-anguinum (Upper two-thirds)	M. cor-anguinum (Two varieties)
Low-zonal Series	
M. cor-anguinum (Lower third)	M. precursor M. cor-testudinarium
M. cor-testudinarium	M. cor-testudinarium M. precursor
Holaster planus	M. cor-testudinarium M. precursor M. Leskei M. cor-bovis
Terebratulina gracilis	M. Leskei M. cor-bovis

Space permits only a brief discussion of the changes Rowe noted as his study proceeded from lower to higher zones. In general the test changed shape from narrow, cuneiform to broader and more oval. The dorso-ventral measurement increased proportionally. The apical disk moved from an anteriorly eccentric position to a more central position. The ambulacra or petals changed from deeply depressed rather short structures to shallow, longer forms. The structure of the interporiferous area of the ambulacra changed from smooth to ornamented. These structures are complex and it is not possible to describe the changes in detail in this paper. Of special interest is the sub-anal fasciole which always is poorly developed in the lower zone but is very highly developed in the higher zone. The wall of the test of *M. cor-bovis* is thin while higher forms possess thicker tests.

The different species graded smoothly from one to another. Note what Rowe says about the species:

"True species, and even prominent varietal types, are rare, and passage forms and trivial variants are the rule. Nothing but a Group will embrace them all, and give to each series its correlative value." (p. 517)

Accordingly he proposed four groups of variants, namely: *M. cor-bovis*, *M. Leskei*, *M. precursor* (*M. cor-testudinarium* is considered a variety of *M. precursor*), and *M. cor-anguinum*.

(It should be stated at this point that this writer has in her personal collection of fossil echinoids six *Micraster*s, four of which belong to the species studied by Rowe. Three of them, *M. cor-bovis*, *M.*

cor-testudinarium, and *M. cor-anguinum* are superbly preserved. Since they form the basic phyletic line, it has been easy to follow the complex descriptions of Rowe. They exemplify not only the changes but some of the variants discussed.) (Figures 1-6)

Rowe gives a very complete description of *M. cor-bovis* as the ancestral species followed by comparisons between it and *M. Leskei*. He concludes the following:

"Every possible variation between the two species may be traced in their passage forms." (p. 523)

Following further comparisons between the two species Rowe says:

"It will therefore not be unreasonable to look upon this primitive form [*M. cor-bovis*] as the progenitor of *M. Leskei*, and through it of *M. precursor* and *M. cor-testudinarium*." (p. 524)

Although he emphasizes the lack of a sharp division between species and the predominance of intermediate types, Rowe divides the *Micraster*s into two zoological divisions, the low-zonal and the high-zonal, with the break occurring at the point between the lower third and upper two-thirds of the zone of *M. cor-anguinum*. A second break in the low-zonal fossils occurs between the *M. cor-bovis* with its thin test and *M. Leskei* with its thick test.

It was the purpose of Rowe to show that:

". . . we can trace an unbroken continuity in the evolution of *Micraster*; so that as we mount up, zone by zone, fresh features are added to the test, simply owing to the progressive elaboration of the epistroma; and that in each zone the special features of the test are so marked that one can tell by their aid from what zone a *Micraster* is derived." (p. 540)

We see here a contradiction. If there is unbroken continuity, how can there be sharp distinctions between zones? Rowe does not make clear what he means by horizontal features. He states that changes in ambulacra are horizontal, not specific, that all the species in one horizon have one type of an ambulacrum while the species of the next horizon show other characteristics of the ambulacra. He does not explain the basis on which he determined species.

KERMACK'S RESEARCH

In 1954 K. A. Kermack completed a study of *Micraster* evolution from a different angle.¹ He limited his work to the specimens from one area using five hundred sixteen specimens collected by Rowe at Northfleet, Kent. It was Kermack's purpose to make a comparative study of *M. coranguinum* and *M. (Isomicraster) senonensis*. Rowe called the latter *Epiaster gibbus*. Kermack also studied allometric growth rates of certain characters in these two *Micraster*s and considered the relationships of certain characters in a supposedly single interbreeding population. A fourth purpose, that of studying methods of investigation, is not the chief concern of this paper.

After cleaning the tests and rejecting some speci-

mens that for various reasons could not be used, Kermack made thirteen measurements on each specimen. These measurements were taken in millimeters except for one item which was measured in square millimeters and two items which consisted in counting plates. These measurements included dimensions which would reveal the shape of the test as well as its size. The measurement of the sub-anal fasciole proved challenging because of its irregularity. Details won't be included here except to say a camera was used. This measurement was particularly important as will be discussed later.

Kermack took into consideration three classes of possible errors in determining the validity of his evidence. First, errors in measurements would be considered as in any other research. A more important error would be found in bias in the sample. Rowe's personal interests, his attitudes toward the species, his attitudes toward faulty specimens — all these factors would affect the quality of the specimens and the relative numbers of each species. Study of the specimens suggested that Rowe was biased in favor of the passage forms and of *Epiaster gibbus* (*M. senonensis*). The third source of error was considered to be the age distribution of the sample. The uncertainties of preservation is believed to result in a biased representation of the living populations because some ages might be more likely to become fossilized than others.

Rowe had divided his collection into three sections: *M. coranguinum*, *Epiaster gibbus* (*M. senonensis*), and the forms he considered transitional between the two species. Kermack approached the problem of deciding whether there were two closely related species in the population or one variable species. After measuring all the specimens as described above Kermack came to this conclusion:

"... none of the characters under consideration enables us to distinguish between the two species with certainty." ¹(p. 393)

Kermack further says:

"In all characters, except the area of the sub-anal fasciole, the two species completely intergrade. Such intergrading is due to hybridization and is not uncommon between species of recent echinoids: . . . *Micraster senonensis* and *M. coranguinum* may well have hybridized in the same way, thus producing transitional forms. By analogy with recent forms, however, there is no reason to deny to either the status of a good species, although they can certainly be distinguished on the character of the sub-anal fasciole." ¹(p. 406)

He explains the variations as due to differences in growth rates of characters or to inherent shape. Also, Kermack *assumes* that the differences are due to natural selection and the changes are adaptive. Also, he postulates that the two species lived in different ecological niches.

NICHOL'S RESEARCH

In 1959 D. Nichols published the results of a re-

search problem in which he studied the morphology and ecology of extant Spatangoids, giving special attention to *Echinocardium cordatum*, and relating the material to the extinct *Micrasters*. ³(pp. 70-72) He formulated the hypothesis that the low-zonal forms such as *M. cor-bovis* were surface dwellers or did not burrow deeply while the high-zonal species such as *M. coranguinum* burrowed deeply. He based this hypothesis on a comparison of the fossils with living forms. The extant forms which burrow deeply have a strong sub-anal fasciole. This circular groove containing cilia provides a sanitary tube for the removal of wastes. Surface dwelling forms do not need such a tube. Also, the smooth ambulacra of the low zonal forms did not have as well developed cilia as the ornamented ambulacra of the high-zonal types. The cilia facilitate the circulation of water necessary for respiration and the removal of detritus which falls on the animal. Nichols counted the number of pore pairs in the petals and by comparison with extant forms concluded that the increasing number of pairs suggested increased number of respiratory tube feet. He postulated *this* enabled the animal to burrow more deeply. ³(P. 47, 48) Since the lithology of the zones is similar, Nichols concluded the animals lived in different niches in a similar habitat.

SUMMARY OF THE THREE STUDIES

Rowe collected some two thousand specimens from several areas giving particular attention to two factors, namely: the changes from zone to zone and the many transitional forms between species. He postulated that *M. cor-bovis* was the primitive type (thin tested) from which *M. Leskei* (thick tested) evolved. Other species then followed *M. Leskei*. Rowe emphasized the difficulty of determining species because each species smoothly merges into the next with no definite place to draw a line between species. He attached particular importance to changes in the ambulacra, but he used the trait to determine zonal level, not species.

Kermack used Rowe's specimens from one locality assuming the animals comprised one interbreeding population. Using two species, *M. coranguinum* and *M. senonensis*, he made a study of thirteen traits which could be measured. Kermack concluded that twelve of the characters were so overlapping that they could not be used to determine the species. The thirteenth trait, the sub-anal fasciole, is a sure way, according to Kermack, to distinguish the two species with *M. coranguinum* having sub-anal fasciole and the other species lacking the structure. He postulated that the prevalence of transitional forms indicate hybridization while the sub-anal fasciole suggests the animals occupied different niches with the differences being due to adaptation to environmental pressure.

Nichol's study consisted in extensive work with living Spatangoids and use of the data to interpret the significance of the characters exhibited by the *Micrasters*. On the basis of his study he concluded

that some forms were burrowers while others lived on the surface. The structure of the ambulacra, the shape of the test, and the presence or absence of the sub-anal fasciole were the characters considered.

It is significant that the three men approached their studies from a completely evolutionary oriented viewpoint. All data were interpreted from that bias. It was not a matter of determining whether or not evolution is a fact but of finding evidence to support an idea which was taken for granted as true.

GENERAL PROBLEMS OF FOSSIL SPECIES

In considering the significance of the proposed interpretation of the *Micraster*s some general problems of determining fossil species should be noted. Imbrie⁷(p. 125) makes some interesting statements:

"In spite of the extended attention this problem has received, the nature of fossil species remains one of the most controversial topics in paleontology. . . . But two key questions are still being asked: What is a fossil species? How can fossil species be recognized? . . . The concept of fossil species held by most paleontologists is largely an inference, an inference based both on observed structure of living species and on a theoretical model of the evolutionary mechanism."

It might be noted here that neontologists are not in agreement as to what a biological species is. It is not intended to discuss that problem in this paper. Paleontologists necessarily are more restricted in the traits they can use as a basis for specimen determination.

The concept of a *typological species* is widely used both in paleontology and in neontology. According to this plan a specimen is selected as a type specimen and the status of other specimens is determined by comparison.

Inferences as to species also are based on biogeography and ecology. The exploration of these two fields in paleontology is in its infancy, and as is the case in other phases of paleontology, is approached from a completely evolutionary point of view.

Most fossil species are termed by Imbrie⁷(p. 131) *transient species*. By this term is meant each species represents a brief point in the evolutionary history of the organism with gaps both preceding and succeeding the species. This is a purely evolutionary concept. *Successional species* are those, such as the *Micraster* of this study, in which there is a gradual gradation between assumed species. Examples of this are extremely rare in the fossil record.

A CONSIDERATION OF MICRASTER SPECIATION

Regarding the determination of fossil species Imbrie has this to say:

"By the nature of the evolutionary process we cannot eliminate arbitrary taxonomic judgments. Species-making will remain a Practical art as well as a scientific discipline." ⁷(p. 127)

It can be seen from this quotation as well as from the discussions of Rowe and Kermack that the *Micraster* species are determined entirely within an assumed evolutionary framework. Also, that the determination of a species is arbitrary and depends on the opinion of the worker. Rowe discusses the difficulty of species determination of *Micraster* in detail and admits his judgment as to lineage is entirely a personal decision. ⁴(p. 543)

Furthermore, those who have studied the *Micraster*s disagree. All agree on the *M. Leskei-M. cortestudinarium-M. coranguinum* sequence. But Rowe believed *M. Leskei* evolved from *M. corbovis* while Kermack postulates that *M. corbovis* branched from *M. Leskei* which he considers only a small form of *M. cortestudinarium*. Kermack also believes that *M. senonensis* branches from *M. cortestudinarium* and followed a parallel evolution to the main line just as *M. corbovis* evolved along with the main line. Rowe considered *M. senonensis* as belonging to the genus *Epiaster* and divided *M. coranguinum* into two varieties which Kermack ignored as well as the species *precursor* which Rowe postulated. Kermack believed the two species he studied had evolved from stock at lower levels and both belonged to the stratum in which they were found. His basis for rejecting migration is based on comparisons with *Micraster* sequences in other deposits both in North England and on the continent. However, Nichols believes that *M. senonensis* migrated from some other locality.

These investigators believe that the genus evolved from a burrowing type to a surface dweller but none of the scientists attempt to explain what caused the change. James R. Beerbower ⁶(p. 133) simply states the question can't be answered at present.

Kermack states that hybridization prevented full adaptation to environment and would result in "poorly adapted transitional forms" ¹(p. 422) He further states that the formation of a barrier between the two species would permit more perfect adaptation. He does not explain in what way the hybrids might be faulty. If numbers in the population are indication of their success, they were more successful than the true species.

Rowe based his postulates on the assumption that the vertical stratification of the fossil beds represent a succession of evolutionary forms. R. G. Johnson ⁹(p. 123) states that the vertical stratification of modern benthic communities suggests fossil strata will not be pure or that there will be mixing of successive populations, and life spans will overlap. That will have a bearing on the validity of Rowe's assumptions. Johnson further states ⁹(p. 115) that the vanishing of a species such as *M. corbovis* does not necessarily imply a change of immediate environment but that the change may be elsewhere and indirectly affect the local fauna. This puts a question on the assumption of Kermack ¹(p. 422) that the niche of *M. corbovis* suddenly vanished.

As this writer studies her specimens she finds the

differences described by Rowe, but the variations do not exceed in magnitude those observed in the human species or in domesticated animals. Some of the changes in the ambulacra were so small a magnifier is required to see them well. When one considers that these changes, according to uniformitarian estimates of time, took place over a period of perhaps some twenty million years, it can be seen the presumed evolution was indeed slight. Then here is another problem. The Echinoids supposedly arose during the Ordovician about four hundred million years ago. If twenty million years were required to produce the slight differences observed in *Micraster*, how can one account for the many kinds of *Echinoids* even over the three hundred million years postulated for their evolution? There is a discrepancy in the proposed evolutionary rates with *Micraster* evolving much more slowly than the class *Echinoidae* as a whole.

In this brief discussion can be seen the purely subjective nature of the evidence for change of species in the *Micrasters*. Also, it is quite evident that all the investigators are interpreting the evidence from an evolutionary bias. Are the *Micrasters* one highly variable species? Do they exemplify a true change of species? If so, where are the breaks between species? Or did the forms grade so that *M. Leskei* was fertile with *M. cortestudinarium*, and *M. cortestudinarium* could cross with *M. coranguinum*, but *M. Leskei* and *M. coranguinum* were not inter-fertile? No one can answer these questions.

SOME UNEXPLORED PROBLEMS

This entire study does not touch on the geology of the problem. Uniformitarianism is implied by the investigators. The relation of the chalk formations and their paleobiota to flood geology or catastrophism is a subject too involved for exploration in this paper. Other species of the *Micrasters*, the relation of the *Micrasters* to other *Spatangoids*, and the presumed evolution of the *Echinoidae* as a class could form the basis of extended study.

FROM THE CREATIONIST'S POINT OF VIEW

The point of view of a creationist on this problem is simply stated: It doesn't make any difference whether changes of species did or did not take place. If there were no changes, then there is no reason for concern. If there was an actual genetic as well as morphological change, then it was no different from some changes which have been observed in other organisms today. The organisms still were *Micrasters*

and easily could be one of the "kinds" of Genesis. In no sense does changes of species in the *Micrasters*, if such changes did occur, prove the overall hypothesis of evolution. Such changes would not close any of the gaps in the phylogenetic tree of life. But the variations demonstrate the capacity for change the Creator placed in the original "kinds."

"Dr. R. A. Stirton, in his book *Time, Life and Man*, says that the greatest value in the study of paleontology is the satisfaction it affords the individual who enjoys it."¹⁰ (p. 11)

This writer has derived much pleasure from her study of the *Micrasters*. The marvelous beauty and the intricate detail of the fossils produces feelings of awe and wonder — awe toward the Creator who put them here and wonder as to how they were formed. Faith is strengthened rather than weakened by studies such as this — a source of deep satisfaction.

LITERATURE CITED

- ¹Kermack, K. A., "A Biometrical Study of *Micraster coranguinum* and *M. (Isomicraster) senonensis*." *Phil. Trans. Roy. Soc., London. (B)* 237:428, 1954.
- ²Watson, D. M. S., "The Evidence Afforded by Fossil Invertebrates on the Nature of Evolution," *Genetics, Paleontology, and Evolution*, Edited by G. L. Jepsen, G. G. Simpson, and E. Mayr, Princeton University Press, Princeton, N. J., 1949.
- ³Trueman, E. R., "Adaptive Morphology in Paleocological Interpretation:" *Approaches to Paleocology*, Edited by John Imbrie and Norman D. Newell, John Wiley and Sons, Inc., New York, 1964.
- ⁴Rowe, A. W., "An Analysis of the Genus *Micraster*, as Determined by Rigid Zonal Collecting from the Zone of *Rhynchonella Cuvieri* to that of *Micraster coranguinum*," *Quart. Jour. Geol. Society of London*, vol. 55, Longmans, Green, and Co., London, 1899.
- ⁵Ager, Derek V., *Principles of Paleocology*, McGraw-Hill Book Company, Inc., New York, 1963.
- ⁶Beerbower, James R., *Search for the Past*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1960.
- ⁷Imbrie, John, "The Species Problem with Fossil Animals," *The Species Problem*, Edited by Ernst Mayr, American Association for the Advancement of Science, Washington, D. C., 1957 (Publication No. 50).
- ⁸Mayr, Ernst, *Animal Species and Evolution*, Harvard University Press, Cambridge, Mass., 1963.
- ⁹Johnson, R. G., "The Community Approach to Paleocology," *Approaches to Paleocology*, Edited by John Imbrie and Norman D. Newell, John Wiley and Sons, Inc., New York, 1964.
- ¹⁰Amos, Fred C., "GeoTopics," *Ward's Geology Newsletter*, No. 32, Dec. 1963, Ward's Natural Science Establishment, Rochester, N. Y.

Figures 1 to 7 show dorsal and ventral sides of *Micraster* forms given species names as they are found in the various chalk formations. The figures are in the order in which they are found in the series, from *M. leskei* in the low zonal to *M. coranguinum* from the upper horizon. The total time period according to evolutionary geological assump-

tion is about twenty million years. The relatively slight changes, particularly from *M. corbovis* to *M. coranguinum* should be noted. These are scarcely comparable to the known variability shown by races of mankind. Yet this is one of the classic examples of evolution always referred to in courses in invertebrate paleontology.



Figure 1. *Micraster leskei* Desm. Upper Cretaceous chalk Turonian, Rouen, France. Dorsal side.

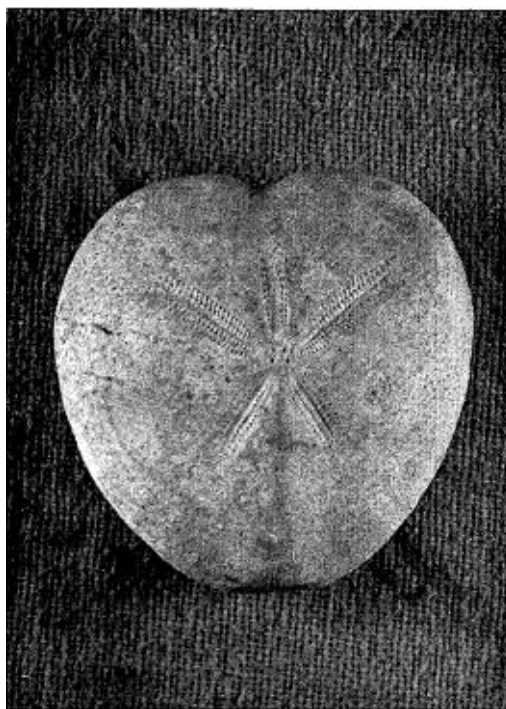


Figure 2. *M. corbovis*. Upper Cretaceous: Danien chalk cliffs, Sussex, England. Dorsal side.

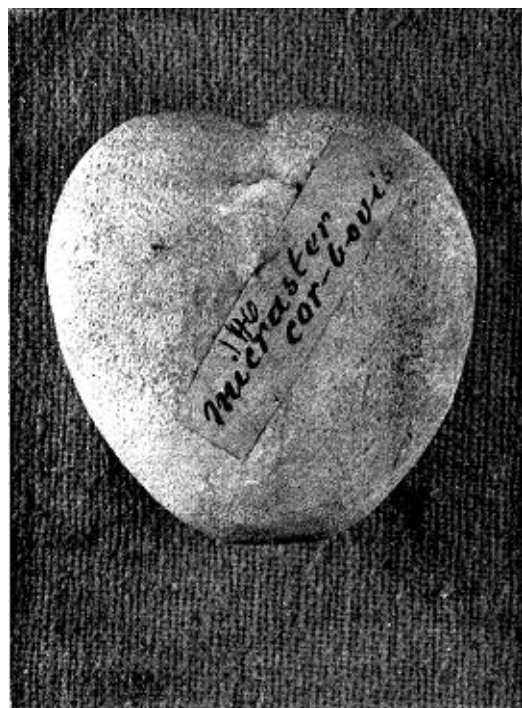


Figure 3. *M. corbovis*. Ventral side of Figure 2.

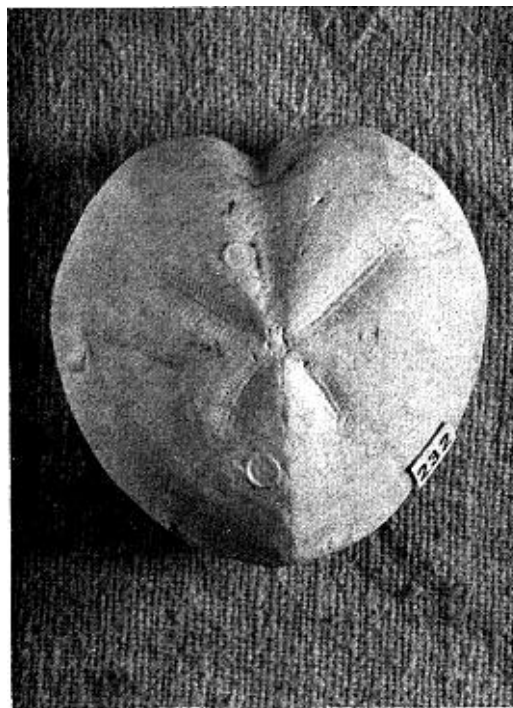


Figure 4. *M. cortestudinarium* Agassiz. Upper Cretaceous chalk cliffs, Norwich, England. Dorsal.

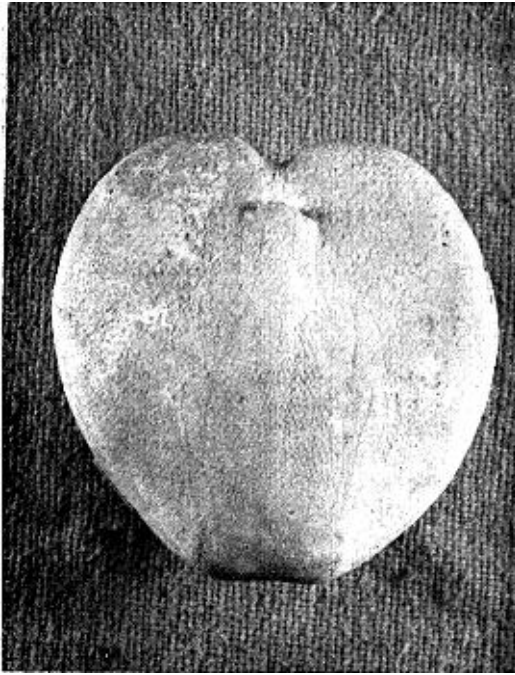


Figure 5. *M. cortestudinarium* Agassiz.
Ventral side of Figure 4.

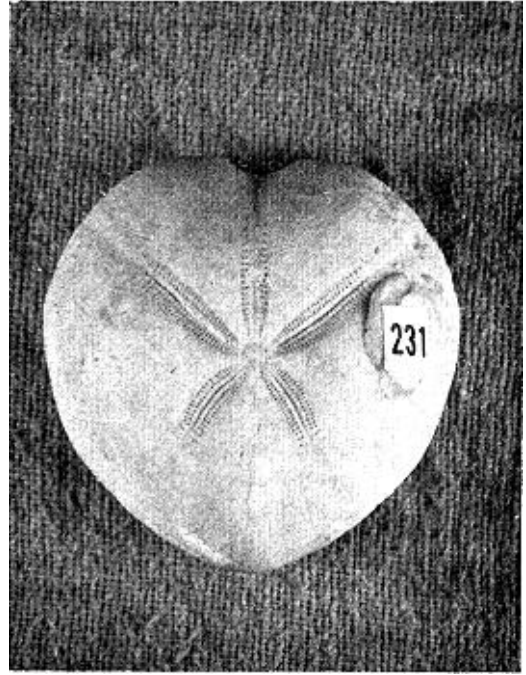


Figure 6. *M. coranguinum*. Upper chalk
Cretaceous, Dorchester, Dorset, England.
Dorsal side.

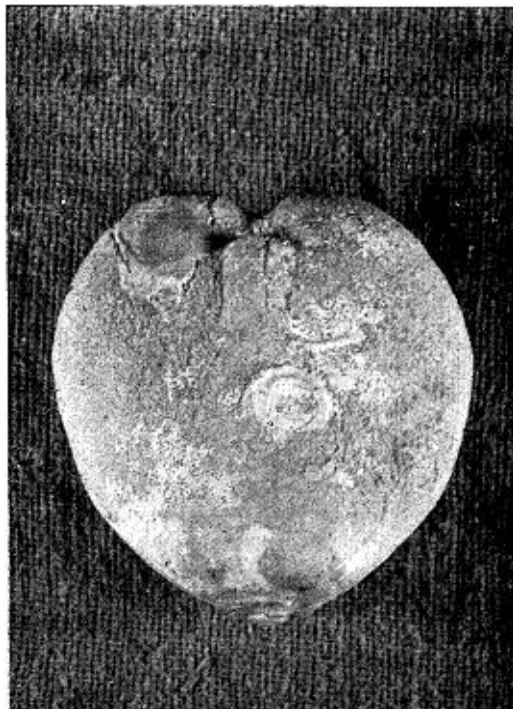


Figure 7. *M. coranguinum*. Ventral side of
Figure 6.

PLANNED INDUCTION OF COMMERCIALY DESIRABLE VARIATION IN ROSES BY NEUTRON RADIATION

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INTRODUCTION

In March, 1961, the successful induction of a wide range of variations in rose plants grown from high energy neutron radiated Queen Elizabeth rose buds was reported¹. Among the variants, increase in petal number, elimination of the dominant and undesirable M or magenta factor, and dwarf types, were sufficiently frequent to make this technique seem worthwhile commercially. Frequently as a result of carefully planned cross pollination hybrids are obtained which are desirable in every way except that they have only 15 to 20 petals and accordingly are not useful either as garden or hot house varieties. When breeding for the very desirable currant red color, varieties having all the qualifications for commercial introduction are obtained but, unfortunately, are magenta red. The following experiments were made in hopes of demonstrating that when semi-double hybrids having the right variability potential are radiated, commercially desirable varieties having increased petal number and good form may be obtained. Also, the possibility of eliminating the dominant magenta or M factor from otherwise desirable hybrids was investigated.

MATERIAL AND METHODS

Buds of H55059/16, a rose red hybrid of Queen Elizabeth x Red Delight having 14-18 very large petals, H56024/39, a hybrid of Queen Elizabeth x Red Delight having 15-20 medium large petals, H56022/9, a hybrid of Queen Elizabeth x Cavalier, a large fully double high centered magenta red, heterozygous for the very desirable currant red color, Pink Sensation, a very double salmon pink hot house variety, the well known floribunda Garnette and Queen Elizabeth for a comparison with the results of 1961 were used in the experiments. Fifty buds of each variety were cut from budsticks and placed in petri dishes on moist filter paper. Two petri-dishes or 100 buds of H56024/39 were used in the experiment, placing one on top of the other. This "piggy-back" experiment was included to see if the same unusual decrease in radiation effect occurred in the upper dish furthest from target. The buds in these petri dishes were exposed to 14 MeV neutrons from a Cockcroft-Wahon accelerator, August 9, 1961. These neutrons resulted from deuterons accelerated to 500 kev bombarding a tritium target. The petri dishes were placed 2-4 inches from the target in a basket type of holder. The total dosage in rads of the various petri dishes varied from 1870 rads on

one side to 2710 rads on the opposite side of dish No. 1 down to 1020-1460 rads on dish No. 7, the top dish of the "piggy-back" pair. Other dishes ranged from 1440-1890, 1720-1840, 2010-2200, 2080-2440 and 2180-2520 rads. The exposure lasted for about six hours, following which the buds were immediately budded into *Rosa multiflora* understock, August 9, 1961.

ACKNOWLEDGMENT

The author wishes to acknowledge the advice and help of Dr. Howard Tewes of the Lawrence Radiation Laboratory, Livermore, California, who radiated the rose buds and calculated the dosage rates of each petri dish exposed to the neutron radiation.

RESULTS

With the exception of the buds from the upper dish of the "piggy-back" experiment, all the neutron radiated buds were retarded and slow in starting. Only 8 of the 50 Garnette buds grew into plants. Other buds started growth but were not able to form shoots and soon died. This variety evidently is more sensitive than others to radiation. As the buds of all varieties began growth, they were very deformed in foliage shape and leaf appearance. As in the 1961 experiment, many became more normal by growth of axillary buds from the very deformed primary shoots. However, even these shoots were abnormal, having thick "strap" like sections of leaf tissue and leaves. Segments of heavily pigmented tissue and abnormally light green tissue was characteristic of these first shoots and leaves. By midsummer of 1962, however, most of the plants were superficially fairly normal in appearance. They exhibited as much variability in height and shape of plant, vigor, petal number, and color of flower as most populations of seedlings resulting from cross pollination. The variation was not transgressive, however.

As in 1961, the buds from the petri dish above the one next to the target grew into plants which were typical of the hybrid H56024/39, except for one plant which had only 6-8 petals. Also, the buds were only retarded slightly as compared to those of the petri dish beneath. This differential result in the "piggy-back" experiments continues to be puzzling since the total number of rads recorded for the upper dish were 1020-1460 as compared to 1870-2710 for the lower dish next to the target and 1440-1890 for one of the other dishes.

In the fall of 1962, the most vigorous plants were

harvested, planted in 2 gallon rose-tainers, and placed in the hot house for closer observation and study. The results may best be summarized by variety.

H55059/6. Queen Elizabeth x Red Delight. This population of 20 plants selected from the 47 surviving plants showed more plant and flower variability than any other one. Leaves varied in shape from thin "straplike" ones (Figure 1) to very much thickened rugose ones (Figure 2). As shown in Figure 3, the leaf variability was great, affecting size of leaflets and stipules, thickness of midrib, size of marginal serrations, and color, some leaflets being very dark green and others much lighter green with greater development of anthocyanin pigment.

The variability in plant vigor and habit is shown in Figure 4. Selection 13, having a large dark green leaf and stem much greater in diameter ($1\frac{1}{2}x$) was studied with special interest since at first it seemed to be an exception to the general rule that all plants from the neutron radiated buds showing observable variations from the normal were either less vigorous or partially sterile. Careful comparison under hot house conditions indicated that it also was significantly less vigorous. At first, after canning up, it grew fully as rapidly as H55059/6. However, it did not "break" as rapidly following flower production and so in a few months was about $2\frac{1}{2}$ feet lower in height than H55059/6 which was then over 8 feet high. Also, it was almost completely sterile. Examination of the pollen indicated that only about 2% was viable. All of the other selections shown in Figure 4 were definitely weaker than normal, though the slender type 2 and 8 grew as rapidly at first. Several plants in this group had from 25-40 petals but were too weak to be worth testing.

Among the 20 plants, several were indistinguishable from normal and one was particularly intriguing from the commercial viewpoint. It had 29-36 large petals instead of the usual 14-18 of H55059/6. The buds were long pointed and had a lovely regularly imbricate high centered form when $\frac{1}{4}$ - $\frac{1}{2}$ open. Comparison of the typical H55059/6 flower and this neutron radiation induced "high double" sport is shown in Figure 5.

Hot house testing shows that it buds true and also breaks fully as rapidly as the normal type. H55059/6 is more vigorous than the average hot house rose, so the slight reduction in vigor of this sport is not a handicap. Whether it will meet all of the other exacting requirements of a good hot house rose remains to be seen.

The significant fact is that we have demonstrated that a semi-double variety can be converted into a commercially desirable one as regards petal number and bud form. Incidentally, the color is very similar to H55059/6.

H56024/39. Queen Elizabeth x Red Delight. The plants from buds in the upper dish of the "piggy-

back" pair were not transplanted since they showed no variability. 20 of the 44 plants from the lower dish showed great variability in habit of growth, leaf form, vigor and petal number. Several plants had only 8-12 petals. All except one plant had flowers typical in color, and it was a light rose red. One plant had flowers only $2\frac{1}{2}$ inches in diameter with 50-60 small petals instead of the usual 4- $4\frac{1}{2}$ inch flower with 15-20 petals. Another had 36 petals and a vivid currant red color. The flower was smaller than H56024/39. As may be seen by reference to Figure 6, the same range of variation in leaf characteristics was found as in H55059/6. Though not clearly evident from the figures one would never mistake a variant plant of H56024/39 for one of H55059/6.

H56022/9. Queen Elizabeth x Cavalier. Tyrian Purple-MMMm. Only a few of the plants observed in the field as having a bright currant red color instead of the usual magenta one were transplanted to rose tainers in the fall of 1962. Considerable variation in color range was observed. Only one selection was sufficiently free of magenta to bud and observe more closely. In the winter of 1963-64 plants of this selection were again dug up and benched in the test hot house. It continued to be much more currant red in color and relatively free of magenta. However, when fully open, especially on the second day and thereafter, it still showed too much magenta to be worthwhile commercially.

Though complete success was not attained, enough improvement in color was effected to justify belief that a large scale neutron radiation of varieties or selections having the magenta or M factor would result in complete inactivation of this undesirable dominant factor. The color resulting would, of course, depend on the recessive factors carried by the variety radiated.

Pink Sensation. Sport of Pink Delight having more petals and a somewhat deeper pink color but showing magenta on outer surface of petals when bud opens.

Many of the surviving plants were so much weaker than normal as to be of no commercial value. At least six reversions to a red color identical to Red Delight occurred. Pink Sensation is a sport of Pink Delight, a salmon pink variety which frequently sports to Red Delight. Some of the variations showed less magenta coloration on the outer surface of the petals and so may be an improvement over Pink Sensation which has too much of a magenta tone when in the $\frac{1}{4}$ - $\frac{1}{2}$ open bud stage. However, it is questionable if any of these selections are vigorous enough to be worth introducing. Some idea of the range in bud form of the variations obtained may be seen by reference to Figure 7. As with H55059/6 and H56024/39, a great range in leaf form and size occurred.

Garnette. A very popular long lasting floribunda

hot house variety. Though unfortunately only 8 plants survived, each was very distinct from normal and one was a very interesting dwarf having flowers similar to Garnette but only about one inch in diameter. It was hoped that variations to pink scarlet or even white would have resulted since these occur naturally and make up a large "family" of Garnette sports. However, all of the 8 plants were variations of the typical Garnette color, some showing less magenta than others. Five of the variations are shown in Figure 8.

Queen Elizabeth. The same range of variation was found in the 47 surviving plants from neutron radiation as in Experiment I of the 1961 series of experiments. One interesting variation of a scarlet color may be worth introducing. Several almost white variations are being tested, but the leaves are also lighter green in color than Queen Elizabeth. Accordingly, it is doubtful if they would be popular as the public usually associates pale green leaf color with weak growth. Even though these variations are almost as vigorous as Queen Elizabeth, they would suffer from this usually well grounded prejudice.

DISCUSSION

As in 1961, these experiments have again demonstrated that neutron radiation of buds cut from bud sticks and placed in petri dishes produce a remarkable range of variation. In discussing the 1961 results the observation was made that "success of a radiation experiment depends not only on dosage rate, but the variability potential of the hybrid or variety used." This relationship has been clearly demonstrated in the above series of experiments. Thus H55059/6 is a hybrid of Queen Elizabeth with Red Delight and the 14-18 petals are very large ones. As indicated by previous experiments (Lammerts 1945²) doubleness is dominant, but also quantitative in its inheritance. Red Delight is a sport of Pink Delight and has 25-30 large petals. Several neutron induced variations had from 25-40 petals. One of these, as reported, was almost identical in every way to H55059/6 except that it had 29-36 petals and was only slightly less vigorous. It had a very lovely long bud, and opened to a high centered regularly imbricate flower. Evidently neutron radiation effected the desired result because H55059/6 was capable of variation to *both* increase in petal number and expression of this in large sized *extra* petals.

By contrast H56024/39 which has a flower only about ½-1 inch smaller in diameter than H55059/6 did not have the variability potential for increased number of large sized petals. Though also a hybrid of Queen Elizabeth x Red Delight, it evidently did not carry factors for large petal size. Accordingly, the vivid currant red mutation with 36 petals was commercially undesirable because most of the extra petals were small.

It would seem then that in order to be successful in converting a semi-double hybrid into a commercially desirable one, at least one of the parents should be a fully double variety in which the extra petals, those from 10 on to the total of 35, are *large* size. Also, the semi-double hybrid selected for radiation should have large petals and relatively few small petaloids which usually indicate that the extra petals which may result from mutation will be small also.

Though the experiment to eliminate the magenta or M factors was only partially successful, the great improvement in color indicates that the dominant M factor is rather easily inactivated. In the case of H56022/9 three M factors were involved since genetically the hybrid was MMMm as regards this locus.³ Obviously, rose red hybrids carrying only one M factor or solferino purples with 2 M factors would be more easily converted to currant red.

From the viewpoint of origin of varieties in the sense of truly unique and great ones such as Peace, Charlotte Armstrong, Herbert Hoover, Queen Elizabeth and Fashion, mutations have little value. There are, of course, whole "families" of varieties such as the Garnette series of sports. Some of these such as the lovely light pink Carol Amling have sold in fairly large quantities, and the new currant red Mohican sport gives promise of much popularity. Also, as indicated previously, Pink Delight a hybrid of Senator x Florex, sported to Red Delight. Aristocrat and Pink Sensation. Many other examples of such "families" of sports could be given. Better Times, a sport of Briarcliff which sported from Columbia a hybrid of Ophelia x Mrs. George Sawyer is the most successful hot house rose so far discovered. It sells in greater quantity than the combined total of all other varieties. However, the varieties in each of these "families" of sports are in general very similar to one another. Thus any variety which is a sport of Garnette can easily be recognized by anyone familiar with the parent variety.

This is definitely not the case, however, with varieties which are the result of hybridization. Thus, no one looking at Queen Elizabeth could ever guess that it was a hybrid of Charlotte Armstrong x Floradora. This unique genotype is the result of a combination of genetic factors tracing back to at least five and probably six different original species. The "gene pool" of variation resulting from interspecific hybridization of these original species is continually re-shuffled, so to speak, by each generation of rose breeders and occasionally truly distinctive varieties are originated. Once this new varietal pattern of development is set up, mutations can only modify its expression, but can never really change it basically. By this I mean that mutated strains of Garnette or Queen Elizabeth are always distinctly recognizable as such. The mutations are

not transgressive in the sense that they transform Garnette into a variety indistinguishable from for example a sport of Pink Bountiful, another rather successful hot house floribunda. Similarly mutations of Queen Elizabeth do not transform it into a variety similar to Chalotte Armstrong or Floradora.

In terms of the pre-patterning theory, it would seem that mutations can only alter various phases of its expression but the *pattern itself cannot be changed*. In terms of this theory, Queen Elizabeth is the expression of a definite pre-pattern. The expression of this pattern depends on the interaction of the environment and the DNA genetic code. Changes in the environment or mutations in the code can alter the expression of the Queen Elizabeth pattern but cannot basically change it.

It is understood that this concept reduces the role of mutations to a relatively minor one. The variability with which rose breeders, or indeed any plant or animal breeders work is traceable to an original diversity of either species or varieties existing naturally within a species. This diversity is the result of numerous patterns which depend for their physical expression on the environment and the genetic code.

Mutations generally are harmful because the complex genetic code was created to perfectly express the pre-pattern in a hospitable environment. Any derangement in either the environment or the code will result in an imperfectly formed expression of the pattern. As indicated in the discussion of the results of both this and the 1961 experiment by far the greater majority of all mutations resulting from neutron radiation are defective. Most of them are weaker, "break" less frequently or are partially sterile. This is, of course, exactly what one would expect from consideration of the remarkably complex code system created to express the various patterns existing in the mind of God, patterns we recognize as species, varieties, and individuals.

Evolutionists recognize that most mutations are harmful. Thus Fraenkel-Conrat 'in discussing the genetic code of a virus reports on 200 chemically induced mutants of the tobacco mosaic virus. One of them made the protein coat of the virus much more susceptible to digestion by an enzyme that removes amino acids from the carboxyl (COOH) end of a protein chain. This enzyme was able to digest or chop off the amino acid threonine at the end of a protein chain. The very first mutant studied by Fraenkel-Conrat and his group made the virus protein much more susceptible to digestion by the enzyme. As a result the enzyme was now able to clip three amino acids off the virus, thus rendering it distinctly less viable. Other RNA mutations render the RNA incapable of even forming the protein coat. Fraenkel-Conrat comments, "One can assume that the protein coat of the common strain of the virus as it evolved by natural selection,

is highly efficient, and that any mutation is likely to reduce the virus' ability."

This sort of reasoning inverts the logical deduction from the overwhelming burden of evidence that mutations tend to be harmful, hence cannot be useful in explaining the evolution *assumed*. Actually, our evolution minded colleagues are now saying, "Yes, of course, most, or possibly all mutations are harmful since natural selection has eliminated all except those most effectively integrated into the DNA code." Hence, *all* plants and animals *now* have the most perfect combinations of mutations and it would be unreasonable to expect to find mutations increasing the viability or conferring any other advantage to the organism studied. This is actually saying that the course of the evolution they postulate is now completed. One might well ask just when in the past was it incomplete? Presumably, according to orthodox paleobotanical theory, very distinctive flowering plants originated in the Miocene time. At least 11 are described as new by MacGinitie in his very excellent report on the Kilgore Flora.⁵ Whether they originated somewhat earlier in the Eocene or late Cretaceous is not the question. Rather one might well ask "if geneticists had been living at that time, would they have concluded that evolution was complete since almost all mutations studied are harmful?" One could thus go back to the Devonian time and argue that because mutations of the then existing simple plants such as Psilophyton (actually probably *Psilotum nudum*) were harmful, natural selection had eliminated all except those most effectively integrated into the DNA code. In fact, Axelrod does essentially this when he tries to explain the survival of *Psilotum* as being due to slow evolving rates and calls them bradytelic types.⁶

Actually, this whole argument of our evolution minded colleagues is very amusing. In essence they first say that all existing lines of evidence clearly prove that evolution has occurred and that all existing plant and animal species trace back to one, or at most, a few "primitive" forms. Then, in searching for a possible mechanism by which this presumed evolution has occurred, they find a source of variation in mutations. Natural selection is then assumed (since actually no one has demonstrated even the origin of a variety by it) as the effective mechanism for selecting the best of these mutations and assembling them into a new or distinct plant or animal. Once these assumptions are granted, they then say, "Well, of course we cannot demonstrate evolution as occurring since it has all been completed."

In essence then evolution is reduced to the same status as creation with DNA, mutation and natural selection taking the place of God in presenting us with a *completed* product!

A little reflection should show that *if* evolution occurred by natural selection of mutations, it

should be a continuing process. Surely this is not the most perfect of worlds and plants and animals should be changing in their basic patterns of expression to meet the challenges of new environments. The fact that they change only within the limits of their variability potential and that most mutations are harmful should make evolution minded scientists reconsider their basic assumptions. Do the various lines of evidence from an impartial study of nature conclusively point to evolution as the mechanism by which the remarkable diversity we see around us originated? As we have endeavored to show in various articles, many of us, competent in various fields of sciences, do not think so. Rather we see clear evidence for creative design, a past environment much better suited for the ideal expression of the various patterns of life, and a series of catastrophes which have marred a world originally created perfect in every way.

SUMMARY

1. Data are given which indicate that semi-double rose hybrids having only 14-18 petals may be converted into fully double ones having commercially desirable high centered regularly imbricate flowers by neutron radiation of the buds cut from bud sticks and placed on wet filter paper in petri-dishes.
2. Elimination of the dominant M or magenta factor may easily be accomplished by neutron radiation thus allowing the desirable crimson or currant red factor to be expressed.
3. The importance of selecting hybrids having the right variability potential for effecting these changes is discussed.
4. Biologically, all of the mutations were defective variations from the pattern of development characteristic of the variety radiated.
5. The interrelation of environment, pre-pattern and mutation is discussed and the observation made that mutations obtained are not transgressive.
6. Mutations can only alter various phases of the basic varietal pattern expression, but the pattern

itself is not changed. Truly unique and outstanding varieties such as Peace, Charlotte Armstrong or Queen Elizabeth would never result from the accumulation of mutations.

7. The evolutionary concept that mutations are harmful because natural selection has accumulated the most efficient combination of mutations is examined in terms of its implication that the assumed process is complete. The conclusion is reached that environments are not always ideal for plants now. Therefore, if the present variation we see is due to natural selection adapting species and varieties to their environment, the process should be continuing and experimentally demonstrable.

8. The overwhelming lines of evidence indicating that under the usual normal environmental conditions, mutations are for the most part harmful, indicates a need to re-examine the presumed evidence for evolution.

9. It is our belief that the evidence clearly indicates creative design, a Past environment much better suited for the ideal expression of the manifold patterns of life, and a series of catastrophes which have marred a world originally created perfect in every way.

LITERATURE CITED

- ¹Lammerts, Walter E. Neutron Induced Variation of Roses. American Scientific Affiliation Journal. March, 1961.
- ²Lammerts, Walter E. The Scientific Basis of Rose Breeding. American Rose Annual, 1945; pp 71-79.
- ³Lammerts, Walter E. Inheritance of Magenta Red Color in Roses. American Rose Annual, 1960; pp 119-125.
- ⁴Fraenkel-Conrat, Heinz. The Genetic Code of a Virus. Scientific American. October, 1964.
- ⁵MacGinitie, H. D. The Kilgore Flora. University of California Publications in Geological Sciences. Volume 35. No. 2 — pp 67-158; 16 plates, 2 figures in text.
- ⁶Axelrod, D. Evolution of the Psilophyton Paleoflora. Evolution Vol. XII, No. 2, June 1959, pp 264-275.
- ⁷Whitcomb, John C., and Henry M. Morris. The Genesis Flood. Presbyterian and Reformed Publishing Company, 1962.

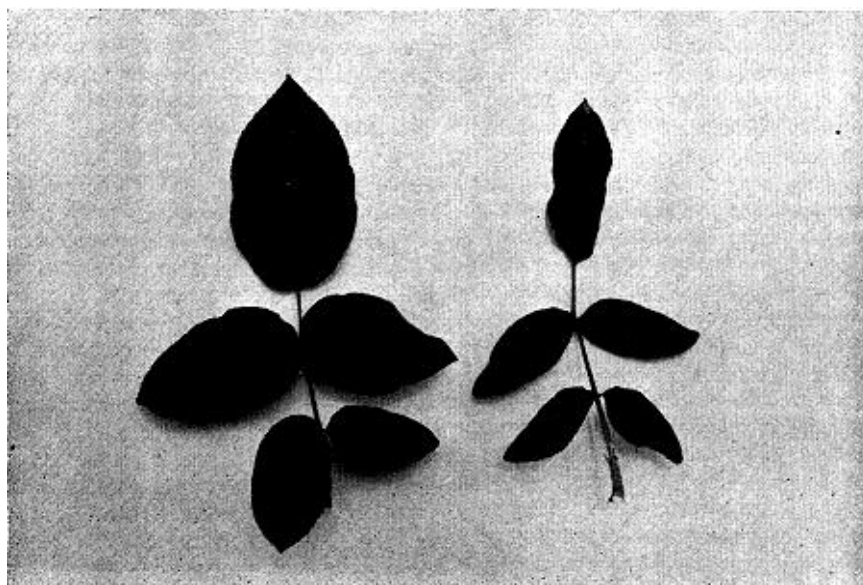


Figure 1 -- H55059/6 normal compared to No. 2 strap leaf.

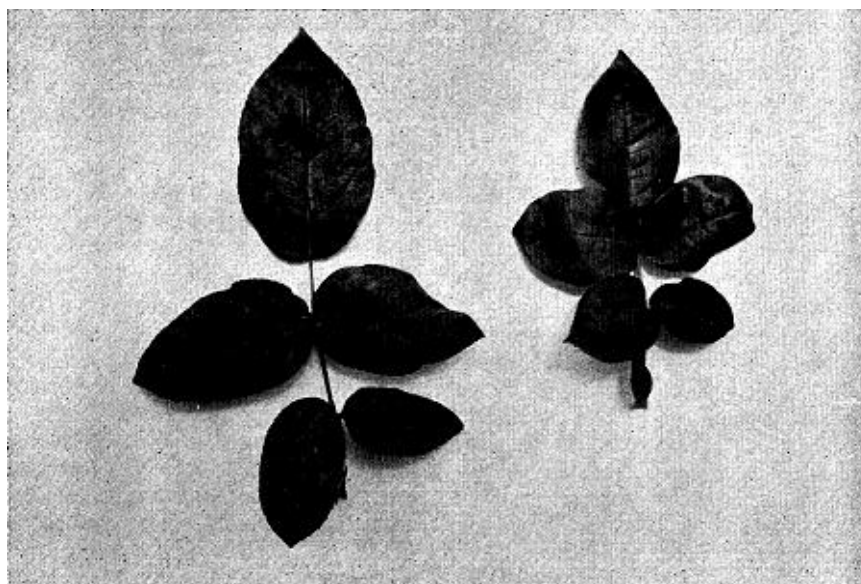


Figure 2 — H55059/6 normal compared to No. 13 rugose thick leaf.

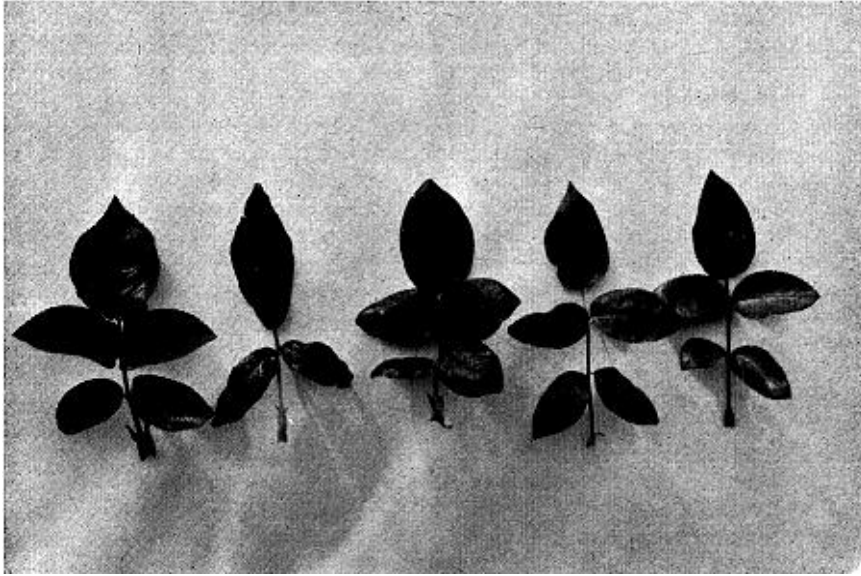


Figure 3 — H55059/6 normal leaf on left compared to four leaf variations on right.

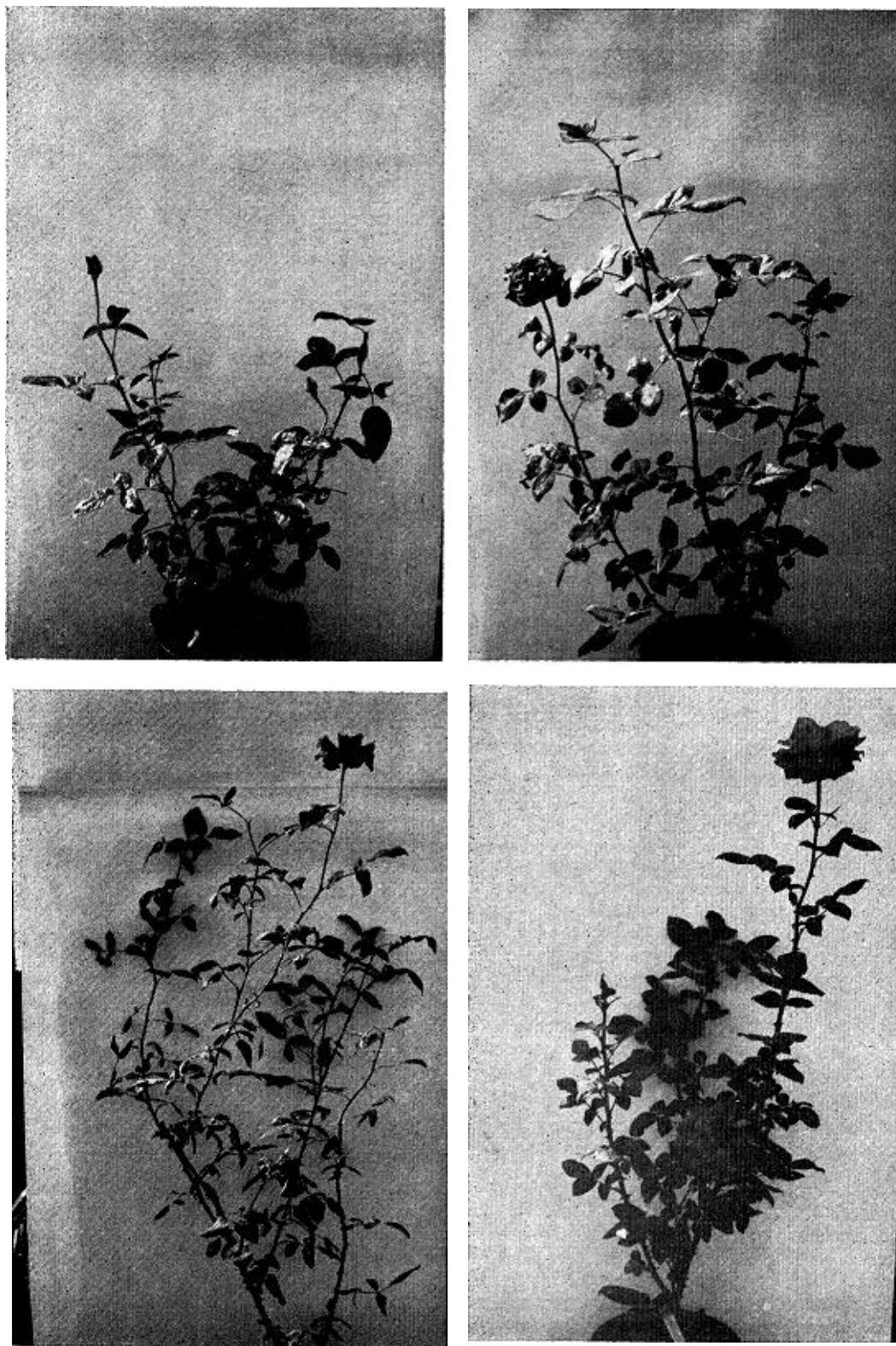


Figure 4 -- H55059/6 (Top left) No. 20—Dwarf. (Top right) No. 9—Dark red large double flower. (Bottom left) No. 2—Slender elongate, and (Bottom right) No. 13—Thick dark green leaf and stem.

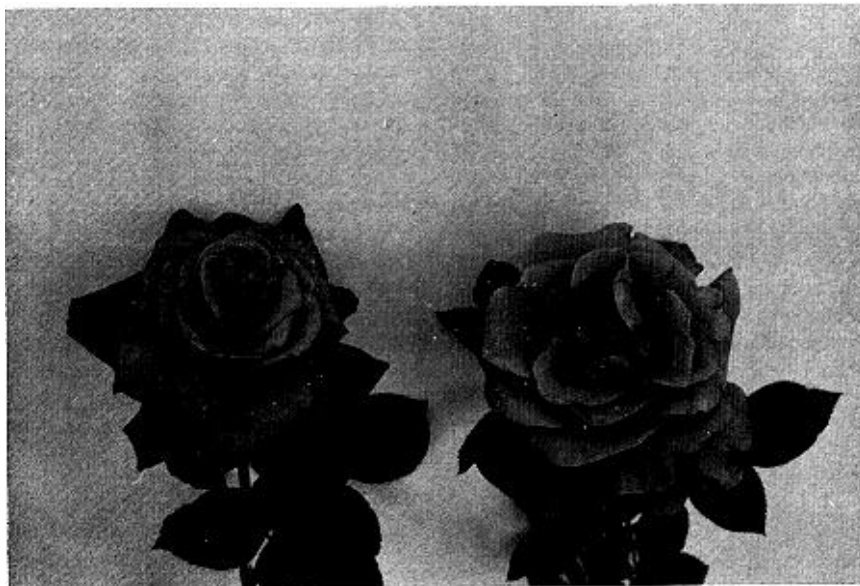


Figure 5 -- Mutation with 24-36 petals on left compared to normal H55059/6 having 14-18 petals on right.

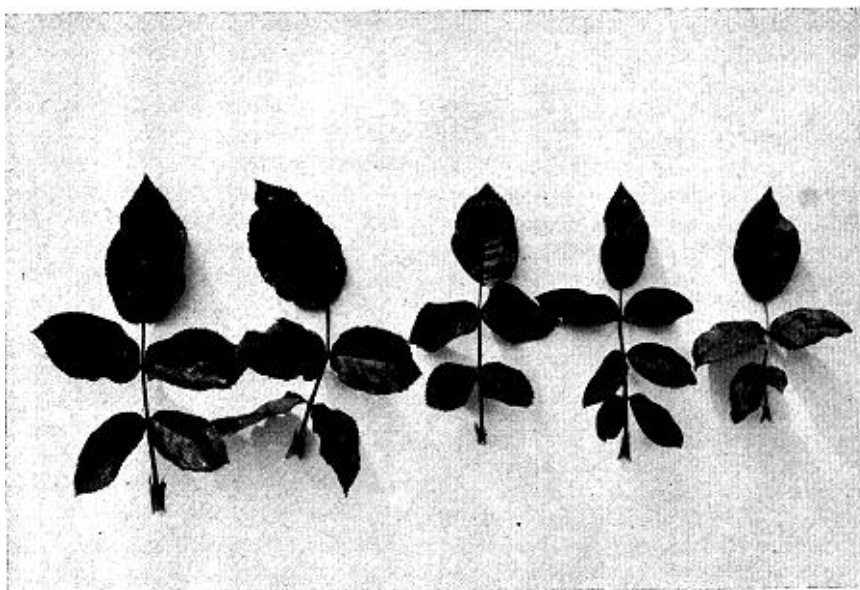


Figure 6 — H56024/39 normal leaf at left compared to four leaf variations on right.

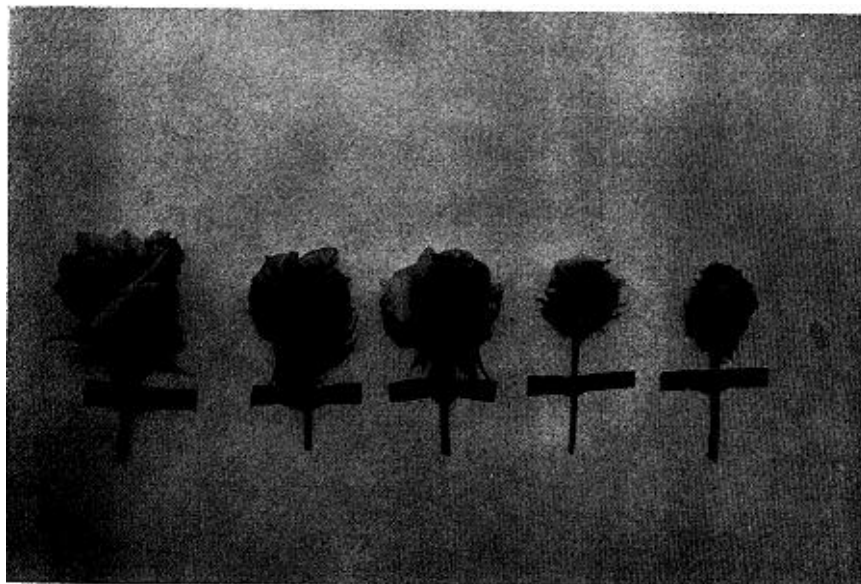


Figure 7—Flower bud of Pink Sensation at left compared to induced mutations on the right.

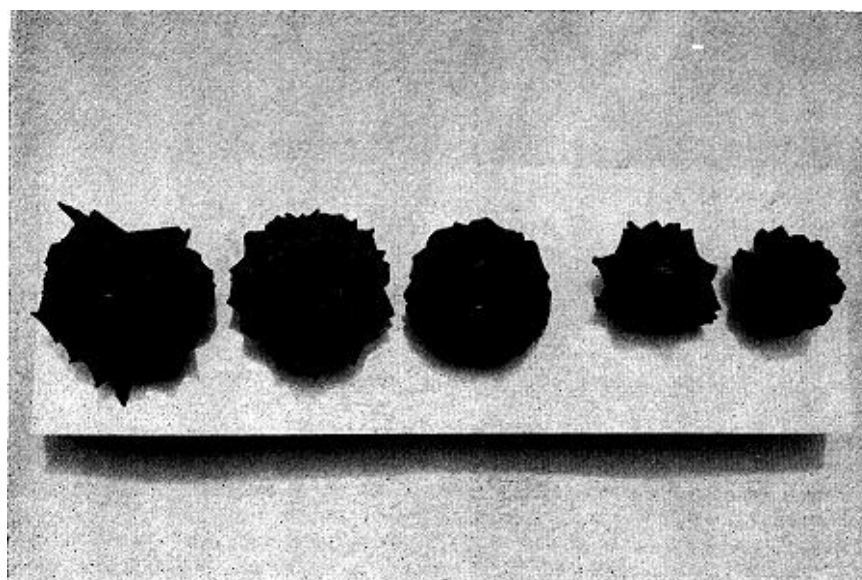


Figure 8 —Variations in flower form induced by neutron radiation of Garnette. Typical Garnette at left.

REVIEW OF H. FRAENKEL-CONRAT, THE GENETIC CODE OF A VIRUS

By BOLTON DAVIDHEISER, Ph.D.

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Fraenkel-Conrat, Heinz

The Genetic Code of a Virus

Scientific American 211:4:47. October, 1964.

The first hint of the existence of viruses came in 1892, when the Russian bacteriologist D. Ivanovsky found that he could infect healthy tobacco plants with a filtrate obtained from extracts of diseased plants passed through a porcelain filter that screened out all bacteria. Knowledge about the tobacco mosaic virus has increased until at present some 200 mutant forms are known and it has been shown that the RNA code is made up of a helix of 6400 nucleotide subunits. This is more than was expected by those who are trying to decipher the "genetic code" of this virus. Although the nucleotides are of only four kinds, their arrangement is complex beyond the expectation of the researchers. The RNA molecule bears the genetic code for synthesizing the 158 amino acid subunits found in the protein coat of the virus, and also for synthesizing various enzymes.

It was found that nitrous acid brings about the replacement of the amino group of some of the nucleotides with the hydroxyl group, and in doing so produces mutant forms, some of which match previously known mutants. These mutants were studied in an effort to discover the arrangements of the nucleotides associated with the synthesis of certain proteins. It became evident that this situation also is more complex than expected.

In this article the Darwinian term *natural selection* is used in two different ways, just as it is in other evolutionary literature. It is said that the most frequently occurring exchanges of amino acids in the shell are probably not the result of mutations occurring preferentially at these sites, a more likely explanation being that they are observed most frequently because they do the least harm to the organism. Thus they are preserved by "natural selection" and are comparable to the natural selection observed by Kettlewell in industrialized areas of England, where dark moths are increasing in number and light moths are decreasing because the

birds can see the light colored moths more easily as they sit in the daytime on the darkened trunks of the trees. As the birds eat more of the light moths, they decrease in number and the camouflaged dark moths increase. It is admitted that the difference between the dark and light moths can be due to a single mutant gene. On the other hand, it is assumed that the protein coat of the virus developed through natural selection. This is an altogether different matter, and it is comparable to the problem of how moths evolved from something which was not a moth. Incidentally the light colored moth still persists showing inefficiency of natural selection even in this classical case after 100 years of industrialization and resulting smog.

As in the case with other creatures, most mutations found in this virus are deleterious. As usual when discussing this phenomenon in other creatures, it is said in connection with this virus that natural selection has done such a good job in evolving a good protein coat for the virus that it is rather to be expected that any mutation would be detrimental and would reduce the viability of the virus. Various enzymes are able to partially digest the protein coat of this virus. Thus one of them digests or chops off the amino acid threonine from the carboxyl (COOH) end of the protein chain. The first mutant studied made the virus so much more susceptible to the enzyme digestion that three instead of only one amino acid could be clipped off by it, thus making the virus distinctly less viable.

A few generations ago biologists accepted a combination of Darwinian natural selection and the de Vriesian mutations as the basis of evolution. Later it was realized that living creatures are too complex to have come about in this way, and it was admitted that the mechanism of evolution was not known. Now, although so much progress has been made in the study of the hereditary mechanism that the scientists write hopefully of "cracking the genetic code" and of "genetic surgery," they have, for want of anything better, returned to accepting the formerly rejected combination of mutations and natural selection as the basis of evolution.

BOOK REVIEW

By WILLIAM J. TINKLE, Ph.D.

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Georges Cuvier, Zoologist. William Coleman, Harvard Univ. Press, Cambridge, Mass., 1964, xii+212 pp. Illus. \$4.75.

Georges Cuvier (1769-1832) was highly respected and very influential during his lifetime. Acceptance of the theory of evolution obscured some of the findings of this great man and made him seem old-fashioned but his principal conclusions never have been disproved.

Mr. Coleman has done science a service by giving detailed facts to replace the legends, some of which are not true.

Cuvier was a devout Lutheran and it has always been supposed that his firm rejection of transmutation of species was caused primarily by his theological convictions. Using unpublished as well as published primary materials, this biographer comes to the conclusion that, contrary to accepted opinion, Cuvier's uncompromising position was based solidly on zoological arguments and was influenced only secondarily by religious feelings.

Unlike the men of his day who used nature to prove their system of theology, Cuvier was content to argue that there is no necessary conflict between science and religion. Since science has not proved otherwise he was at liberty to accept on faith the biblical narrative about the creation of all species near the same time.

The son of an army officer, Georges received a well-rounded education at a four-year academy. While this may seem inadequate to us, it exceeded the training of a number of men of his day who later became famous. This schooling was supplemented by his self training, observing, dissecting, and drawing every type of animal which he found.

Many people have wondered how this unusual man was able to hold high positions continuously while the French government underwent dramatic revolutions. It certainly was not the result of currying favor with officials. During the Reign of Terror young Cuvier was in the quiet province of Normandy (1788-1795), acting as tutor to the son of a noble family named d'Herichys. When he was called to Paris he became Inspector of Public Instruction and later, Vice President of the Ministry of the Interior. He was not a politician but an honest and efficient administrator. It was only because of his efficiency that he was able to carry on extensive zoological research along with his public duties.

Seeing the need for textbooks, Cuvier wrote manuals and texts in zoology which were used throughout the nineteenth century. He is famous also for monographs on fossil quadrupeds.

Although the *Origin of Species* had not yet been written there was much argument in favor of trans-

mutation of species, and Cuvier's opposition to the theory was by no means due to ignorance of it. He recognized that there are some changes but would not admit that new and successful types could be formed. The animal is a functional unit with each organ related to every other organ in such a manner that it is a successfully functioning whole. Another species has different organs but all of them fitted to each other, else they could not cooperate in such a manner as to enable the animal to live successfully. In this way animals are skillfully fitted for the life which they must lead.

Now it can be seen that if there is an accidental change in a harmonious animal, that individual is thenceforth at a disadvantage and is likely to lose its life. An accident incurred during the lifetime of an animal, however, is not inherited by the offspring, hence does not have permanent effect upon the species. The author of this doctrine, acquired characters, J. B. Lamarck, was a contemporary of Cuvier. During his life time very few scientists agreed with Lamarck and now again his work has been rejected.

If an animal is born with an unusual character however, that change is likely to be heritable. In Cuvier's time such animals were called sports and no one studied them carefully. Recently such aberrant forms have been studied very widely and called mutants. Carefully devised experiments by H. J. Muller and others have proved that a majority of such changes (mutations) are lethal¹ and it is hard to mention any which are beneficial to the animal or plant. Thus the modern creationist agrees with this scientist of the past and gives empirical data to prove his position.

Now let us sum up the position of Cuvier on transmutation. He believed that all the species — or perhaps genera as classified at present — were created with planned, harmonious parts. If one should be born with a change in one of its parts it thereby is at a disadvantage and is likely to lose its life before leaving descendants. To survive it would have to be changed to a new type; but this would necessitate changes in all its organs so that a new harmony would be established. Such changes are not found in nature and are not claimed even by evolutionists.

As stated above, some changes are noted in animals but it is not admitted that they can accumulate and so change the type. Some of these changes may be due to the masking of a recessive gene by a dominant, or conversely by a recessive gene expressing itself after being masked. Such variation is necessarily limited, since new genes would be needed to bring about extensive change; especially to develop complex types from simple types.

Cuvier, unlike many of his contemporaries, had no theory about the method of the earth's beginning and was impatient with persons who spun theories which had no empirical foundation. But he had definite views about the methods used in fashioning the surface of the globe. It was postulated that several very severe floods were responsible for the major topographical features and that the last of these was reported in Genesis² and also in the legends of several nations. The most logical method of these floods was the sinking of a large area of land with the resulting rushing in of the sea, accompanied by the lifting of the sea floor in some other area. From the viewpoint of Flood geology the series of catastrophic events would be in reverse order from those postulated by Cuvier. That is the worldwide Flood would come first followed by a series of major but relatively local events.

The opposite explanation of geological change, first stated by James Hutton and later popularized by John Playfair and Charles Lyell, is that all the geological work has been done by forces no different from nor greater than those acting today. Cuvier was familiar with these arguments and commented against them at length. Rain, snow, and ice do attack and wear away the mountains and hills but this argument assumed the preexistence of mountains, valley, and plains, and so could not have given rise to these inequalities. Volcanoes cause local disturbances but do not affect the surrounding strata. Comets also lack force.

The case for cataclysm was based upon observation which is hard to refute. Land animals were found buried under heaps of marine productions. In the Alps were overturned masses of rock which were too massive to be moved by the present slow-acting-, gradual forces. It is just as though a man should attempt to overturn with his hands a boulder weighing a ton. No amount of continued effort would avail and he would have to use another method: either secure help from others or employ machinery. Likewise the present forces of nature are inadequate to account for the topography and no amount of time would make them effective.

Another evidence of fast action is the mammoths which were found frozen in Siberia, the flesh being preserved so well that the dogs accompanying the explorers ate it with relish. "On the other hand, this perpetual frost did not previously occupy the area where we now find it, for these animals could not live at so low a temperature. It was therefore at one and the same instant that these animals perished and the the glacial conditions came into existence."³

Our biographer, Coleman, omits the argument of well preserved fossil shells but the present reviewer considers it important. Cuvier noted that in some places shells must have been covered quickly because, "They are almost everywhere in such a perfect state of preservation that even the smallest

of them retain their most delicate parts, their sharpest ridges, and their finest and tenderest processes." It is evident that they were covered not only quickly but also deeply enough that they were not moved again until fastened in the rock. Any one who has visited the sea shore has noticed how shells are shifted back and forth by the waves until they are worn smooth beyond recognition. Likewise wherever soft parts of animals have left their records in fossils we have proof of fast and powerful burial.

The chief opponent of this principle of catastrophism was Charles Lyell. Yet in his *Principles of Geology* 'he did not try to refute Cuvier's arguments but was content to state his own beliefs. The majority of geologists followed him but it seems to the present reviewer that he followed the *zeitgeist* of the age rather than giving a true interpretation.

Examining the strata of rocks deep in the earth, Cuvier and others found groups of fossil animals different from the living animals of that region. Still deeper there were sometimes other fauna and so on until granite or other igneous rock was encountered. It has been stated that Cuvier believed all animals were killed in the floods which he described, after which God created other species to replace them. This report is in error, and Coleman traces it to a paper by P. Flourens. Cuvier believed that the destructions from floods were not complete and that after each such cataclysm animals migrated to repopulate the devastated areas.

To make the idea clear, our author said, suppose that Australia and the surrounding islands should suddenly sink, destroying all kangaroos and other species of that fauna. If this island should rise again with a land bridge to Asia, animals of different type would migrate to Australia. Then geologists would dig into the rocks and find fossils different than the living animals.

Cuvier, however, was mistaken in one respect, in that he believed the structure of an animal to be preformed already in the female germ or egg. This theory has been disproved by embryology but Cuvier never specialized in that field. He seemed to associate the opposite belief, epigenesis, with spontaneous generation, which he correctly opposed, and which has been sought in vain.

The book is well written, printed, and bound. It is evident that the biographer disagrees with Cuvier in his view of creation, yet I am amazed that he mentions so little evidence against that view.

LITERATURE CITED

- ¹ L. H. Snyder and P. R. David, *The Principles of Heredity*, D. C. Heath, 1957, p. 354.
- ² Genesis 6:8.
- ³ G. Cuvier, *Essay on the Theory of the Earth*, Blackwood, 1818, p. 8.
- ⁴ Chas. Lyell, *Principles of Geology*, Vols. I & II 1837, index.