

The whole contact resembles very much the unconformity on Winn Mountain in Glacier Park; there are also similarities to the formation at Crow's Nest Pass in Canada.

I suggest that the Glarus formation shows a complex petrologic history of depositions, metamorphism, folding, erosion, fresh deposition, and more regional metamorphism. There are marked unconformities, but no signs of thrusting; only signs of readjustment after the folding.

### Conclusion

Creationists need often to point out that the undeniable fact of variation, or micro-evolution as some prefer, is by no means evidence for macro-evolution. Likewise, in this matter of thrusts, a creationist need not deny that overthrusts have occurred on a modest scale, and that the Scottish formations are very likely examples.

But from that it by no means follows that such formations as Glarus, or that on Heart Mountain (near northeast entrance to Yellowstone National Park), are overthrusts, as is so often alleged. Indeed, there is good evidence that overthrusting on such a scale would be mechanically impossible. Moreover, once the falsity of organic evolution is recognized, there is no need to suppose thrusting, in order to have the rocks in what is supposed to be the right order.

### References

- <sup>1</sup>Burdick, Clifford 1975. European invasion, Bible-Science style, *Bible-Science Newsletter*, 13 (7):3-5. July.
- <sup>2</sup>Howe, George F. 1972. Overthrust evidence as observed at faults caused by the San Fernando earthquake, *Creation Research Society Quarterly*, 8 (4):256-260.
- <sup>3</sup>Lammerts, Walter E. 1972. The Glarus overthrust, *Creation Research Society Quarterly*, 8 (4):251-255.
- <sup>4</sup>Billings, M. P. 1955. Structural geology. Prentice-Hall, New York, p. 131.

## ORIGIN AND MAINTENANCE OF OPTICAL ACTIVITY

LARRY S. HELMICK\*

*Optical activity is a fundamental physical property of all living organisms. Therefore, any theory used to account for the origin of life on earth must also account for this amazing phenomenon. The mechanistic theory, involving chance and natural selection, is inadequate to explain the origin and maintenance of optical activity which is presently observed in the biosphere. However, a teleological theory based upon a recent, highly ordered divine creation, followed by degeneration, will account for this phenomenon. Moreover, such a theory is in agreement with the Genesis account of creation, the laws of thermodynamics, modern chemical theory, and chemical, biological, and geological data.*

### Introduction

Biological evolution has been a major topic of interest for over a century. However, significant research interest in alleged chemical evolution, i.e., "the chemical events that took place on the primitive, pre-biotic earth (about 4.5-3.5 billion years ago) leading to the appearance of the first living cell,"<sup>1</sup> began only recently, but is rapidly expanding. This increasing interest in presumed evolution at the molecular level might well be attributed to the growing respectability of this field for scientific research, to impetus from American and Russian space programs, and to international symposia of leading researchers in this area in recent years. As a result, much good chemical research has been done, but several major problems have been encountered.<sup>2</sup>

One such problem, the origin of optical activity (the property of rotation of the plane-polarized light by a dissymmetric molecule), has been referred to as "the key unsolved problem of detailed biogenesis."<sup>3</sup> Since practically all components of living systems are optically active, optical activity is a fundamental physical property of life as we know it.<sup>4</sup> Any theory, then, used to explain the origin of life on Earth must also account for this amazing phenomenon. Since this phenomenon arises due to the three-dimensional character of chemical compounds, an understanding of the following basic principles of modern stereochemistry is necessary to fully appreciate the problem.

\*Larry S. Helmick, Ph.D., is Professor of Chemistry at Cedarville College, Cedarville, Ohio 45314.

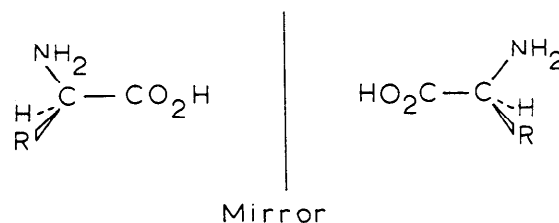


Figure 1. The two enantiomers of an amino acid.

Chiral† compounds may exist as two isomers, called enantiomers, which are mirror images of each other, see Figure 1. Individual enantiomers can generally be shown experimentally to rotate plane polarized light and are thus optically active. Mixtures containing equal concentrations of both enantiomers, racemic modifications as they are called, are found to be optically inactive.

Enantiomers are known to possess identical physical properties, except for the direction in which they rotate plane-polarized light. They also possess identical chemical properties, except when treated with pre-existing optically active reagents. Since, apart

†"Chiral" means literally "handed," in the sense of right- or left-, and is synonymous with "optically active." As mentioned, the direction of polarization of polarized light, upon passing through these materials, will be turned to the right or left, in the way in which a right- or left-hand screw would be turned to drive it. This behavior is associated with a dissymmetry in the molecular structure of the material, but the relationship may not be a simple one.

from dissymmetric conditions, the physical and chemical properties of the enantiomers are thus intrinsically identical, the question arises as to what major factors contributed to the selection and production of living systems containing only one of the two possible enantiomers. It would appear that two fundamental explanations<sup>5</sup> may exist:

1) a mechanistic theory<sup>6,7</sup> involving chance and natural selection;

2) a teleological theory<sup>8</sup> involving design and special creation;

Although several hypotheses have been suggested in support of the mechanistic theory,<sup>9,10</sup> at present no generally accepted hypothesis accounts for this amazing phenomenon.<sup>11-14</sup> On the other hand, the teleological theory has been given relatively little attention, at least in connection with optical activity.

It is the purpose, then, of this paper to consider this matter of optical activity from a creationistic viewpoint. Some basic ideas are proposed, in the hope that they may stimulate research and discussion about a teleological theory, and that the resulting teleological theory may be more adequate than any mechanistic theory proposed so far. In so doing, the challenge of J. D. Bernal, as expressed in the following quotation, is accepted.

Now that we are embarking on a serious scientific discussion of the question of the origin of life, it is time that . . . we were furnished with a more precise, complete, and self-consistent account of the spiritual or divine origin of life than any that have been produced as an alternative to the mechanistic one. Such an argument . . . should provide us with a clearer path to further scientific advance, even if it does not reach the end.<sup>15</sup>

This, of course, first brings up the question of whether origins are even subject to scientific investigation. Concerning the origin of life, Dr. Alexander I. Oparin, Director of the Bach Institute of Biochemistry, has stated:

It is generally accepted today that the development of the first forms of life on Earth was not a solitary "happy" event (as had formerly been assumed) but an event whose repetition was an integral part of the general development of matter—and thus an event that lends itself to serious scientific investigation.<sup>16</sup>

Dr. Sidney W. Fox, Director of the Institute for Molecular Evolution and Professor of Biochemistry at the University of Miami has written:

The belief is growing that theories derived from inferences of the nature of the prebiological world can be tested against knowledge of the chemical composition and behavior of organisms. The subtle interplay between experiment and theory in this field may be expected to provide a means of checking our various inferences about organic geochemistry before life appeared and before life altered it in some as yet undetermined degree.<sup>17</sup>

Obviously, these two leading researchers believe that the origin of life is subject to scientific investigation. On the other hand, Dr. M. G. Rutten, Professor

of Geology, State University, Utrecht, Netherlands, has stated:

. . . natural organic compounds cannot . . . be formed in nature now, except through processes occurring in living matter already in existence. Under present conditions, it follows that the origin of life from inorganic beginnings is impossible, because only living matter in its turn can synthesize organic compounds.

The crucial point lies not, however, in the fact that such an origin is altogether impossible, but only in that it is impossible under present circumstances.<sup>18</sup>

If the origin of life from inorganic beginnings is impossible to demonstrate under present circumstances, it is outside the realm of science at the present state of development,<sup>19</sup> and is consequently presently impossible to prove. Nevertheless, theories which result in experimentally testable hypotheses and questions are valuable in that they may lead to additional insight as to how life may have originated. The results of such experiments may very well *disprove* one theory, or *support* another theory, but they *can not prove* a theory.<sup>20</sup> It is under these conditions, then, that theories concerning the origin of optical activity need to be considered.

### Mechanistic Theory

According to modern chemical theory, *all* syntheses of chiral compounds not employing some type of pre-existing chiral reagent, catalyst, or force, will produce racemic modifications, rather than optically active products. Experimentally, *all* syntheses of chiral compounds conducted under simulated prebiotic conditions not involving chiral reagents have indeed actually resulted in racemic modifications.<sup>21-24</sup>

Therefore, it seems that any process resulting in the synthesis of the *initial* optically active compounds under prebiotic conditions must necessarily have involved some type of chiral conditions. Consequently, this is the direction of research concerning the origin of optical activity.

However, syntheses involving circularly polarized light, adsorption on clay, quartz crystals, stereospecific autocatalysis, and stereospecific polymerization have all been seriously criticized by experts in this field for various reasons, and none appear adequate to account for the origin of optical activity.<sup>25-30</sup> Consequently, further consideration and criticism here appears unnecessary.

Since researchers have not been able to demonstrate convincingly the feasibility of optical activity arising under supposed primitive earth conditions involving chiral reagents, they have begun to look elsewhere for potential answers to this problem.

The only apparent alternative consistent with the mechanistic theory which might account for the origin of optical activity during the *initial* (synthesis) stage of molecular evolution would be the occurrence of a single chance event which resulted in the determination of the chirality of one compound. This compound, being optically active, might then influence the synthesis and consequently the chirality of other compounds in the environment, eventually resulting in

the high degree of optical activity which is observed today.<sup>31-34</sup>

This possibility cannot be denied. A single chance event, however, does not appear to be as strongly supported in recent years as it once was. Instead, it is assumed that conditions which could result in the production of life in one location would also exist at several other locations. This implies that life "evolved" essentially simultaneously at several different localities throughout the earth. Consequently, the fundamental properties of living organisms, such as optical activity, should reflect the common conditions of the prebiotic environment rather than the unique conditions of a single event.<sup>35-38</sup>

If the occurrence of optical activity as the result of a single chance event during the initial stage of molecular evolution is arbitrarily eliminated, as is presently being advocated, then, according to the mechanistic theory, optical activity must necessarily be the result of *natural selection* of one enantiomer from a racemic modification during some *latter* stage of molecular evolution.<sup>39</sup> As shown in the following discussion involving thermodynamics and statistics, however, **this process of spontaneous resolution of racemic modifications can neither be explained theoretically nor observed experimentally.**

**The Second Law of Thermodynamics:** According to this law, in the gas and liquid phases, the formation, not resolution, of a racemic modification is the spontaneous process. The Gibbs free energy change,  $\Delta G$ , associated with the formation of a racemic modification at constant temperature and pressure is given by:  $\Delta G = \Delta H - T \Delta S$ , where  $\Delta H$  is the change in enthalpy,  $T$  is the absolute temperature, and  $\Delta S$  is the change in entropy.<sup>40</sup> If the change in Gibbs free energy is negative, the process will be spontaneous.

Assuming ideal behavior, which is probably valid for the dilute solutions postulated to have been present on the primitive earth, the change in enthalpy is zero.<sup>41</sup> Consequently, the change in Gibbs free energy would be determined by the change in entropy.

The change in entropy due to mixing two enantiomers is given by:  $\Delta S = -Rn_1 \ln X_1 - Rn_2 \ln X_2$ , where  $n_1$  and  $n_2$  are the number of moles of enantiomer 1 and 2, respectively;  $X_1$  and  $X_2$  are the mole fractions of enantiomer 1 and 2, respectively; and  $R$  is the ideal gas constant, 1.987 cal deg<sup>-1</sup> mole<sup>-1</sup>. For formation of one mole of a racemic modification,  $n_1 = n_2 = 0.5$  and  $X_1 = X_2 = 0.5$ . Consequently,  $\Delta S = 1.38$  cal deg<sup>-1</sup> mole<sup>-1</sup>.

The change in entropy due to racemization (formation of a racemic modification from only one enantiomer) is given by:  $\Delta S = -R \ln (1/2)$ , which equals 1.38 cal deg<sup>-1</sup> mole<sup>-1</sup> also. Therefore the change in entropy is independent of the mechanism involved in formation of the racemic modification, and is positive due to formation of a more disordered state.

At room temperature (298°K), then,  $\Delta G = -410$  cal mole<sup>-1</sup>. The decrease in free energy means that formation of a racemic modification is the spontaneous process (Table 1, A). Since Gibbs free energy is a function only of the initial and final states of the system, it follows that the reverse process, resolution of a racemic modification (Table 1, B), would not be a

Table 1.  $\Delta G = \Delta H - T \Delta S$

	$\Delta H$	$\Delta S$	$\Delta G$	Spontaneous Process
A.	0 <sup>a</sup>	+	—	racemization
B.	0 <sup>a</sup>	—	+	racemization
C.	—	+	—	racemization
D.	—	—	+ <sup>b</sup>	racemization
E.	—	—	— <sup>c</sup>	resolution
F.	+	+	+ <sup>c</sup>	resolution
G.	+	+	— <sup>b</sup>	racemization
H.	+	—	+	racemization

<sup>a</sup>For ideal solutions.

<sup>b</sup>For dilute aqueous solutions,  $T \Delta S > \Delta H$ .

<sup>c</sup>For concentrated solutions,  $\Delta H > T \Delta S$ .

spontaneous process, *regardless of the mechanism involved in the resolution process.*

But suppose the solution is not ideal. The two quantities,  $\Delta H$  and  $\Delta S$ , may have opposite signs. If  $\Delta H$  is negative while  $\Delta S$  is positive (racemization), then  $\Delta G$  will be negative and racemization will again be spontaneous (Table 1, C). If  $\Delta H$  is positive while  $\Delta S$  is negative (resolution), then  $\Delta G$  will be positive and resolution will not be spontaneous (racemization will be spontaneous, Table 1, H).

On the other hand, if  $\Delta H$  and  $\Delta S$  have the same sign, then the relative absolute magnitudes of the two terms ( $\Delta H$  and  $T \Delta S$ ) become significant. For real dilute aqueous solutions, the absolute magnitude of  $\Delta H$  would be expected to be small (and would approach zero as the solution approached ideal behavior on further dilution). At any temperature for which the solution could exist as a liquid (any temperature above freezing, 273°K) the  $T \Delta S$  term would be larger than 376 cal deg<sup>-1</sup> mole<sup>-1</sup> and would be expected to be the dominant term. Consequently, racemization would again occur spontaneously (Table 1, D and G).

Finally, the solution may be concentrated or even supersaturated. Such solutions are often postulated to have existed on the primitive earth, if water reservoirs slowly evaporated. Then  $\Delta H$  would be expected to have a large absolute magnitude, and could be the dominant term in the equation. In this case, if  $\Delta H$  and  $\Delta S$  both have the same sign, resolution would appear to occur spontaneously (Table 1, E and F).

This is actually the case in one procedure which has been suggested as a possible means of accounting for the spontaneous origin of optical activity totally apart from any dissymmetric reagents, catalysts, or conditions. It concerns the spontaneous fractional crystallization of one enantiomer from a supersaturated solution of a racemic modification of a quaternary amine which undergoes autoracemization.<sup>42</sup> This system is novel because, as one enantiomer crystallizes out, the equilibrium which exists between the two enantiomers is shifted, causing the solution to remain racemic (See Figure 2).

Crystallization of only one enantiomer, while the solution remains racemic, appears to constitute spontaneous resolution of a racemic modification, as well as spontaneous generation of optical activity, totally apart from any dissymmetric conditions. However, this is contradicted by statistical data.

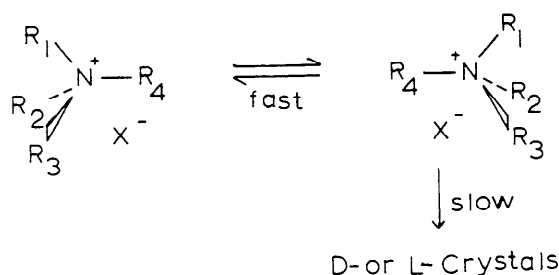


Figure 2. Stereospecific crystallization.

**Probability and Statistics:** Chemical theory is based on probability and statistics. The laws of probability are applicable only when a large number of independent pieces of data are being considered. The single isolation of one enantiomer from a supersaturated solution of a racemic modification is only one piece of data. When impurities are carefully excluded and a large number of independent runs are considered, determination of which enantiomer will crystallize out in any given run appears to be random.<sup>43, 44</sup> Thus, the probability of one enantiomer predominating significantly after many crystallizations is exceedingly small.

Therefore, when the statistically large number of trials which are thought to have occurred throughout the primitive earth are considered, this process would seem useless for explaining the origin of optical activity. Furthermore, the relatively high temperatures and mixing action of wind and water would rapidly produce racemic modifications and thus negate any positive results within any one locality.<sup>45, 46</sup> Consequently, this process would also produce optically inactive systems under primitive earth conditions.

Although it is thus apparent that resolution of a racemic modification is not likely to be a spontaneous process in the liquid and gas phases under primitive earth conditions, a theoretical treatment of the solid phase process is beyond the scope of this paper. Nevertheless, from experimental data, it is clear that even in the solid state, racemization, not resolution, is occurring under actual as well as simulated geological conditions. Racemization has actually been reported to be occurring in recent ocean sediments,<sup>47</sup> fossil shells,<sup>48</sup> fossil bones,<sup>49</sup> and during thermal polymerization of amino acids.<sup>50</sup>

Since spontaneous generation of optical activity must occur, according to the mechanistic theory, it is highly significant as well as devastating to the theory to note that "the spontaneous generation of optically active material in a closed racemic system in the absence of any dissymmetric agent has *never been demonstrated*."<sup>51</sup> (Emphasis added)

Thus, it would appear from both theoretical and experimental considerations that, under the conditions assumed to have existed on the primitive earth, **optically active systems necessary for the evolution of**

living organisms could not have arisen by means of natural processes.<sup>†</sup> Consequently, Dr. George Wald, Professor of Biology at Harvard University, proposed that selection of one enantiomer from the racemic modifications might be the *result* of life, rather than a *prerequisite* for life.<sup>52</sup> He suggested that selection of one enantiomer from a racemic modification by a growing  $\alpha$ -helix was possible due to the inherent stability afforded by the preferential interactions of substituents on the amino acids during polymerization.

In initial experiments, however, the right-handed helix formed by condensation of L-amino acids in a solution containing only L-enantiomers is longer and forms faster than the right-handed helix formed from D and L-acids in a solution containing racemic amino acids.<sup>53</sup> This, of course, supports the common postulate that life consisting of one enantiomer in an environment of the same enantiomer would have an advantage over racemic life in a racemic environment.

In fact racemic life might not even be expected to be viable. "Requirements of cellular size alone to accommodate this [racemic] system should diminish the probability [that it would support life] to the vanishing point."<sup>54</sup> Furthermore, "it is apparent . . . that the proper conformation and amino acid sequences of many different regions of an enzyme are essential for its physiological activity."<sup>55</sup> Thus, maintenance of configurational integrity is essential to the survival of an organism.<sup>56</sup>

As expected, however, no advantage was noted for formation of the right-handed helix by L-amino acids over formation of the left-handed helix by D-amino acids. Consequently, both enantiomeric forms of primitive life, one consisting of L-enantiomers in right-handed helices and the other of D-enantiomers in left-handed helices, would have been equally viable.<sup>57</sup> It has even been suggested:

The transformation of all molecules and organisms on Earth into their mirror images should not interfere with continued survival. Thus, a left-handed  $\alpha$ -helix composed of D-amino acids in such a hypothetical system should have the same chance for survival as does a right-handed  $\alpha$ -helix composed of L-amino acids in the actual systems.<sup>58</sup>

Since then, it has been shown that there is little, if any, stereoselectivity evident at the oligopeptide level due to the inherent stability afforded by preferential interactions of substituents on the amino acids during polymerization.

These results suggest that the synthesis of stereohomogeneous polypeptides would have had to depend on chance associations at the simple peptide level and then on stabilization of homopolymers by the  $\alpha$ -helix at higher degrees of polymerization.<sup>59</sup>

But even then, *both forms of enantiomeric life would have been equally probable and viable*. Consequently, this hypothesis also is not an explanation of how one enantiomer could have been selected from racemic modifications to be retained by all biological systems. Therefore, the answer sought has not been found, and it does not appear that there are any additional alternatives consistent with mechanistic theory.

<sup>†</sup>Dr. James F. Coppedge, Director of the Center for Probability Research in Biology, Northridge, California, reached this same conclusion from a consideration of probability theory. See Coppedge, J. F. 1973. *Evolution: possible or impossible*. Zondervan Publishing House, Grand Rapids, Michigan, pp. 71-79 and 95-115.

It is in such a vacuum, then, that the teleological theory involving design and special creation may be put forward to stimulate new ideas, discussion, and research.

### Teleological Theory

It has already been boldly stated, "It is simple to account for optical activity if life was created."<sup>60</sup> However, such a position does not appear in the literature in any appreciable detail. Perhaps the following remarks will stimulate the formation of a more detailed account which may then be evaluated and criticized by creationists and evolutionists alike. However, this will require careful scrutiny of basic presuppositions and modes of thought, as well as existing data, and, as indicated by the following plea by Dr. Peter T. Mora of the National Institutes of Health, an inquiring mind.

Let us think freely. Let us not be afraid to question the sufficiency of principles of physics applied to biology, no matter how successful these principles are in physics, and especially let us not fool ourselves with probability where there is no room for it. Let us even dare to ask whether there is something special in the living, which cannot be treated by physics as we know it, but is still amenable to proof or disproof. By this type of thinking we may be able to devise experiments which may lead to the expansion of knowledge. Who knows, we may be able to throw new light on this old problem.<sup>61</sup>

Theories of origins, of course, are generally based upon *untestable presuppositions*. But this does not exclude the *conclusions* drawn from the presuppositions from critical analysis and comparison with existing data. They should be consistent with observable phenomena and known scientific laws, particularly the first two laws of thermodynamics.

The first law of thermodynamics is recognized as the "most powerful and most fundamental generalization about the universe that scientists have ever been able to make."<sup>62, 63</sup> The law is: "Energy can be transferred from one place to another, or transformed from one form to another, but it can be neither created nor destroyed."<sup>64</sup> The second law: "Every naturally occurring transformation of energy is accompanied, somewhere, by a loss in the availability of energy for the future performance of work,"<sup>65</sup> is also well established.

These two laws involve the concept, stated as certainly as scientists can state anything, that the diversity, or disorder, in the universe is increasing, rather than decreasing. Since disorder is still increasing, the universe cannot be infinitely old, or it would already be in a totally random state. Consequently, the universe must have had a beginning as a highly ordered system.<sup>66, 67</sup> Scientists sometimes refer to such a highly ordered condition as a perfect state.

It would appear that a perfect state such as this, which subsequently underwent degeneration, is implied in the Genesis account of creation, and was the result of design by a holy God.<sup>68</sup>

If the perfect holy God created, then the

creation would be perfect. Here would be perfection in nature, perfection in the universe, and as far as the solid state, perfect crystals. However, today we find very little, if any, perfection in nature, and this change from order to disorder must have occurred by divine edict later than Genesis 1:31. He spoke all nature into being, and then cursed His perfect creation because of man's sin.

Thus the perfectly ordered crystalline materials that God created have degenerated into atomically disordered materials because of the operation of the second law of thermodynamics. The crystalline lattices in solids no longer exhibit order but are filled with defects that interrupt order and cause disorder.<sup>69</sup>

This degeneration applies to more than just the inanimate solid state. Similar statements concerning degeneration of man and animals<sup>70, 71</sup> have also been made: "The intake in any way of any disordered material would destroy the ordered perfection of the newly created creatures."<sup>72</sup> "Man was created perfect. . . . Like the atom, he came from the hand of God a 'finished product'."<sup>73</sup> "Changed nucleotide bases, additions or losses, . . . all yield defective or degenerative results. If this is so, then the first or original man must have possessed the superior, or the ultimate in genetic quality, with decreasing potential (and increasing variations) being expressed in subsequent generations."<sup>74</sup> Thus the whole creation living as well as nonliving, was initially a highly ordered state, but is presently becoming more and more disordered.

The existence, then, of an initially designed and highly ordered creation, followed by degeneration, as described in Genesis and by the laws of thermodynamics, is the *basis* of the teleological theory. It can now be shown that *this basis affords not only the initial optically active systems* necessary to propagate life and optical activity, but that *it also is a basis for predicting degeneration* by means of spontaneous racemization, which accounts for the degree of racemization presently observed in the geological strata and the biosphere.

As has already been pointed out, the highest degree of order for chiral compounds occurs in the resolved state, in contrast to the racemic state. Thus, in order to obtain the highest degree of order, one would predict from the teleological theory that the original creation consisted primarily of *only one* of the two possible enantiomers of each of the chiral compounds.

Furthermore, according to the teleological theory, the original creation was perfect with all of the various facets working together in harmony. This requires that all enantiomers of an homologous series of compounds have the same configuration. For example, due to food chains, ". . . it would become highly advantageous [for all organisms] to utilize a single configurational series of molecules. Anything else would create endless difficulties."<sup>75</sup> In this context, then, the universal phenomenon of optical activity in living systems is neither a theoretical nor experimental problem, but it is both *predicted* from the theory and *observed* experimentally.

### Maintenance of Optical Activity

One would also predict from the teleological theory that spontaneous racemization would occur with time, in agreement with the second law, causing the biosphere to gradually degenerate to the thermodynamically more stable racemic modification. That this has not already occurred may very well be another indication that life on earth is not billions of years old, as is commonly claimed.

If enantiomeric life was designed and created *recently*, as suggested by several independent lines of evidence,<sup>76</sup> and if racemization of amino acids is a slow process under geological conditions, then the geological column should exhibit a *low* degree of racemization, even when inorganic sources of racemic amino acids are included in the analysis. However, if enantiomeric life has existed on the earth for billions of years, as evolutionists claim, and if racemization actually occurs at any appreciable rate whatsoever under geological conditions, then there ought to be tremendous quantities of racemic amino acids everywhere in the geological column, provided they have not been completely destroyed by other means during that time. The rate of racemization of amino acids under geological conditions, and the degree of racemization in the geological strata may be estimated from existing data.

The rate of racemization of several amino acids, as well as the rate of epimerization of isoleucine (inversion of only the  $\alpha$ -carbon of isoleucine, which has two asymmetric carbons) to its diastereomer, alloisoleucine (See Figure 3), has been determined under various laboratory conditions.<sup>77</sup> Isoleucine is one of the slowest amino acids to "racemize," and the easiest to detect experimentally, since it forms a diastereomer rather than an enantiomer. Since this diastereomer is not a naturally occurring amino acid, its presence in biological material is generally believed to be the result of epimerization of isoleucine.<sup>78</sup>

Racemization of amino acids proceeds at measurable rates only at elevated temperatures (85-225°C).<sup>79</sup> However, from rates determined at several temperatures, the energy of activation for the rate determining step in the epimerization of isoleucine has been calculated. Thus the rate of epimerization at lower environmental temperatures (0-30°C) could also be calculated.<sup>80</sup>

The rate of racemization of amino acids has also been shown to be a function of pH, and the electron withdrawing property of the substituent on the  $\alpha$ -carbon. Some evidence has suggested that buffer concentration, peptide bonds, and the inorganic matrix may also affect the rate.<sup>81, 82</sup>

Racemization of amino acids is presumed to follow first order kinetics, and to proceed via an enol stabilized carbanion intermediate.<sup>83, 84</sup> This would account for the lack of inversion of the second asymmetric carbon in isoleucine under ordinary racemization conditions.

Simulation of geological or biological conditions, however, is considerably less precise. Since acidity and temperature appear to be the major rate determining factors under laboratory conditions, contributions from the buffer base, inorganic matrix and peptide

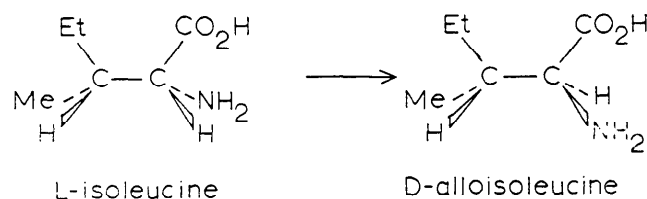


Figure 3. Epimerization of isoleucine.

bonds have been neglected in calculating the rate of epimerization of isoleucine under geological conditions.

Thus assuming a pH of 7.6 and an average temperature of 0°C, the half-life for epimerization of isoleucine is  $4.4 \times 10^6$  years.<sup>85</sup> It has been noted, however, that a 5° increase in average temperature will double the rate of epimerization.<sup>86</sup> Furthermore, a slightly more basic medium, such as in carbonate shells or sediments, or a destabilizing matrix, could increase this rate by an additional factor of ten.<sup>87</sup>

About 20 million years (five half-lives) then, would appear to be an upper age limit for complete racemization of amino acids under geological conditions. Other estimates range from  $10^5$  to  $10^7$  years. Material thought to be *older* than this, which includes *nearly all* of the geologic column, should be *completely racemized*. Isoleucine should be in equilibrium (approx. a 1 to 1.25 ratio)<sup>88</sup> with alloisoleucine. Furthermore, unstable amino acids should be completely absent.

Therefore, it is certainly interesting to note that many "old" specimens do indeed contain incompletely racemized or unstable amino acids. The three billion year old (estimate) Fig Tree Chert contains only L-amino acids.<sup>89</sup> The Precambrian Gunflint Chert, estimated at two billion years old, contains isoleucine, but little or no alloisoleucine.<sup>90</sup> A Precambrian asbestos sample and unheated Miocene sediments show "little or no alloisoleucine."<sup>91</sup> Therefore, a recent biological source for those amino acids has been suggested.

Also the 60 million year old (again estimated) Green River oil shale is not completely racemized.<sup>92</sup> Unstable amino acids have been reported in sediments older than Pleistocene.<sup>93</sup> Amino acids in Mesozoic and Paleozoic shells, and in some fossil corals, may include "material of more recent origins."<sup>94, 95</sup>

The rock matrix around some fossil shells (which exhibit increasing amounts of alloisoleucine relative to isoleucine with depth) . . . has no appreciable amount of alloisoleucine, although there are significant amounts of isoleucine.<sup>96</sup> This observation is particularly interesting since fossils are generally considered to be the same age as the strata in which they are found. Finally, peptides, which should have hydrolyzed long ago, have been reported in fossil nacreous shells as old as Ordovician.<sup>97</sup>

In summary, there have been a number of studies of the amino acids in generally random samples of geological interest. Samples representing most of the geologic column including the Precambrian have been reported to contain several amino acids including some relatively unstable ones.<sup>98</sup>

From these broad but preliminary results under geological conditions, it would appear that unstable or optically active amino acids are commonly found *throughout* the geologic column, rather than just in relatively recent strata. If considered apart from the time scale demanded by evolutionists, it becomes apparent that enantiomeric life, and the strata containing such remains, originated relatively recently, in accord with the teleological theory. By using the mechanistic theory, on the other hand, the evolutionist is unable to explain these observations, except to suggest that much of the geologic column has somehow been contaminated with recent amino acids.<sup>99</sup>

Optically active amino acids are not only found in geological strata, they are also found in high enantiomeric purity in practically all presently *living* organisms. Thus any theory used to explain the origin and maintenance of optical activity must also account for this high degree of optical activity in living organisms.

Several questions might be raised in this regard. For example, "... what happens to molecules which are accidentally racemized and to the small but probably finite number of molecules which are synthesized in the wrong configuration, etc."<sup>100</sup>

Obviously, the number of molecules synthesized in the wrong configuration or spontaneously racemized, would increase with time, even if the rate of racemization in living organisms was slow. Furthermore, a small number of these molecules might be expected to accumulate in the proteins of living organisms, both as a result of racemization in the individual organism, and as a result of nonlethal mutations resulting in D-amino acids accumulating in the species. Depending upon the rate of racemization, the length of time available for racemization since the origin of the species, and the sensitivity of analytical instruments, D-amino acids might eventually reach detectable and physiologically significant concentrations.

Since the mechanistic theory is used to explain the present high degree of optical activity in living organisms as resulting from the unobserved spontaneous *resolution* of racemic modifications over long periods of time, then it cannot be used to account for this reverse, but probably significant, process. On the other hand, one can predict from the teleological theory, in agreement with experimental observation, that most organisms would still maintain a high degree of optical activity due to their recent creation.<sup>101</sup>

Any change, of course, in perfect proteins would, of necessity, result in some type of ill affect on the organism. An accumulation of such errors would be expected to be visible as genetic defects, inferior viability, susceptibility to various diseases, and rapid aging or death due to the decrease or interruption of the physiological activity of the imperfect enzymes.<sup>102-105</sup>

The decreased viability of organisms containing mutant genes which would allow incorporation of D-amino acids into the proteins would serve to eliminate these genes from the gene pool of the species, and thus generally prevent the accumulation of a high concentration of D-amino acids in the proteins of the species.

Thus, creationists using the teleological theory, in agreement with the second law of thermodynamics, are able to explain the degree of racemization presently maintained in all living organisms.

### Conclusions

The question of the origin and maintenance of optical activity is open to scientific investigation. Thus far, however, researchers employing chiral reaction conditions have been unable to demonstrate the feasibility of optical activity arising during the initial stage of supposed molecular evolution. Thus the mechanistic theory rests upon the spontaneous resolution of racemic modifications during some latter stage of molecular evolution. However, according to theoretical considerations as well as experimental data, resolution under primitive earth conditions would not have been spontaneous. Consequently, the mechanistic theory is useless as a means to account for the origin of optical activity. Furthermore, the present degree of optical activity observed in the geological strata and the biosphere is unexplainable by the mechanistic theory.

The teleological theory, on the other hand, is based upon the laws of thermodynamics as well as the Genesis account of a recent creation followed by degeneration. Thus it can be used to account for not only the origin of optical activity, but also the degree of optical activity maintained in the geological strata and the biosphere. Consequently, the teleological theory is superior to the mechanistic theory as an explanation of the origin and maintenance of optical activity on the earth.

Moreover, the existence of optical activity in many places is excellent evidence of a young earth.

### Summary

One outstanding characteristic of all living organisms is the presence of optically active compounds. However, a fundamental conclusion deducible from modern chemical theory is that an optically active system cannot arise spontaneously from an optically inactive one. Consequently, when evolutionists utilize a mechanistic theory to propose that the present optically active biosphere arose from optically inactive reagents under supposed primitive earth conditions, they encounter a significant dilemma at the molecular level, for which no generally acceptable solution has yet been proposed.

However, a teleological theory based on a recent highly ordered divine creation, followed by degeneration, as described in Genesis, is consistent with the laws of thermodynamics and is in agreement with chemical, biological, and geological data. Furthermore, initially highly active systems necessary to produce the degree of optical activity observed in the biosphere today are logical consequences of a teleological theory. Thus, creationists can offer a teleological theory as a long sought answer to the origin and maintenance of optical activity, an answer which evolutionists have been unable to provide with a mechanistic theory.

### Acknowledgments

Comments concerning the manuscript by Randy Helmick, Roger Helmick, and Dr. Dennis Flentge are greatly appreciated.



## References

- <sup>1</sup>Lemon, R. M. 1970. Chemical evolution, *Chemical Reviews*, 70 (1):95-109.
- <sup>2</sup>Bernal, J. D. 1967. The origin of life. World Publishing Co., N.Y., pp. 138-158.
- <sup>3</sup>*Ibid.*, p. 144.
- <sup>4</sup>"Indeed, optical activity is now recognized as such an inherent feature of life that the failure of other planets to yield optically active material will be taken as evidence for the absence of life of complexity comparable with the Earth's." Elias, W. E. 1972. The natural origin of optically active compounds, *Journal of Chemical Education*, 49:448-454.
- In fact, the presence of racemic modifications of amino acids in the Murchison Meteorite, which landed in Australia in 1969, has actually been interpreted to imply that the amino acids were of inorganic origin (See Abernethy, J. L. 1972. The concept of dissymmetric worlds, *Journal of Chemical Education*, 49:455-461). This was also one of the reasons for the careful search for amino acids in the moon rocks recovered by the Apollo expedition (See Fox, S. W., et al. 1970. Bio-organic compounds and glassy microparticles in lunar fines and other materials, *Science*, 167 (3918):767-770).
- <sup>5</sup>Bernal, J. D. *Op. cit.*, pp. 138-142.
- <sup>6</sup>Keosian, J. 1964. Origin of life. Reinhold Publishing Corp., N.Y., p. 76.
- <sup>7</sup>Florkin, M. and E. Stotz, Editors. 1962. Comprehensive biochemistry. Elsevier Publishing Co., N.Y., 1:225.
- <sup>8</sup>Mora, P. T. 1965. The origins of prebiological systems and their molecular matrices. S. W. Fox, Editor. Academic Press, N.Y., pp. 39-64.
- <sup>9</sup>Wald, G. 1957. The origin of optical activity, *Annals of New York Academy of Science*, 69:352-368.
- <sup>10</sup>Elias, W. E. *Op. cit.*, pp. 448-454.
- <sup>11</sup>Bernal, J. D. *Op. cit.*, p. 144.
- <sup>12</sup>Eliel, E. L. 1962. Stereochemistry of carbon compounds, McGraw-Hill Book Co., N.Y., pp. 78-81.
- <sup>13</sup>Garay, A. S. 1968. Origin and role of optical isomery in life, *Nature*, 219 (5152):338-340.
- <sup>14</sup>Lemmon, R. M. *Op. cit.*, p. 108.
- <sup>15</sup>Bernal, J. D. *Op. cit.*, p. 141.
- <sup>16</sup>Fox, S. W. and K. Dose. 1972. Molecular evolution and the origin of life. W. H. Freeman and Co., San Francisco, p. VII. Foreword by A. I. Oparin.
- <sup>17</sup>Fox, S. W. 1963. Organic geochemistry. I. Berger, Editor. Pergamon Press, N.Y., p. 36.
- <sup>18</sup>Rutten, M. C. 1962. The geological aspects of the origin of life on Earth. Elsevier Publishing Co., N.Y., pp. 46 and 47.
- <sup>19</sup>Mora, P. T. 1963. Urge and molecular biology, *Nature*, 199 (4890):212-219.
- <sup>20</sup>Mora, P. T. 1965. *Op. cit.*, p. 56.
- <sup>21</sup>Fox, S. W. and K. Dose. *Op. cit.*, p. 123.
- <sup>22</sup>Eglinton, G. and M. T. J. Murphy, Editors. 1969. Organic geochemistry. Springer, Verlag, N.Y., pp. 449-450.
- <sup>23</sup>Abernethy, J. L. *Op. cit.*, p. 457.
- <sup>24</sup>Elias, W. E. *Op. cit.*, p. 450.
- <sup>25</sup>Wald, G. *Op. cit.*, pp. 352-368.
- <sup>26</sup>Eliel, E. L. *Op. cit.*, p. 78.
- <sup>27</sup>Elias, W. E. *Op. cit.*, pp. 449-454.
- <sup>28</sup>Kenyon, D. H. and G. Steinman. 1969. Biochemical predestination. McGraw-Hill Book Co., N.Y., pp. 214-217.
- <sup>29</sup>Steinman, G. 1967. Stereoselectivity in peptide synthesis under simple conditions, *Experientia*, 23 (3):177-178.
- <sup>30</sup>Asymmetric decomposition of tyrosine using plane-polarized  $\beta$ -radiation has also been reported (See Garay, A. S. *Op. cit.*, pp. 338-340), but evaluation of its significance in relation to the problem of the origin of optical activity must await further information (See Lemmon, E. M. *Op. cit.*, p. 109), especially since a key control experiment was not conducted (See Harada, K. 1970. Origin and development of optical activity of organic compounds on the primordial earth, *Naturwissenschaften*, 57 (3):114-119), and related experiments have previously failed to demonstrate significant induced optical activity (See Ulbricht, T. L. V. and F. Vester. 1962. Attempts to induce optical activity with polarized  $\beta$ -radiation, *Tetrahedron*, 18 (5):629-637).
- <sup>31</sup>Bernal, J. D. *Op. cit.*, p. 144.
- <sup>32</sup>Elias, W. E. *Op. cit.*, p. 453. (Reference 5)
- <sup>33</sup>Fox, S. W., K. Harada, G. Krampitz, and G. Mueller. 1970. Chemical origins of cells, *Chemical and Engineering News*, 48 (26):80-94.
- <sup>34</sup>Harada, K. *Op. cit.*, p. 118.
- <sup>35</sup>Mora, P. T. 1965. *Op. cit.*, p. 58.
- <sup>36</sup>Fox, S. W. and K. Dose. *Op. cit.*, p. VII.
- <sup>37</sup>Fox, S. W. 1973. Origin of the cell: experiments and premises, *Naturwissenschaften*, 60 (8):359-368.
- <sup>38</sup>Fox, S. W. 1963. *Op. cit.*, p. 36.
- <sup>39</sup>Fox, S. W. and K. Dose. *Op. cit.*, p. 123.
- <sup>40</sup>There is no change in surface area or number of moles of reactants. Consequently terms involving these will be zero and have been omitted.
- <sup>41</sup>Eliel, E. L. *Op. cit.*, p. 32. (Reference 12)
- <sup>42</sup>Calvin, M. 1969. Chemical evolution. Oxford University Press, pp. 149-152.
- <sup>43</sup>Pincock, R. E., et al. 1971. Probability distribution of enantiomorphous forms in spontaneous generation of optically active substances, *Science*, 174 (4013):1018-1020.
- <sup>44</sup>Havinga, E. 1954. Spontaneous formation of optically active substances, *Biochimica et Biophysica Acta*, 13:171-174.
- <sup>45</sup>Wehmiller, J. and P. E. Hare. 1971. Racemization of amino acids in marine sediments, *Science*, 173 (4000):907-911.
- <sup>46</sup>Wald, G. *Op. cit.*, pp. 354-358. (Reference 9)
- <sup>47</sup>Kvenvolden, K. A., E. Peterson, and F. S. Brown. 1970. Racemization of amino acids in sediments from Saanich Inlet, British Columbia, *Science*, 169 (3950):1079-1082.
- <sup>48</sup>Hare, P. E. and P. H. Abelson. 1966-1967. Racemization of amino acids in fossil shells, *Carnegie Institute of Washington, Yearbook* 66: 526-528.
- <sup>49</sup>Bada, J. L. 1972. Kinetics of racemization of amino acids as a function of pH, *Journal of the American Chemical Society*, 94 (4):1371-1373.
- <sup>50</sup>Lemmon, R. M. *Op. cit.*, p. 106. (Reference 1)
- <sup>51</sup>Pincock, R. E. *Op. cit.*, p. 1018.
- <sup>52</sup>Wald, G. *Op. cit.*, pp. 358-366.
- <sup>53</sup>Fox, S. W., K. Harada, G. Krampitz, and G. Mueller. *Op. cit.*, p. 90.
- <sup>54</sup>Abernethy, J. L. *Op. cit.*, p. 460.
- <sup>55</sup>Neurath, H., Editor. 1966. The proteins. Academic Press, N.Y., Second Edition. IV:8.
- <sup>56</sup>Florkin, M. and E. Stotz, *Op. cit.*, p. 226.
- <sup>57</sup>Elias, W. E. *Op. cit.*, p. 452. (Reference 5)
- <sup>58</sup>Florkin, M. and E. Stotz. *Op. cit.*, p. 225.
- <sup>59</sup>Steinman, G. *Op. cit.*, p. 178. (Reference 29)
- <sup>60</sup>Zimmerman, P. A. 1971. Scientific studies in special Creation. W. E. Lammerts, Editor. Baker Book House, Grand Rapids, Mich., p. 326.
- <sup>61</sup>Mora, P. T. 1965. *Op. cit.*, p. 51. (Reference 20)
- <sup>62</sup>Asimov, I. 1970. In the game of energy and thermodynamics, you can't break even, *Smithsonian Institute Journal*, June, p. 6. (Reference 3 in reference 63)
- <sup>63</sup>Morris, H. M. 1970. Evolution, thermodynamics, and entropy, *Institute for Creation Research Impact Series*, No. 3, p. 4.
- <sup>64</sup>Asimov, I. *Op. cit.*, p. 6.
- <sup>65</sup>Lindsay, R. B. 1959. Entropy consumption and values in physical science, *American Scientist*, 47:378. (Reference 5 in reference 63)
- <sup>66</sup>Morris, H. M. *Op. cit.*, p. 3.
- <sup>67</sup>Penny, D. 1972. The implications of the two laws of thermodynamics in the origin and destiny of the universe, *Creation Research Society Quarterly*, 8 (4):261-269.
- <sup>68</sup>Turner, C. E. A. 1972. Teleology: purpose everywhere, *Creation Research Society Quarterly*, 9 (1):38-40.
- <sup>69</sup>Williams, E. L. 1970. Why not Creation? W. E. Lammerts, Editor. Presbyterian and Reformed Publishing Co., Philadelphia, pp. 75 and 76.
- <sup>70</sup>Segraves, K. L. 1973. Jesus Christ Creator. Creation Science Research Center, San Diego, California, pp. 66 and 67.
- <sup>71</sup>Williams, E. L. 1973. Thermodynamics: a tool for creationists, *Creation Research Society Quarterly*, 10 (1):38-44.
- <sup>72</sup>Williams, E. L. 1970. *Op. cit.*, p. 77.
- <sup>73</sup>Enoch, H. 1966. Evolution or Creation. Evangelical Press, London, p. 128.
- <sup>74</sup>Shaw, R. D. 1971. Symposium on Creation III. D. W. Patton, Editor. Baker Book House, Grand Rapids, Mich., p. 135.



- <sup>75</sup>Wald, G. *Op. cit.*, p. 365. (Reference 9)
- <sup>76</sup>For example, radiocarbon dating (See Whitlaw, R. L. 1970. Time, life, and history in the light of 15,000 radiocarbon dates, *Creation Research Society Quarterly*, 7 (1):56-71, 83), decay of the earth's magnetic field (See Barnes, T. G. 1972. Young age vs. geologic age for the earth's magnetic field, *Creation Research Society Quarterly*, 9 (1):47-50), stalactite formation (See Keithley, W. E. 1971. Note on stalactite formation, *Creation Research Society Quarterly*, 8 (3):188), fossil footprints (See Meister, W. J. 1968. Discovery of trilobite fossils in shod footprint of human in "trilobite beds"—a Cambrian formation, Antelope Springs, Utah, *Creation Research Society Quarterly*, 5 (3):97-102; and Rusch, W. H. 1971. Human footprints in rocks, *Creation Research Society Quarterly*, 7 (4):201-213); and age of the solar system (See Slusher, H. S. 1971. Some astronomical evidences for a youthful solar system, *Creation Research Society Quarterly*, 8 (1):55-57).
- <sup>77</sup>Bada, J. L., B. P. Luyendyk, J. B. Maynard. 1970. Marine sediments: dating by the racemization of amino acids, *Science*, 170 (3959):730-732.
- <sup>78</sup>Eglinton, G. and M. T. J. Murphy. *Op. cit.*, p. 457. (Reference 22)
- <sup>79</sup>*Ibid.*, p. 455.
- <sup>80</sup>Bada, J. L., B. P. Luyendyk, J. B. Maynard. *Op. cit.*, p. 731.
- <sup>81</sup>Hare, P. E. and R. M. Mitterer. 1967-68. Laboratory simulation of amino acid diagenesis in fossils. *Carnegie Institute of Washington, Yearbook* 67: 205-208.
- <sup>82</sup>Bada, J. L. *Op. cit.*, p. 1372. (Reference 49)
- <sup>83</sup>Kvenvolden, K. A., E. Peterson, and F. S. Brown. *Op. cit.*, p. 1081. (Reference 47)
- <sup>84</sup>Eglinton, G. and M. T. J. Murphy. *Op. cit.*, p. 457.
- <sup>85</sup>Bada, J. L., B. P. Luyendyk, J. B. Maynard. *Op. cit.*, p. 730.
- <sup>86</sup>McKenna, M. C. 1971. Route to late Cenozoic temperature history?, *Science*, 172 (3982):503.
- <sup>87</sup>Wehmiller, J. and P. E. Hare. *Op. cit.*, p. 907. (Reference 45)
- <sup>88</sup>Bada, J. L., B. P. Luyendyk, J. B. Maynard. *Op. cit.*, footnote 15.
- <sup>89</sup>Kvenvolden, K. A., E. Peterson, and F. S. Brown. *Op. cit.*, p. 1081.
- <sup>90</sup>Eglinton, G. and M. T. J. Murphy. *Op. cit.*, p. 462.
- <sup>91</sup>*Ibid.*, p. 458.
- <sup>92</sup>Kvenvolden, K. A., E. Peterson, and F. S. Brown. *Op. cit.*, p. 1081.
- <sup>93</sup>Hare, P. E. and R. M. Mitterer. *Op. cit.*, p. 205.
- <sup>94</sup>Eglinton, G. and M. T. J. Murphy. *Op. cit.*, p. 458.
- <sup>95</sup>Wehmiller, J. and P. E. Hare. *Op. cit.*, p. 907.
- <sup>96</sup>Eglinton, G. and M. T. J. Murphy. *Op. cit.*, p. 458.
- <sup>97</sup>*Ibid.*, p. 458.
- <sup>98</sup>*Ibid.*, p. 459.
- <sup>99</sup>*Ibid.*, p. 463.
- <sup>100</sup>Elie, E. L. *Op. cit.*, p. 81.
- <sup>101</sup>Williams, E. L. 1971. Resistance of living organisms to the second law of thermodynamics: irreversible processes, open systems, creation and evolution, *Creation Research Society Quarterly*, 8 (2):117-126.
- <sup>102</sup>Harris, M. 1971. Mutagenicity of chemicals and drugs, *Science*, 171 (3966):51-53.
- <sup>103</sup>Lammerts, W. E. 1970. Why not Creation? W. E. Lammerts, Editor. Presbyterian and Reformed Publishing Co., Philadelphia, pp. 254, 301, 308.
- <sup>104</sup>Armstrong, H. 1970. Why not Creation? W. E. Lammerts, Editor. Presbyterian and Reformed Publishing Co., Philadelphia, p. 293.
- <sup>105</sup>Neurath, H. *Op. cit.*, p. 8. (Reference 55)

## CHARLES LYELL CENTENNIAL

BOLTON DAVIDHEISER\*

*The year 1975 is one which members of the uniformitarian establishment might have been expected to notice. In fact, the anticipated flourish of trumpets and roll of drums has been strangely missing. It is left up to creationists, then, to comment on the occasion. The year, in fact, is the anniversary of Charles Lyell's death. Lyell's theories in geology went along with Darwin's in biology. It is shown here that not only do the two "theories" go together, but also there is similarity in the ways, not always in accord with good scientific practice, in which the "theories" were promoted.*

Charles Lyell, lawyer turned geologist, whose writings were the inspiration of Charles Darwin, died a century ago—February 22, 1875. Darwin wrote of him, "I always feel as if my books came half out of Lyell's brain, and that I never acknowledge this sufficiently . . . for I have always thought that the great merit of *Principles [of Geology]* was that it altered the whole tone of one's mind . . ."<sup>1</sup> At the time of Lyell's death Darwin said, "I never forget that almost everything which I have done in science I owe to the study of his great works."<sup>2</sup>

As Darwin promoted an evolutionary "theory"† which was not original with him and got it accepted, Lyell promoted a uniformitarian "theory" of geology which was not original with him either, and also got it accepted.

Darwin was anticipated a century earlier by the neglected genius, Pierre Louis Moreau de Maupertuis; and subsequently by lesser figures including his grandfather, Erasmus Darwin. Darwin collected, it is true, much more data than any of the others had done to

obtain apparent support for the "theory" of evolution through natural selection, or "survival of the fittest," as Herbert Spencer called it.

James Hutton formulated the basic principle of uniformitarian geology—that geologic phenomena can be explained by processes operating and observable at the present time. This denied catastrophes—particularly the Biblical flood (II Peter 3:3-6)—as causes of geological formations. Hutton's *Theory of the Earth* was published in 1795, but little attention was paid to his views until John Playfair published his *Illustrations of the Huttonian Theory* in 1802.

Charles Lyell traveled a great deal and accumulated data which he used successfully to promote uniformitarianism. His chief work was *The Principles of Geology*, published in three volumes, 1830-1833.

As the young Charles Darwin embarked on his voyage with the *Beagle*, his friend Professor Henslow presented him with a copy of the first volume of Lyell's

\*Bolton Davidheiser, Ph.D., receives mail at Box 22, La Mirada, California 90637.

†Reader attention is called to the fact that Darwin's ideas do not rank in scientific methodology with the Gene Theory or the Atomic Theory according to rigorous analysis. Nor is it possible to consider Darwinian or modern evolutionary ideas as fact as do leading evolutionists such as G. G. Simpson.