

Creation Research Society Quarterly

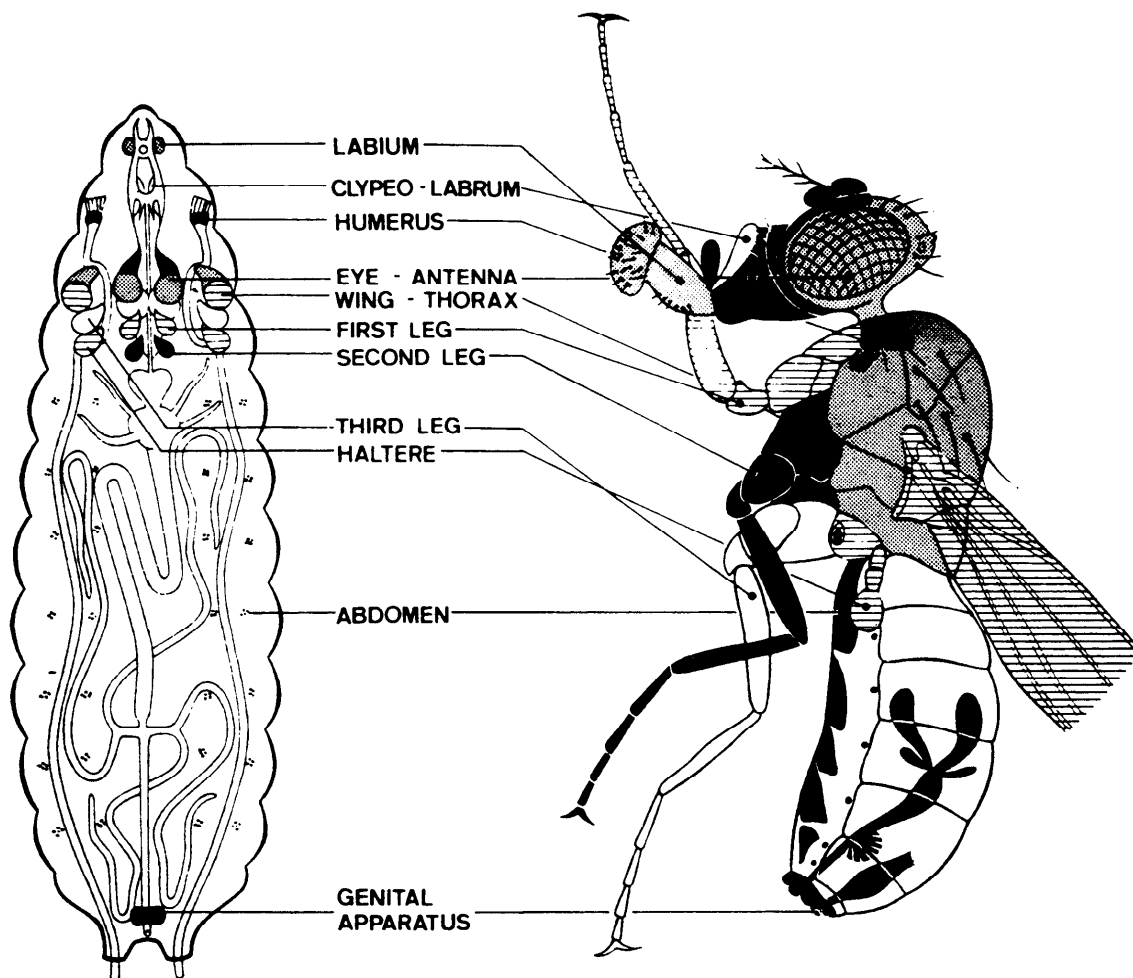
Haec credimus:

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

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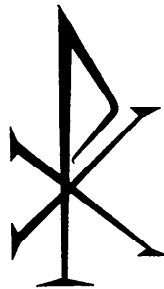
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ABOUT THE FRONT COVER

The cover illustration was supplied by Dr. W. J. Ouweneel, of The Netherlands, and is in fact Figure 1 for his article in this issue of the *Quarterly*. On the right is an adult fruit fly, *Drosophila melanogaster*; on the left a larva.

Locations of the various "imaginal discs" within the larva are indicated. These discs are sac-like rudiments, consisting of thousands of embryonic cells, from which the adult cuticular structures develop during the pupal stage. The lines connect the imaginal discs with the corresponding adult organs, which always show the same hatching or shading.

Mutations shift certain cells in these discs. However, the mutations do not result in superior creatures, as claimed by those arguing in favor of "evolution." Rather, handicapped creatures are produced, which would never survive in the natural situation, let alone become dominant. Study of the mutations considered here does not yield support for the "theory of evolution," but contrariwise is evidence against it.

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CREATIONISM IN BRAZIL

A. B. Ferguson, of Brazil, has written about increasing support for Creationism in that country. The C.R.S. book, *Biology, A Search for Order in Complexity*, has been translated into Portuguese, and is now in the hands of the publishers. There is organized activity for Creationism, especially in Northeastern Brazil, and the Minister of Education is receptive to the teaching of creation in the schools.

It is indeed good to hear news of this kind.—*Editor*

STRANGE FIRE ON THE EARTH

ERICH A. VON FANGE*

It is well known that, as well as Scriptural accounts such as that of Sodom and Gomorrah, there are legends in many parts of the world about great destruction by fire. It is not so well known that in many places there are marks, both on artifacts and on the face of the earth itself, of violent conflagration. Some of these stories and pieces of evidence are collected here, in what, it is hoped, will be the beginning of the investigation and eventual understanding of these fires in past times.

I. Introduction

It is "fantastically and incredibly possible" that atomic chain reactions boiled on the earth in the distant past. The evidence of a prehistoric spontaneous nuclear reaction was found by French researchers at the Oklo mine, Pierrelatte, in Gabon, Africa. As evidence the scientists noted that the ore of this mine contained abnormally low proportions of U_{235} such as are found only in depleted uranium fuel taken from atomic reactors. The ore also contains four rare elements in forms similar to those found in depleted uranium.

No one knows what combination of conditions produced the atomic reaction long before the feat was duplicated in the early 1940's in America. The same reaction may well have occurred in other parts of the earth. The physical effects of these possible reactions on the earth can only be guessed at.¹

But this strange story is not the only report of events in the past which involved intense blasts of heat in various parts of the world. Stones and sand melted into glass in desert regions. Hill forts show vitrified portions of the stone walls. Evidence of intense heat, far beyond the burning of a city in some ancient sites, raises important questions about the earth so often assumed as serene and predictable.

This is not an account of volcanoes and lava flows, of lightning, of the destroying fire of the invader, of accidental fire, nor even of jars of olive oil set on fire. There is evidence not yet pieced together of other strange fires. If a pattern can be derived from examination of accounts of intensive heat, it may be possible some day to apply the pattern to a clearer understanding and chronology of the ancient world. The known world of today is not the same as the ancient earth in some important respects.

II. Evidence from Desert, Hilltop, and City

A. Melting in the Desert

In the *Iliad*, Homer related that the goddess of the moon was warned not to battle with Mars but to leave the task to the Earth. But the goddess became involved in battle, was smote on the breast and her heart melted.² It is startling to read in 1973 in an article by Asimov that the surface of the moon was once heated quite strongly causing low-melting compounds to boil off, leaving high-melting compounds. This explanation is offered to explain the large proportion of glassy materials on the moon as the surface melted and solidified again. The evidence seems to be moon-wide. Asimov suggested that despite the surrounding atmos-

phere, there might be evidence of the same heat period on earth, too. He admitted that none has been found, and that that may be because the heat occurred in the first billion years of moon history.³

Can it be possible that Homer told of eye-witness accounts, that men on earth saw the fiery event happen on the moon? There is no reason other than conjecture to take presently adopted moon chronology seriously. Contrary to Asimov's opinion, there is a great deal of evidence lying about on the earth of unusual blasts of heat, besides a large number of literary references to such a phenomenon.

It goes more than a little "against the grain" to picture a large lake and at least three great rivers flowing from west to east across the whole width of the Arabian peninsula. Farther to the south are ancient ruins which date back to the time when the land was fruitful, and was copiously watered and there was luxuriant forest. A total of 28 fields of burned and broken stones, called harras, has been found in western Arabia, covering up to 7000 square miles each. The stones are densely packed, sharp-edged, and scorched black. They cannot be volcanic in origin. The stones fell from the sky and must be associated with the time when fertile land burned into instant desert.⁴ The important role of Arabia in prehistory is only beginning to emerge.

A blast of heat and other catastrophic events created the Sahara, which before that time evidently was a tropical region with heavy rainfall, large rivers, and abundant vegetation. In extensive parts of the desert, once cultivated soils are overlain by a thin cover of sand. Recently scientists have become aware that there is a vast reservoir of water below the Sahara, the only source of which could have been the heavy rains from the time before disaster struck.⁵

Further study is needed on just how recently the vast areas of North Africa, Egypt, Arabia, and other regions became deserts.⁶

In the Euphrates valley of southern Iraq, exploratory digging was done in 1947. Beneath the many cultural levels covering many centuries even before the time of Sumer was a floor of fused glass. It was similar to nothing else except the desert floor in New Mexico after the atomic blasts. Intensive heat melted the rock and sand into glass.⁷

In the interior of Africa, engineer Albion W. Hart, traversed a great desert area. At one place he came upon a large expanse of greenish glass which covered the sands as far as he could see. Later he recognized the same type of silica fusion at White Sands after the first atomic explosion there.⁸

The surface of the Gobi desert near Lob Nor Lake is covered with vitreous sand which is the result of atomic tests conducted by China. But the desert has

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certain other areas of similar glassy sand which have been present for thousands of years. The source of the intense heat is unknown. Similar sites are reported in Iraq.^{9, 10}

In the Mohave Desert there are huge circular or polygonal places which are covered by a hard substance like opaque glass.¹¹

B. Forts and Tombs

In many locations in Scotland, Ireland, and England towers bearing undoubted marks of uncommon fire have been found. The stonework has become calcined from the action of great heat. The portions above ground show this evidence. Lightning could not have been the cause.¹²

Other writers have reported that something in the past melted in streaks the stones of forts on the tops of hills in Brittany and Bohemia. Again strange vitrified walls can be observed.¹³

Hill forts of the west Atlantic coast fringe, from the Lofoten Islands off northern Norway to the Canary Islands off northwest Africa, became so-called fused forts, and the piled boulders of their circular walls have been turned to glass like frozen treacle on the outer portions of the wall facing the west. Some intense heat created the same effect on the inner sides of the eastern part of the circle. Similar vitrifications have been reported from the Western Pacific.¹⁴

The same phenomenon has been observed in the mounds and barrows of the British Isles. Some have at one time been filled with an intense heat. The stones of the innermost cell of a long barrow near Maughold on the Isle of Man have been fused together like the mysterious vitrified towers of Scotland and elsewhere. The memory of this historic event has been passed down in legends, as shown by an incident in *Beowulf*, where the dragon, enraged by the theft of treasure from its lair, attacked the king's castle and with the heat of its breath melted the stones until they stuck together in one lump. Many myths of many lands identify the dragon with astronomical phenomena. The vitrified stones are there. The legend needs decoding.¹⁵

Philo wrote of a stream of heaven-sent fire which overran great regions of the inhabited earth. Prometheus was chained to a rock for bringing fire to man. It is interesting to note that Augustine said that Prometheus lived at the time of Moses. In the tomb of Antefoker, vizier of Sesostri I, Pharaoh of the Middle Kingdom, a puzzling mystery was reported. A fire, clearly deliberate, raged in the tomb, as noted in many others in Egypt. The combustible material was abundant and of a light nature. The fierce fire left no trace of blackening except at the lowest levels of the tomb.¹⁶

According to Egyptian myths of the Old Kingdom the first dynasty was brought to an end by the erratic action (war) of planets. It is a fact that nearly all the royal monuments of this dynasty were obliterated by fire. Manetho wrote of many portents and a very great calamity at this time in Egyptian history. There was stability for a time during the second dynasty. Then a sudden change in the object of worship occurred which might have indicated new terror from the sky. Again bad fire damage occurred during the second

dynasty. The terror of fire from heaven might be reflected in the exceptional use of red in the inscriptions of the third dynasty.¹⁷

There are enigmatic signs of fire in the graves of both the Old and Middle Kingdoms of Egypt. Some kind of volatile substance penetrated the tombs and burned.¹⁸

Claude Schaeffer has identified six separate upheavals of earthquake and fire which had profound effects on the ancient world, including Asia Minor, Mesopotamia, Caucasus, Iranian plateau, Syria, Palestine, Cyprus, and Egypt. Some of these events closed great ages. The most ancient upheaval identified occurred between 2400-2300 B.C. and ended the Old Bronze Age. The end of the Middle Kingdom was marked by volcanic eruptions. At an early date lava flows on the Sinai Peninsula burned down forests leaving desert behind. In Palestine lava erupted filling the Jezreel Valley. Early in the 20th century a Phoenician vase was found embedded in the lava. The vase was dated approximately 1500 B.C.¹⁹

C. Cities

Catal Huyuk in south-central Turkey is believed to be one of the oldest cities in the world. According to first known evidences it was fully civilized and died suddenly just as mysteriously many centuries later. Excavators have reported a strange phenomenon at one of the levels, labelled VIa. Thick layers of burnt brick fused together by tremendous heat of a fire were found. The terrific heat penetrated to a depth of about a meter or more below the level of the floors, carbonizing the earth, the bones of the dead, and burial gifts. The scorching heat arrested all bacterial decay.²⁰

Excavation of a large ziggurat in Babylonia resulted in a puzzling observation. It appeared that fire had struck the tower and split it down to the very foundation. In different parts of the ruins immense brown and black masses of brickwork had changed into a vitrified state. At a distance the ruins looked like edifices torn apart at the foundations. Evidently the fiercest kind of fire created the havoc. The most curious of the fragments found was several misshapen masses of brickwork, black, subjected to some kind of fierce heat, and completely molten.

The whole ruin has the appearance of a burnt mountain. On one side of it, beneath the crowning masonry, lay huge fragments torn from the pile itself. The calcined and vitreous surface of the bricks had fused into rock-like masses. It is difficult to explain the cause of the vitrification of the upper building. Great boulders were vitrified, and brickwork had been fused by fire.²¹

Woolley studied a north Syrian site called Alalakh (now Atchana). The royal buildings burned so thoroughly that even in the core of the thick walls the mud-bricks were bright red and crumbling. The wall plaster, a mixture of mud and lime, had been vitrified and the basalt wall-slabs were in some places actually melted. At another site in Mesopotamia, Birs Nimroud, the vitrification is almost 20 feet deep.^{22, 23}

Farther to the east in India, between the Ganges and the mountains of Rajmahal, charred ruins were found which could not be due to some ordinary fire.

Several huge masses of stone were fused and hollowed. Similar ruined buildings have been discovered in the heart of the Indian forests by other travellers. Walls were like thick slabs of crystal, holed, split, and corroded by agents unknown. An internal courtyard had a very odd, half-vitrified floor.²⁴

An Early Bronze Age settlement was discovered recently on the Greek island of Samos, mentioned in Acts 20:15. The site was destroyed by a terrible fire and never repopulated. The all-consuming fire reduced most bricks to a reddish mass. Only a few remotely resembled the original shape.²⁵

When the island of Thera exploded some centuries later with at least four times the fury of Krakotoa in the nineteenth century, it was noted that the burning of cities occurred from gas and vapors.²⁶

At Pylos, the palace was destroyed in a holocaust, which even melted gold ornaments into lumps and drops. The devastating fire melted brick and stone into a solid mass as hard as rock. Pots were made into a molten vitrified layer over whole floors. Stones melted and disintegrated or burned into lime.²⁷

An enigmatic tale from an even more enigmatic adventurer, William Walker, needs evaluation. While exploring Death Valley in 1850, Walker reported the ruins of a mile-long settlement. At the center on rock 20-30 feet high, he found the remains of a large building. The south end of the building and supporting stones had melted and vitrified. The area is now sterile desert. According to Walker, the whole region between the rivers Gila and St. John was covered with ruins. Remains of settlements are very extensive and they are burnt out and vitrified in part, full of fused stones and craters caused by fires which were hot enough to liquify any rock or metal. Paving stones and houses were torn with monstrous cracks which seem to have been attacked by a giant's fire-plough.^{28, 29}

Near the old Inca capital city of Cusco is Sacsayhuaman, or Falcon Rock. Here granite blocks are found which show signs of vitrification from tremendously high temperatures.³⁰

In Brazil is the site of Sete Cidades (Seven Cities), first described in 1928. The formation is in the Province of Piaui, near the equator. The site is a monstrous chaos as one might imagine Gomorrah was. The stones are dried out, destroyed, melted. A great fire raged there. No excavation has been conducted yet. There is no geological explanation of the surrounding plain which has the appearance of an infinite number of tortoise backs. These may also have been the result of great heat.³¹

III. Observers and Explainers

All the known physical evidence for strange fires in the past have been listed. Undoubtedly much more still exists on the earth, and still more are remarked upon in obscure books and journals. When there is no acceptable explanation for a phenomenon, it tends to be set aside and forgotten.

No doubt there are conventional explanations for some of the evidence given. In other cases the evidence may be in error and should be corrected. Still, enough evidences of strange fires remain to require some attempts at explanation. Therefore, in this sec-

tion, two kinds of observation and attempted explanation are considered: myth and ancient history, and scientific theory.

It is very difficult, if possible at all, to separate myth from history regarding ancient events. And, up to this point in time, those promulgating theory have been selective by choosing only those events which can be placed far back into geological time. Somehow it is more reassuring to place an event millions of years in the past than to place it 2700 or 3500 years ago. Fused glass in a desert is given scientific attention; fused stone in an ancient fort or city, only stony silence.

A. Myth and History

Only a few years ago it would not have been prudent to list myth alongside of history. In recent years, however, more and more scholars have come to realize that a good deal of myth may well be coded history. As one relatively modern example, it is more than a little startling to discover the amount of English history that has been coded into familiar Mother Goose Rhymes. Parents pass the rhymes on to children with no awareness of their historical content, much as myths may be passed on from generation to generation with the original meaning long forgotten.³²

From all over the world come myths, legends, history, and other literary references to strange fire on the earth. Many of these, from widely separated places, must be relevant to the same events.

The Sun: The Greeks, Carians, and others who lived on the Aegean Sea shores referred to the time when the sun was driven off its course and disappeared for an entire day. The earth burned and drowned. Ovid described the horror vividly. The earth burst into flame, moisture all dried up, meadows burned to white ashes, trees were consumed, and whole nations were reduced to ashes. Mounts Aetna and Parnassus were blazing, the Caucasus in the land of the Scythians burned as did the Alps and the cloud-capped Apennines.

Libya became a desert, the waters of the Don steamed, the Euphrates burned, and the great rivers of the Ganges, Phasis, Danube, and Alpheus boiled, the sands of Tagus melted from the heat. Even the streams of the Nile were empty and filled with dust for a time, as were the Thracian river, Hebrus, Strymon, Rhine, Rhone, Po, and Tiber. Great cracks yawned everywhere. In places the sea shrank and became a dry plain of sand. There was a world conflagration, blazing volcanoes, boiling rivers, disappearance of seas, the birth of deserts.³³

At the time the earth stood still, mountains fell and others rose from level ground. The earth was heated and the ocean boiled in many places. Rock liquefied, volcanoes ignited, and forests burned.³⁴

Apollo, son of Zeus, and his chariot took over many of the attributes of an older sun god, Helios, who had a son named Phaethon. The boy asked his father to let him drive the sun chariot for a day. The father was aghast, but he had given his word. Phaethon was incapable of managing the horses and came off the proper path, resulting in unbelievable confusion in the heavens. The horses bolted, first soaring so high that the earth shivered and the North

Star glowed with heat. Then the horses plunged down so close to earth that the grass caught fire, the rivers boiled. No constellation remained in place, and the Earth was terribly scorched, which then cried to Jupiter to act. Zeus intervened and hurled a thunderbolt at Phaethon.

Ovid quoted Solon who maintained that Phaethon was not a fable, but a deviation of the bodies that revolve in the heavens, and that a destruction, at long intervals, occurred of things on the earth from a great conflagration. This myth, which goes back to Sumerian times, appears to be a clear statement about regions of the earth which had been scorched as a result of the passage near the earth of astral bodies.^{35, 36}

Planets and Comets: There is a legend that the great pyramid was built to memorialize a terrible destruction within the planetary system which affected the earth with fire and flooding. The world was turned upside down and stars fell from the sky.³⁷

Ovid tells of world ages and of a certain time after the great flood when both sea and land, and even heaven, should feel the force of Vulcan's scorching brand to the extent that the world would be wrecked.³⁸

In an ancient tale from Egypt called *The Shipwrecked Sailor* a star fell which produced flames and people burned up.³⁹

According to the Edda myth the world came apart, and there was a battle in the sky among the planets. There were all-engulfing flames and destructive fire in the world. The apparent cause was the erratic behavior of Mars. Chaldeans, Greeks, and Chinese all attributed the element of fire to the planet Mars.^{40, 41}

The author of the *Aeneid* reported a stream of fiery light in heaven, and a flaming torrent that went down in spirals. Somehow Mars was associated with the destruction.⁴²

In the *Iliad*, Venus uttered her loud cry, and over against her sprouted Mars, dread as a dark whirlwind. All the roots of many-founted Ida were shaken and all her peaks. They rushed with surging flood, and the fair streams seethed and boiled.⁴³

Manilius stated that the world took fire, and new stars were kindled as a bright remembrance of the event.⁴⁴

The Druids said that due to the universal wickedness of man, the great God, by means of a violent wind, sent a virulent poison on the earth. Death was inhaled with every breath. The poisonous wind was succeeded by a tempest of fire, which rent the earth asunder.⁴⁵

In the Epic of Gilgamesh, Enkidu died because he was smitten by the poisonous breath of the heavenly beast. Something in the sky produced tremendous heat.⁴⁶

Donnelly referred to a myth about the world in flames and people who felt a comet strike the earth.⁴⁷

Chinese legends contain mention of aerial battles, blinding rays and poison gases, dragons of fire, spheres of flame, shining darts and lightning. The legends appear in the dragon symbol with eyes flaming and jaws of fire. The beasts roar among the sky winds and plunge into ocean depths, reducing whole cities to ashes from their burning breath.⁴⁸

According to an Amazonian source a snake spurted

flame and burnt up the forests, charring land and making rivers boil.⁴⁹

Rain of Fire: The Ipuwer papyrus includes a tale of horror that there was a downpour of bitumen and sticky substance. There was the great din of fire above the heads of the people. Gates, columns, and walls were consumed by fire.⁵⁰

In the Midrashim, commentary on the Hebrew Scriptures, God poured out naphtha over the people, and burning blains.⁵¹

Among the Voguls of Siberia it is related that God sent a sea of fire upon the earth. Fire raged for seven winters and summers which burned up the earth.⁵²

Motifs in Irish myth include a world-fire which occurred centuries after the flood. It was a conflagration that destroyed the earth, and the flame of fire from heaven was swifter than a blast of wind.⁵³

According to the Aztec codex, Chimalpopoca, there was a rain of fire, and all who existed were burned. The fire burned with a great tumult and men were lost and destroyed in a rain of fire. The sun was on fire, and everything together with the houses was consumed. In an Aztec prayer: "Make an end of this smoke and fog of thy resentment. Quench also the burning and destroying fire of thine anger." And in a Mayan document, called the Chilam Balam, a fiery rain fell, ashes fell, and rocks and trees fell down.⁵⁴

Heat and Melting: Many sources among the myths of people around the world describe meltings of the surface of the earth and boiling of the sea in places from intense heat.⁵⁵

Etruscan annals, according to Varro, included traditions of the combustion of the world at various times, each of which ended a world age.⁵⁶

Philo of Alexandria, 20 B.C.-54 A.D., noted repeated destructions of the earth by water and fire as the reason that later generations did not receive from the former the memory of the order and sequence of events.⁵⁷

There is a lively account in a Chinese manuscript of how the earth was struck during the reign of Emperor Yao by a terrible calamity. Intense heat lit up the earth, harvests were destroyed, and the seas boiled.⁵⁸

And in a Hawaiian myth there was chaos from the burnt-out world, the wreck and ruin of an earlier world.⁵⁹

B. Theory and Conjecture

If the strange fires really occurred as observed and described, a number of catastrophic actions took place in historic times. For more than a century, hardly a word in the English language evoked more ire and fire than the word "catastrophe" among both geologists and archaeologists. The reason of course is obvious. Every catastrophe in nature is also a catastrophe for meticulously constructed geological and archaeological time scales.

It is refreshing in the face of this to note that in 1963 at the meeting of the American Geological Society, many geologists advised the rehabilitation of catastrophism. In 1968 the reputable archaeologist Carpenter was willing to speak of drastic changes in very recent times.⁶⁰ The pioneering works of two

theorists of catastrophism in the twentieth century, George M. Price and Immanuel Velikovsky, may yet become respectable.

Meteorites: Meteorites of gigantic size might have struck the sea. In fact the odds greatly favor a seafall over a landfall. The results would be most devastating. Large meteorites did fall on the earth in historic times, including the craters at Wabar in Arabia. Asteroids are a hazard to the earth.⁶¹ Among the actual and possible giant meteorites were the blast in 1908 northeast of Lake Baikal in Siberia and perhaps Crater Lake in Colorado.⁶² Chubb crater was discovered in northern Labrador in 1950. The crater covers an area of four square miles, and is believed to represent the fall of a small asteroid. By comparison the large crater in Arizona is only $\frac{1}{4}$ th mile in diameter.

Recent finds of large craters have been noted in Australia, Arabia, Mexico, besides the half-million oval craters along the Atlantic coast, especially in the Carolinas. These strange elliptical depressions (called bays locally) are scattered thickly over the Carolina coast and more sparsely along the entire Atlantic coastal plain from southern New Jersey to northeast Florida. The larger bays average from 2200 to 8000 feet long, and they are oriented in a remarkable parallelism. The long axis of each runs from the northwest to the southeast. The rims of earth invariably are elevated at the southeastern end.

Uncounted numbers of the meteorites may have fallen into the ocean. It is worth noting also that a large number of meteorites have been found in the southern Appalachian region.⁶³ The enormous number of meteors probably grazed the Blue Ridge Mountains and hit the earth at about 150,000 miles per hour. They must have devastated 100,000 square miles with resulting heat and explosions.⁶⁴ Similar lakes or bays have now been found in the Alaskan tundra.⁶⁵

Although the topic is controversial, some authorities are willing to grant that the earth was bombarded many times in the past by huge astral bodies. (Incidentally, the surfaces of the moon and Mars are very similar to the surface of the earth, except for the effects of sedimentation, volcanism and weathering.) Thus far more than 70 large depressions on the earth are believed to be old craters formed by meteorites. These have been reported as definite or possible in such locations as the Michigan basin; Hudson's Bay; Wells Creek Basin, Tennessee; the Vredefort Dome in South Africa, and many other places. The Ries Kessel (giant kettle) in Bavaria is 17 miles in diameter. In 1961 Dr. R. S. Dietz termed such enormous "fossil" craters "astroblemes" (star wounds).⁶⁶

In 1965 a group of geologists from Columbia University reported evidence that a great cosmic body crashed into the earth at Campo del Cielo (Field of Heaven) in Argentina. There was no clue as to the nature of the cosmic body. It may have been an earth satellite. Incredibly they reported that the body may have been as large as the moon.⁶⁷

As long as catastrophes are placed safely back far enough in time, Dr. Harold Urey, an implacable foe of recent catastrophes, has come out in favor of repeated comet-earth collisions, in order to explain such phenomena as tektites, catastrophic breaks between

geological periods, sudden great climatic changes, seismic effects, enormous lava flows, oceans sweeping over the land, dinosaur destruction, and the initiation of the Tertiary division of time.⁶⁸

Petroleum: W. F. Libby of C14 fame has suggested that oil is raining on the planet Jupiter. And Oro and Han have maintained that petroleum is now being formed on Jupiter. A deep layer of tar is postulated on Titan, a satellite of Saturn, and L. P. Gaucher has argued that many rains of oil occurred early in earth history. It is strange and sobering to note that rains of petroleum on the earth, sometimes burning, are described most vividly in many myths.⁶⁹

Earth Wobble: The theory has been proposed that the earth wobbles on its axis causing magnetic field reversals. And supposedly because of such a catastrophic event more cosmic radiation struck the earth, killing off whole species of plants and animals.

Two British physicists believe that giant comets struck the earth. As the comet head or nucleus struck the earth, tons of molten rock were hurled thousands of miles into the atmosphere, falling and hardening in tektite-like patterns. At the same time gases, frozen ammonia and methane, spread through the atmosphere and water, drastically changing the environment. In a swirling finale, lightning ignited the deadly mixture of methane and air causing vast spreading explosions. Again the theory entails possible events far back in the past. The tektite falls are believed to correlate with the magnetic reversals.⁷⁰

Supernova: In *Nature*, 1971, an author suggested that supernova might have come close to the Solar System. The exploding supernova created catastrophe on the earth by radiation or by disastrous effects on the climate.⁷¹

Glaciation: While glaciation is not explained, it is believed by some to be the cause of worldwide cataclysm. As the ice increased the ocean level was lowered to the point where the sea bed no longer counterbalanced the land. Supposedly, the earth ruptured and lava and water seethed in a boiling cauldron, and vapor and dust surrounded the earth. With little sunlight and the hot earth, much animal and plant life became extinct. Presumably, life still on the earth descended from the survivors.⁷²

Mars: If Mars once approached the earth, enormous tides, volcanic eruptions, and earthquakes would have resulted. Interplanetary charges might have fried entire ancient cities. Some hint is given of the possibility of such a catastrophe by the fact that storms observed on Mars are at their greatest when Mars is closest to earth each 15 years.⁷³

Moon: In 1968 Astronomer Munk suggested that some time in the past the moon may have come close to the earth. The resulting tides would have been most destructive. The tides would have formed bores that surged across continents. The heat from the friction would have evaporated huge quantities of water.⁷⁴

Goldreich in 1972 assumed the same theory, including tides several kilometers high. Friction would have caused so much heat as to evaporate much of the water and even melt some of the crust in an enormous catastrophe.⁷⁵

Intense application of heat in a short time could have created the mysterious evaporites: great beds of salt, gypsum; and anhydrite beds.⁷⁶

IV. The Hebrew Bible

Because of the physical evidence on the earth, history and myths that are so persistent about strange fires and fires from heaven, it may be instructive to examine scriptural references to fire. Such references may be tied to other events noted around the world.

In Genesis 19:24-25: "Then the Lord rained on Sodom and Gomorrah brimstone and fire from the Lord out of heaven; and he overthrew those cities, and all the inhabitants of the cities, and what grew on the ground." Anyone visiting the area where those cities once flourished supposedly would be greatly struck by the biblical description that it was well watered everywhere, as the garden of the Lord.

After study of the area, Kyle assumed that salt was mixed with the descending fiery rain. A stratum of rock salt lies along the western lower end of the Dead Sea and forms the base of a conical mountain called Jebel Usdum today. Usdum, of course, is Sodom. The stratum of salt is 150 feet thick and there may be more of the stratum underground. It is almost absolutely pure rock salt. Overlying this formation is marl filled with free sulphur in a very pure state. The area is a burned-out region of oil and asphalt. The slime pits of old are still evidenced by the asphalt found at the lower end of the sea.

Kyle has proposed that this catastrophe should be treated as an actual historical event as a result of the direct action of God in 29 passages in 15 books of the Bible plus other possible indirect references.⁷⁷ Various earth strata have been found welded together as though by intense heat.⁷⁸

In Moab Israel joined himself unto Baalpeor: and the anger of the Lord was kindled against Israel. Numbers 25:3 Baalpeor, it is suggested, is the god or lord of fire. Mendenhall noted that there is no satisfactory Semitic etymology for the word Peor, but the meaning now seems clear. Peor is the Hittite word for fire. It is the base of the Greek word, Pyr, meaning fire, and of course the English word fire. In the Middle East in ancient times there was an amazing number of literary references to a garment of flame, the goatskin dyed red, or a ramskin dyed red, or a red-dyed goat. The meaning is completely obscure.⁷⁹

The ancients worshipped what they most feared and dreaded. Human sacrifices were made to appease the angry gods. If indeed dreadful fires came down from the sky on a number of occasions, it would be entirely plausible that worship of fire or Peor would commence in a desperate attempt for survival. Both the word Peor and the goatskin dyed red may allude to the fiery times.*

There are a great many references in the Hebrew Bible to such events as quakes, mountains moved and shaken, hills melted like wax, mountains smoking, and

skipping like rams. According to Gaenssle, these are "highly poetical texts" and they should not be taken literally.⁸⁰ This view must be considered especially since it is very commonly held by students of the Scriptures. It seems reasonable to ask, however, how the wording would differ if indeed actual events observed by eye-witnesses were being described? Consider the impact of a series of passages from the RSV Edition, given without immediate comment.

Exodus 9:23-4 . . . and the Lord sent thunder and hail, and fire ran down to the earth. . . . There was hail, and fire flashing continually in the midst of the hail. . . .

Numbers 21:28 For fire went forth from Heshbon, flame from the city of Sihon. It devoured Ar of Moab, the lords of the heights of the Arnon.

Deuteronomy 29:23 . . . the whole land brimstone and salt, and a burnt-out waste, unsown, and growing nothing, where no grass can sprout, an overthrow like that of Sodom and Gomorrah, Admah and Zeboiim, which the Lord overthrew in his anger and wrath.

Deuteronomy 32:22 For a fire is kindled by my anger, and it burns to the depths of Sheol, devours the earth and its increase, and sets on fire the foundations of the mountains.

2 Samuel 22:8-9, 16 Then the earth reeled and rocked; the foundations of the heavens trembled and quaked, because he was angry. Smoke went up from his nostrils, and devouring fire from his mouth; glowing coals flamed forth from him. . . . Then the channels of the sea were seen, the foundations of the world were laid bare, at the rebuke of the Lord, at the blast of the breath of his nostrils.

Job 1:16 . . . The fire of God fell from heaven and burned up the sheep and the servants, and consumed them; and I alone have escaped to tell you.

Job 18:15 . . . brimstone is scattered upon his habitation.

Psalms 11:6 On the wicked he will rain coals of fire and brimstone; a scorching wind shall be the portion of their cup.

Psalms 104:32 (The Lord) looks on the earth and it trembles, (He) touches the mountains and they smoke.

Psalms 21:9 You will make them as a blazing oven when you appear. The Lord will swallow them up in his wrath; and fire will consume them.

Psalms 29:5-9 The voice of the Lord breaks the cedars, the Lord breaks the cedars of Lebanon. He makes Lebanon to skip like a calf, and Sirion like a young wild ox. The voice of the Lord flashes forth flames of fire. The voice of the Lord shakes the wilderness, the Lord shakes the wilderness of Kadesh. The voice of the Lord makes the oaks to whirl, and strips the forests bare.

Psalms 50:3 Our God comes, he does not keep silence, before him is a devouring fire, round about him a mighty tempest.

Psalms 97:3-7 Fire goes before him, and burns up his adversaries round about. His lightnings lighten the world; the earth sees and trembles. The mountains melt like wax before the Lord, before the Lord of all the earth. . . . All worshipers of images are put to shame, who make their boast in worthless idols.

*Editor's note: Obviously references to ramskins dyed red as in Exodus 25:5 describe directions from God for construction of the sacred tabernacle, and would have no connection with pagan use of goat skins dyed red.

Psalm 148:7-8 Praise the Lord from the earth, you sea monsters and all deeps, fire and hail, snow and frost, stormy wind fulfilling his command.

Psalm 83:14-5 As fire consumes the forest, as the flame sets the mountains ablaze, so do thou pursue them with thy tempest and terrify them with thy hurricane.

Psalm 46:6 The nations rage, the kingdoms totter; he utters his voice, the earth melts.

Isaiah 29:5-6 (regarding the city of Ariel where David camped) . . . And in an instant, suddenly, you will be visited by the Lord of hosts with thunder and with earthquake and great noise, with whirlwind and tempest, and the flame of a devouring fire.

Isaiah 30:30 (Assyria) And the Lord will cause his majestic voice to be heard and the descending blow of his arm to be seen, in furious anger and a flame of devouring fire, with a cloudburst and tempest and hailstones.

Isaiah 66:15-16 For behold, the Lord will come in fire, and his chariots like the stormwind, to render his anger in fury, and his rebuke with flames of fire. For by fire will the Lord execute judgment. . . .

Isaiah 34:2-4 For the Lord is enraged against all the nations, and furious against all their host, he has doomed them, has given them over for slaughter. . . . All the host of heaven shall rot away, and the skies roll up like a scroll. All their host shall fall, as leaves fall from the vine, like leaves falling from the fig tree.

Jeremiah 4:4 (Judah) . . . lest my wrath go forth like fire, and burn with none to quench it, because of the evil of your doings.

Jeremiah 43:12-3 He shall kindle a fire in the temples of the gods of Egypt; and he shall burn them and carry them away captive; and he shall clean the land of Egypt, as a shepherd cleans his cloak of vermin; and he shall go away from there in peace. He shall break the obelisks of Heliopolis which is in the land of Egypt; and the temples of the gods of Egypt he shall burn with fire.

Jeremiah 48:45 . . . for a fire has gone forth from Heshbon, a flame from the house of Sihon;

Jeremiah 49:27 And I will kindle a fire in the wall of Damascus, and it shall devour the strongholds of Benhadad. . . .

Jeremiah 50:32 (Babylon) . . . I will kindle a fire in his cities, and it will devour all that is round about him.

Ezekiel 15:7-8 And I will set my face against them; though they escape from the fire, the fire shall yet consume them; and you will know that I am the Lord, when I set my face against them. And I will make the land desolate because they have acted faithlessly, says the Lord God. (Jerusalem)

Ezekiel 20:47 (against the forest land in the Negeb) . . . Behold, I will kindle a fire in you, and it shall devour every green tree in you and every dry tree; the blazing flame shall not be quenched, and all faces from south to north shall be scorched by it.

Ezekiel 38:22-3 (against Gog) With pestilence and bloodshed I will enter into judgment with him; and I will rain upon him and his hordes and the many

peoples that are with him, torrential rains and hailstones, fire and brimstone. So I will show my greatness and my holiness and make myself known in the eyes of many nations. Then they will know that I am the Lord.

Ezekiel 39:6 I will send fire on Magog and on those who dwell securely in the coastlands; and they shall know that I am the Lord.

Joel 1:19-20 For fire has devoured the pastures of the wilderness, and flame has burned all the trees of the field. Even the wild beasts cry to thee because the water brooks are dried up, and fire has devoured the pastures of the wilderness.

Amos 1:7, 10 So I will send a fire upon the wall of Gaza, and it shall devour her strongholds. . . . So I will send a fire upon the wall of Tyre, and it shall devour her strongholds. (Other similar judgments)

Amos 7:4 . . . the Lord God was calling for a judgment by fire, and it devoured the great deep and was eating up the land.

Amos 9:5 The Lord, God of hosts, he who touches the earth and it melts, and all who dwell in it mourn . . . who calls for the waters of the sea, and pours them out upon the surface of the earth—the Lord is his name.

Micah 1:4 And the mountains will melt under him and the valleys will be cleft, like wax before the fire, like waters poured down a steep place.

Nahum 1:3-5 . . . His way is in whirlwind and storm, and the clouds are the dust of his feet. He rebukes the sea and makes it dry, he dries up all the rivers; . . . the mountains quake before him, the hills melt; the earth is laid waste before him, the world and all that dwell therein.

Acts 19:35 Men of Ephesus, what man is there who does not know that the city of Ephesians is temple keeper of . . . the sacred stone that fell from the sky?

Revelation 16:8-9 The fourth angel poured his bowl on the sun, and it was allowed to scorch men with fire; men were scorched by the fierce heat, and they cursed the name of God who had power over these plagues, and they did not repent and give him glory.

V. A Closing Word

It is difficult to accept the idea of strange fires on the earth in the past, but it would be even more difficult to write off all the physical evidence, the literary evidence, and the testimony given in the Bible. In many cases fire did not occur in isolation. Other agents of destruction were active, as indicated so vividly in the descriptions. Yet it seems of value to collect in one place the references of all known reports of strange fires or the effects of unusual heat.

Time after time the earth is scarred. Slowly it heals again and man forgets, but some of the tell-tale evidence remains to arouse curiosity and wonder today.

On the one hand God has promised in Genesis 8:21-22,

I will never again curse the ground because of man, for the imagination of man's heart is evil from his youth; neither will I ever again destroy every living creature as I have done. While the

earth remains, seedtime and harvest, cold and heat, summer and winter, day and night, shall not cease.

Perhaps the focus of the promise should be on the words "every" and "cease"; and the promised blessings have not ceased up to the present day.

Yet God has brought strong rebukes and judgments upon many peoples of the earth since the time of Noah, as at Babel, in Sodom, in Egypt, and in many nations of the earth, named and unnamed. There have been terrible catastrophes since the flood, extinctions

since the flood, and strange fires on the earth since the flood. The extent to which God used natural phenomena, e.g., comets and planets, is not known; neither can one say to what extent He intervened directly on the earth in ways which will never be subject to scientific explanation. Both kinds of events ultimately are derived from the same Source.

This paper is a beginning of an investigation of unusual phenomena which should be followed by deeper study. Perhaps, some day, wiser heads will determine a precise chronology of such past events.

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THE MOCCASIN FLOWER WAS DESIGNED

ALLEN B. CORNELL*

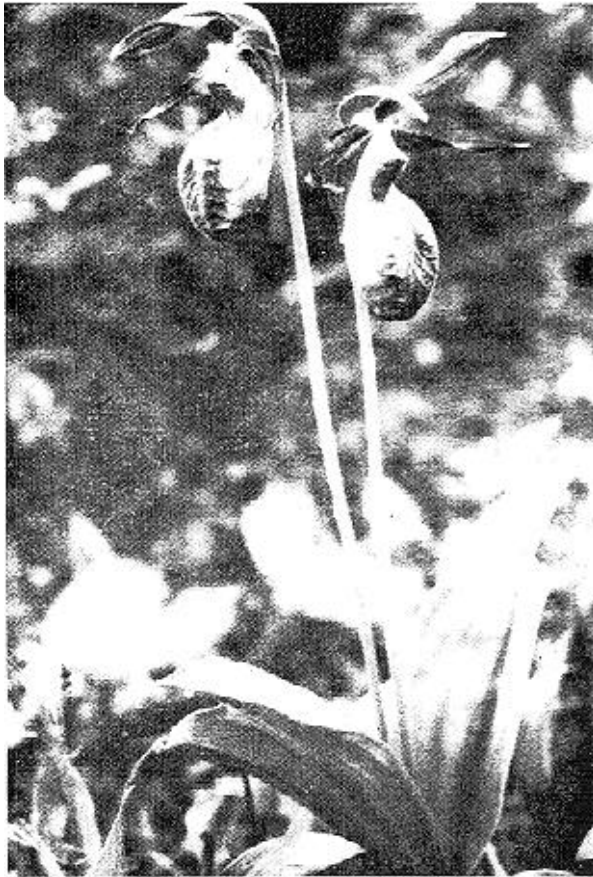


Figure 1. The pink moccasin flower, *Cypripedium acaule*.

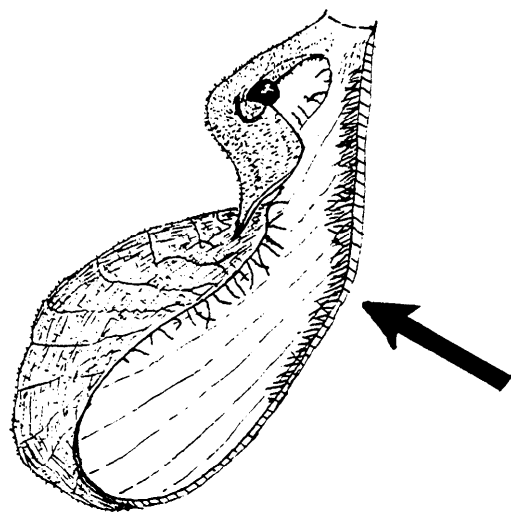
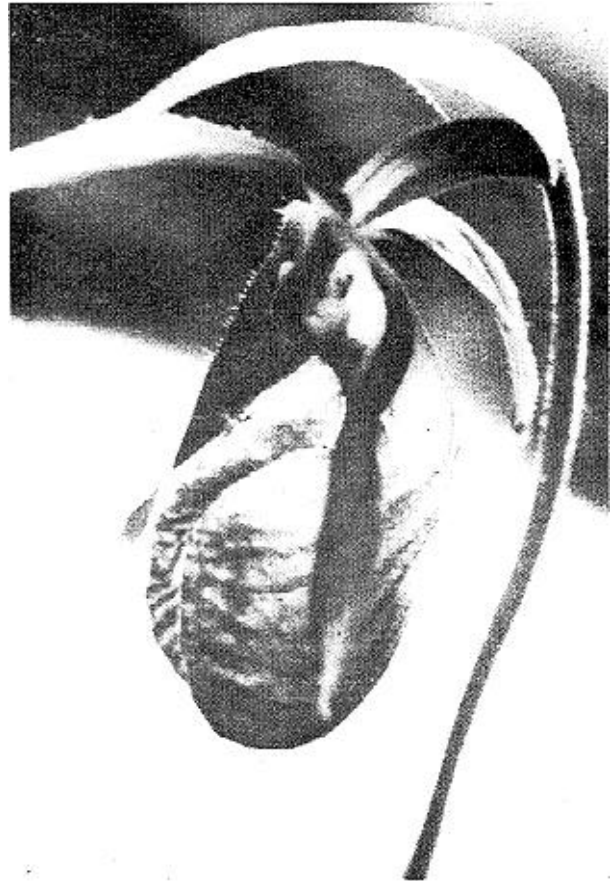


Figure 2. A close-up of the moccasin flower (above). The illustration (below) shows the "ladder" of interior hairs (indicated by the arrow) used by bees in climbing out of the flower; and thus, being forced to contact stigma and anther, they pollinate the flower.

Gardeners who have recognized the beauty of the pink moccasin flower (*Cypripedium acaule*), shown in Figure 1, have usually been frustrated in their attempts to grow it from seed, or to transplant it. Those who truly appreciate the flower have learned to leave it where they find it, unless there is certain destruction of the particular growth site.

But there are other problems with the pink moccasin flower. The explanations put forth by evolutionists are inadequate to account for the intricate designs and ecological relationships involved in pollination and early growth of this flower.

Actually in the process of pollination, the bee is attracted to the flower but does not really gain any food. Thus according to evolutionary reasoning the very existence of this flower, and other slipper flowers, seems precarious. The pollination action of the bee is merely a wasted effort on the part of the bee, and seems to have no survival value for the bee. Therefore, if a different bee came into existence that avoided these kinds of flowers, there might be some selective advantage for that bee. Then in time the slipper flowers would not be pollinated and would become extinct.

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After alighting on the flower, the bee soon enters or falls into the pouch of the moccasin. Entrance is usually made through the fissure along the "instep" of the moccasin. The steep sides of the pouch and the infolding margins of the fissure make escape by the same route impossible.

However, there is a way of escape from the moccasin flower. The bee grasps onto a row of hairs (see Figure 2), which form a sort of ladder, and quite effectively climbs out of the pouch. As the bee climbs out, it first rubs the stigma, depositing pollen from its body onto the stigma. Then the bee rubs against an anther picking up a supply of pollen, some of which will be left as it climbs out of the pouch of another moccasin flower.

Like the seeds of most orchids, the 15,000 to 50,000 seeds of a single pink moccasin flower are minute and contain a very small food supply. After germination the roots must be invaded by a fungus that supplies carbon and perhaps some vitamins.

Thus the moccasin seedling is a saprophyte, utilizing the fungus material as food, until it is large enough to become autotrophic. The fungus can exist separately, but does exceptionally well in the presence of the orchid roots. This is known as a symbiotic relationship.

The great amount of speculation involved in explaining the origin of such mechanisms, from the evolutionary point of view, really leads one to believe that the whole scheme is more imaginative than scientific.

The vast difference between the four genera of slipper flowers and all other orchids led Darwin to speculate that an enormous wave of extinction swept away a multitude of intermediate forms.¹ Because of the vast differences, creationists assume that these slipper flowers were created separately from all other orchids. They may represent one or a few created kinds.

It is true that many crosses are possible between species in some of the genera; and a generic cross is possible between *Selenipedium* and *Cypripedium*.² A created kind, with a great potential for variation, could degenerate along different lines until it could not cross with other individuals within the created kind. Such an explanation is proposed in place of "emergence" of the different slipper flowers from some so-called common ancestor.

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A THOUSAND YEARS OR A DAY?

Recently a correspondent quoted 2 Peter 3:8, "... one day is with the Lord as a thousand years, and a thousand years as one day," in defense of the possibility of a very old universe. In fact, that quotation is used quite often for such a purpose, sometimes in connection with the "age-for-a-day" thesis. May I suggest, however, that the point of the quotation, with regard to original context, is quite the opposite?

Clearly Peter was quoting Psalm 90:4. Now in that context, the point is plainly that, compared with God, all created things are transient, and of a short duration. So far from providing evidence for a great age for the universe, the quotation might actually be used to support the teaching that the universe is relatively young.—*Editor*

AN APPROPRIATE QUOTATION

The World was made to be inhabited by Beasts, but studied and contemplated by Man: 'tis the Debt of our Reason we owe unto God, and the homage we pay for not being Beasts. Without this, the World is still as though it had not been, or as it was before the sixth day, when as yet there was not a Creature that could conceive or say there was a World. The Wisdom of God receives small honour from those vulgar Heads that rudely stare about, and with a gross rusticity admire His works: those highly magnifie Him, whose judicious inquiry into His Acts, and deliberate research into His Creatures, return the duty of a devout and learned admiration.—Sir Thomas Browne, from his *Religio Medici*

HOMOEOTIC MUTANTS AND EVOLUTION

WILLEM J. OUWENEEL*

About 1950 geneticist R. B. Goldschmidt and paleontologist O. H. Schindewolf independently came to the conclusion that neo-Darwinism was completely inadequate to account for macroevolution. Goldschmidt judged that natural selection only results in preservation of the status quo and that accumulation of mutations with tiny effects could never explain the origin of really new organs and organismal types. Schindewolf judged that the sudden appearance of higher systematic categories in the fossil record and the discontinuities between present and fossil categories were in serious conflict with neo-Darwinism.

As evolutionists, they came up with an "emergency solution": they decided that macroevolution could be explained only by postulating "macromutations" with large effects, stirring up the whole system. The best examples Goldschmidt could supply were the homoeotic mutants in *Drosophila* which replace certain organs by entirely different organs. The present author, however, reviews the wealth of data now assembled about homoeotic mutants, and extensively documents that the evidence is only negative with regard to evolution. He concludes that the mentioned criticisms of neo-Darwinism are still as valid as in 1950 but that the alternative ideas have proved to be even worse.

Introduction

This paper has the same title as an article by the well-known geneticist, Professor Richard B. Goldschmidt.¹ He wrote several papers on the subject because he considered homoeotic mutants to be of major importance to support his peculiar theory of evolution.

In this introduction I will first explain homoeotic mutants, and Goldschmidt's ideas. Secondly, I will examine how Goldschmidt related homoeotic mutants to evolution; and thirdly examine what is the real evidence about these mutants with regard to the question of origins.

The term *homoeosis* (from Greek *homaios*, "similar") denotes the replacement of one body part by another part usually considered to be homologous (of "similar" design); that is, a given organ or body segment develops structures which are characteristic of an organ or segment normally found elsewhere in the body. The term was coined by Bateson.² In the arthropods several different homoeotic phenomena are known, but those best known and studied are the homoeotic mutations in insects, particularly in the fruit fly, *Drosophila melanogaster*.

These mutations shift certain cells in "imaginal discs" (sac-like rudiments within the larva, consisting of thousands of embryonic cells, from which the adult cuticular structures arise during the pupal stage; see Figure 1 which is on the front cover) into a different developmental pathway, so that they form structures which are normally only formed by other discs or disc parts. For instance, in the mutant strain *aristapedia*, the arista (a feather-like appendage on the antenna) is replaced by a tarsus, i.e. the distal part of a leg (see Figure 2).

Many shifts of one disc to another have been discovered and will be concisely reviewed below, both as to genetic and to developmental aspects. Recently, I have extensively reviewed the phenomenon of homoeosis in *Advances in Genetics*,³ after having



Figure 2. The homoeotic mutant *aristatarsia*, discovered by the author: arista partly (lower and right half) changed into tarsus (upper right: tarsal claw).

worked on it for eight years as one of a few specialists in the field.

Professor Goldschmidt (1878-1958), an outstanding geneticist at the University of California in Berkeley, was one of the pioneers in the field of homoeosis on account of their supposed significance for his view of evolution. Recently, Macbeth again drew attention to this view when he wrote:

It was in 1940, shortly after moving from Berlin to Berkeley, that Goldschmidt published his major work, *The Material Basis of Evolution*.⁵ This touched off a controversy that has not yet entirely died down. The public hardly knew that anything was going on, but within the profession the Goldschmidt episode was a much greater event than the Scopes trial [the well-known judicial collision of creationism and evolutionism in

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Tennessee, 1925]. The thrust and parry are worth reconstructing because they show how far we have moved from Darwin and how shaky the structure of evolutionary theory really is.⁴

In his book (and in later publications), Goldschmidt noted that the majority of species and genera appear suddenly in the fossil record, differing sharply from earlier groups, and that this apparent discontinuity becomes more common the higher the level, until it is virtually universal as regards phyla, classes, orders, and even families.

Secondly, he complained that at the same time the neo-Darwinian geneticists were talking more and more about little "point mutations" as the effective agents in causing change, and complained that their importance was said to vary inversely with their size. He declared himself to feel forced to give these "micro-mutations" up because they seemed to lead nowhere.

He pointed out that one may combine a thousand mutations into one fruit fly, which would be mathematically impossible, but it would still be a fruit fly. What was needed, suggested Goldschmidt, was something larger than point mutations; there must have been what he called "systemic mutations," something that shook up the whole system but still allowed it to survive and breed.

Of course, such big mutations would be so difficult to assimilate that it would most probably be fatal; but Goldschmidt suggested that it might succeed one time in a thousand to create a "hopeful monster," in the sense that divergencies gave "hope" for a glorious future. He listed 17 big changes, evolutionary novelties, which according to him (and creationists as well) could never be explained on a step-by-step basis.⁶ The studies of microevolution might have a little value in explaining how the details were worked out after the macro-changes took place,⁷ but in general, stated Goldschmidt, such studies would hardly have any value in the study of evolution as a whole.

Goldschmidt connected these statements with the supposition that the classical theory of the gene as an actually existing unit, lying on the chromosome like a bead in a string of beads, was no longer tenable.⁸ He did not want to focus on genes and loci or even on chromosomes anymore but assumed something like "saltational mutations" to have occurred involving large portions of the genome and disturbing the whole system. Now, as valid as his objections to neo-Darwinism were, his ideas on the gene in general and on "systemic mutations" in particular were invalid. However, Goldschmidt seemed to make a strong case on some points, not the least by his studies on homoeotic mutants.

Goldschmidt on Homoeosis

Among the 17 inexplorable evolutionary novelties, i.e. the first appearance of new organs, Goldschmidt listed the segmentation of arthropods and vertebrates. In his 1940 book he observed:

In two of the most important phyla of animals, in arthropods and vertebrates, one of the major features of evolution is the progressive specialization in segmentations of the body. In the primitive forms all segments are practically alike, each

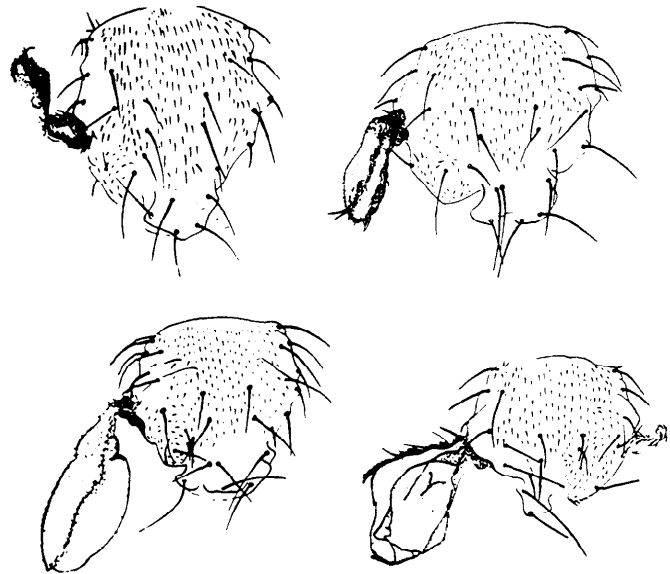


Figure 3. Picture from Goldschmidt's book, *The Material Basis of Evolution* (Reference 5, page 328), showing different conditions of wing transformation into a haltere in *Drosophila* mutant *tetraltera*. Only thorax and wings represented. Normal right wing not drawn where present. The picture is used here by permission of the Yale University Press.

metamere containing a nephridium, a gonad, a muscle segment, a ganglion in arthropods, a neuromere in vertebrates, and an identical pair of appendages. In the course of evolution homomery is changed into a heteromery. In arthropods the appendages differentiate into mouth parts, legs, gonapophyses, disappear in some segments, change their function in others. In vertebrates the comparative anatomy of muscles, segmental nerves, and vertebral column demonstrates the changes from the considerable homomery of *Amphioxus* to all types of heteromery. Among these evolutionary steps there are many of a type which preclude an evolution by slow accumulation of micromutations. The mouth parts of a mosquito or of a bee, certainly derived from the primitive type of crustaceans and primitive insects, are an example in question: gradations between generalized and specialized types would have died of starvation.

For a long time the phenomenon of *homoeosis* (called heteromorphosis by some authors) has been known as an occasional monstrosity in arthropods. The term signifies the appearance of a homologous appendage in a segment to which it does not belong. The classical example is the regeneration of an antenna after removal of the eyestalk in Decapods (Herbst). Homoeosis is now known to be produced also by simple mutation in *Drosophila*, an occurrence which permits an analysis in relation to our problem.⁹ (Emphases added.)

Goldschmidt continued by mentioning the homoeotic mutants then known, and treating some research concerning larval development; obviously, after 35 years these data can be widely extended as is done below.

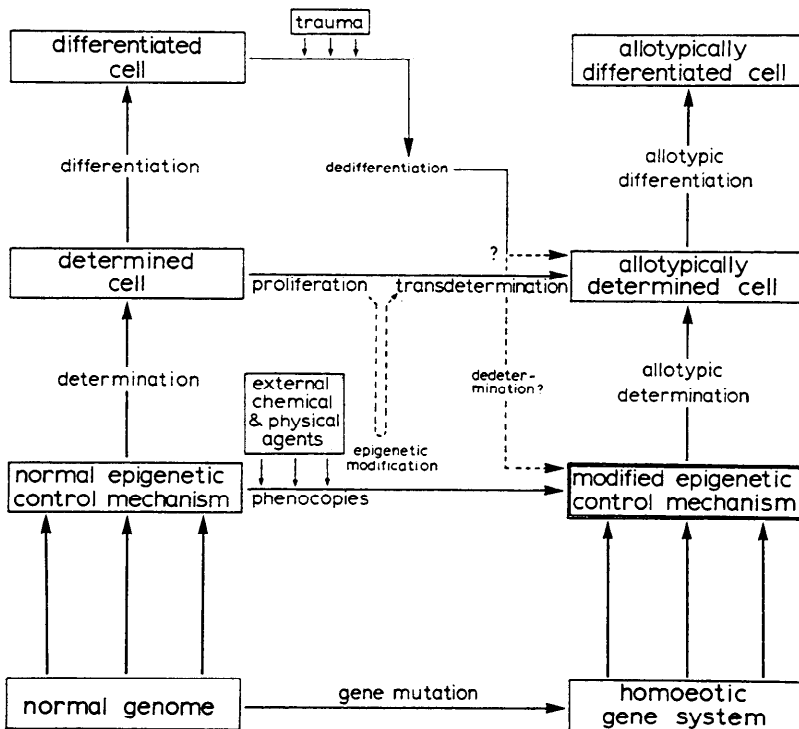


Figure 4. Diagram representing the hypothetical relationships between the different types of homoeosis arranged according to four developmental levels (bottom to top). The crucial element is the interference with the "epigenetic control mechanism" (regulating gene activities), the nature of which is not yet understood (cf. Figure 10). Allotypic = homoeotic.

In a following paper¹⁰ in 1945, Goldschmidt described the homoeotic mutant *podoptera*, in which part of the wing is transformed into a leg-like structure with a complete series of transitions in different siblings in a strain (see Figure 3). He wrote in the discussion:

In the forementioned book I discussed in detail how a decision [on the right genetic view of evolution] can be derived from genetics as well as from a proper evaluation of embryonic potentialities, and I showed how mutations acting upon certain developmental processes might accomplish in one step huge deviations. Homoeotic mutants served as one of the examples to furnish proof of such ideas. The homoeotic mutant analyzed in this paper is a still better example for such a discussion. Here we have a clear-cut case of an organ characterizing a class [viz. the winged insects] being able to mutate in one step into another more primitive organ. We have every reason to believe that the opposite also happens, namely, mutation of leg into wing, which occurs as occasional freaks. There exists also one little-known mutant in *Drosophila* in which it is claimed that an antenna (itself capable of mutating to a leg) transforms into a wing-like structure. It would certainly be difficult [but not impossible . . . W.J.O.] to evade the conclusion that the first wing must have appeared as a mutant of a parapodium containing a trisegmented leg-like appendage [which, claimed Goldschmidt, is found back in the tri-

segmented "costa" at the proximo-anterior wing border].¹¹

Other statements by Goldschmidt will be considered below, after a review of present knowledge of homoeotic phenomena.

Types of Homoeotic Transformation

Within the arthropods four types of homoeosis are known, occurring on four different developmental levels (see Figure 4):

(a) *Homoeotic mutations* involve a change in one or more genes, or in chromosomal arrangement, leading to the formation of altered gene products which effectuate shifts in cell differentiation and pattern formation. They have been found in several insect genera.

(b) *Homoeotic phenocopies*; this term refers to organs or flies which are phenotypic copies of known homoeotic mutants and are caused by external chemical and physical factors which apparently interfere with the relevant gene products or their metabolites during development but leave the genes intact. The factors involved (chemicals in the food, vapors, cold and heat shocks, X and UV irradiation, neutron bombardment) have been applied to embryonic or larval stages of *Drosophila*.

(c) *Transdetermination*; this is homoeotic alteration occurring in imaginal-disc cells that were already "determined" for a certain developmental pathway. It can be brought about by culturing imaginal-disc fragments (dissected from a mature larva) for a suffi-

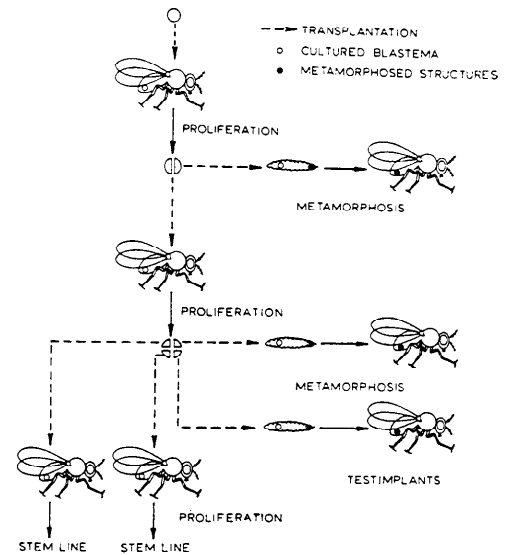


Figure 5. A fragment of an imaginal disc can be cultured in the abdomen of a fly or a larva. In the first case it strongly proliferates only, in the second case it undergoes metamorphosis along with the host. Tissues cultured in a fly can be divided again into fragments which can be further cultured in subsequent flies or can be transplanted as test implants into larvae.

ciently long period within adult hosts where they cannot undergo metamorphosis (see Figure 5). This culturing usually leads to a gradual increase in proliferation rate, but even after years of serial transplantation (from one host to another) the cells maintain the original embryonic character.

When pieces of these cultured fragments are transplanted back into a larval host they undergo metamorphosis along with the host and nearly always develop into adult cuticular structures. Such test pieces usually produce the structures for which they were originally determined, but test pieces from later transfer stages may, probably as a consequence of the extensive and rapid proliferation, differentiate into homoeotic structures, i.e., normally only formed by other discs.

(d) *Homoeotic regeneration* has been described in various adult arthropods outside the insects. In this case an extirpated appendage is replaced by a serially homologous one. I quoted already Goldschmidt mentioning the regeneration of an antenna instead of a removed eyestalk in Decapods. Occasionally spontaneous homoeotic aberrations (either embryonic or regenerative in origin) have also been encountered.

The interesting factor in homoeotic regeneration is that the cells involved are already "differentiated" (i.e., in their terminal developmental stage). It is obvious, therefore, that the cells at the wound surface first have to undergo "de-differentiation" (a return to a more embryonic state) and then will proliferate, at the same time undergoing a kind of transdetermination.

It is interesting to note, by the way, that phenomena similar to homoeosis may occur in other phyla too. Morphological and physiological alteration of "determined" or fully "differentiated" cells during embryogenesis and during regeneration is a well-known phenomenon in several animals, and is usually called *metaplasia*. For those familiar with embryology I may note that even phenomena such as embryonic induction and regulation, and even neoplasia (cancer), can be related to metaplasia and homoeosis. I refer again to my extensive 1975 review article (Reference 3).

Types of Homoeotic Mutation

By far the most homoeotic mutations have been found in *Drosophila melanogaster*, but I will also mention below some other insects. I will consider several examples of mutations producing, from a given imaginal disc, structures normally formed by other discs. In 1940 Goldschmidt knew only of five types of homoeotic mutation, but at present several dozens have been identified. They are known for all imaginal discs (i.e., the labial, eye-antennal, prothorax, wing, haltere, leg, and genital discs), although not all homoeotic transformations known to be possible from transdetermination experiments have been encountered.

Some reasons for this might be, e.g., that homoeotic mutations in the genital disc would prevent reproduction and mutations producing wing structures from the leg disc would impede emergence from the puparium. Indeed, several of such homoeotic mutants have

been encountered by allowing imaginal discs from lethal mutants to metamorphose in host animals.¹²

Homoeotic transformation is a highly specific process, as is strikingly evident in the antenna: (a) *aristapedia* (*ss^a*) changes the arista into the distal part of the tarsus; (b) *tumorous-head* (*tuh*) changes the arista and part of the "third antennal segment" (ant. III) into a complete tarsus; (c) *Antennapedia* (*Antp*) changes the arista and the whole ant. III into a tarsus, tibia, and femur; (d) *lethal*(4)29 changes ant. I and ant. II into a coxa and trochanter (i.e., more proximal leg segments); (e) while *Nasobemia* (*Ns*) moreover changes the cuticle around the antennal basis into a sternopleura (i.e., the thoracic structure around a leg basis) (Figure 6).

All these transformations imply that each antennal part corresponds to a specific leg part. *Antennopodix* (*Apx*) is also able to form a complete midleg, but the arista is usually not entirely replaced. All homoeotic changes in the antenna are toward leg formation, with the striking exception of the mutant producing a wing-like structure mentioned by Goldschmidt (see quote above).

The *tuh* stock mentioned exhibits also abdominal tergites instead of eye facets, and anal plates, clasper teeth, and antennal and leg outgrowths instead of rostral cuticle. Such pleiotropic effects are exceptional among homoeotic mutants.

Other homoeotic head mutants, those of the *ophthalmoptera* type, carry wing outgrowths in reduced eyes (Figure 6); my Ph.D.-thesis¹³ involved a study of such mutants. Another head mutant is *proboscipedia* (*pb*) in which the mouth parts are partly transformed into either tarsus- or antenna-like structures. Interestingly, this modification resembles the biting type in certain lower insects, although the homoeotic outgrowths impede feeding—a first indication that homoeotic mutants (a) may as well lead, not to higher but, to lower organismal types of complexity ("evolutionary levels," to use Goldschmidt's language), and (b) are basically destructive in providing for the organism organs it cannot use and at the same time depriving the organism of original, often indispensable organs.

The only rigid leg transformation known was encountered by Waddington in some combined strains of leg mutants and involved a leg terminating in an arista-like spike instead of the usual tarsal claws. Besides that, a number of other mutations partly or completely change the midleg and hindleg into a foreleg, expressed particularly in a shortening of the basitarsus, transformed bristle and hair patterns, and the presence of sex combs on posterior legs (normally only on forelegs) in the males.

Now with regard to the dorsal thoracic structures, there is a remarkable mutant in *Hexaptera* (*Hx*) which, besides an enlargement of the whole dorsal part of the prothorax (i.e., the first thoracic, appendage-less, segment), produces homoeotic appendages on it. They alternatively consist of wing membrane, resemble a haltere (i.e., the dorsal paired club-like flight instruments of the metathorax or third thoracic segment), or are distinct though irregular legs. Sometimes an appendage is proximally leg-like and distally



Figure 6. Two homoecotic mutants expressed in one head: *ophthalmoptera*: eye area producing wing-like outgrowths (upper right), and *Nasobemia*: antennae changed into legs (middle right and lower middle).

wing-like, or a dorsal prothorax may even bear two or three appendages, e.g. two legs and one wing.

On the dorsal part of the mesothorax (i.e., the second thoracic segment) there are wings, which may be genetically replaced by appendages resembling halteres or legs. It is these mutants of the *podoptera* (*pod*) type which were particularly studied by Goldschmidt.^{14, 15} (See also references 1, 5 and 10) I mentioned already that the intermediate stages between wing and haltere form a continuous series; interestingly, this series is entirely similar to the same series in certain other mutants which, reversely, change halteres into wing-like appendages in all degrees. Goldschmidt noted further that the (tripartite) wing costa seems to be homologous to the distal leg (coxa, femur, and tibia) and that as the wing diminishes in size thoracic duplications increase in number, suggesting that the latter replaces wing parts.

Next, consideration should be given to the so-called *bithorax* complex, a series of (at least) seven pseudoalleles changing dorsal and ventral anterior and/or posterior parts of certain body segments into the corresponding parts of other body segments. Only *Contrabithorax* (*Cbx*) affects the mesothorax (including the wings). Three others change the metathorax (including the halteres)—*bithorax* (*bx*), the anterior portion (Figure 7), and *bithoraxoid* (*bxo*) and *postbithorax* (*pbx*) the posterior portion—into the corresponding mesothoracic structures. *Ultrabithorax* (*Ubx*) exhibits a combination of the phenotypic effects of these three recessive mutations.

Contrabithoraxoid (*Cbxo*) exceptionally produces a partial transformation of the metathorax into the



Figure 7. The homoecotic mutant *bithorax*: anterior metathorax and haltere halves changed into anterior mesothorax and wing halves.

first abdominal segment (abd.I) next to it, so that the fly occasionally bears five or even four legs instead of six. Three pseudoalleles interestingly affect the abd.I directly: *Ultraabdominal* (*Uab*) changes it into an abd.II, and *Ubx* and *bxo* transform it into thoracic structures. It is interesting that some mutants such as *bx* and *bxo* affect both the dorsal and ventral segment half: *bxo* sometimes produces both a (dorsal) pair of haltere-like appendages and a (ventral) fourth pair of legs in the abd.I.

Finally as to the genital disc, a lethal mutant is known¹² transforming genital into tarsal and antennal structures. Besides that, also the "sex-transforming" mutants could be considered as homoecotic. They determine genital discs which are chromosomally female to produce male organs, and conversely, and correspondingly affect the development of the gonad primordia.

Homoecotic mutations in species other than *Drosophila melanogaster* are little known. Examples have been encountered especially among other *Drosophila* species, where they are very similar to the corresponding ones in *D. melanogaster*. The same holds for the house-fly, *Musca domestica*. Next are the mosquitos, in which some mutants of the *pb*-type have been found (see above); such mutants may be female-sterile because females cannot pierce skin and hence cannot obtain the blood needed for egg production,¹⁶ which would not be very helpful in evolution.

The *E*-allelic group in the silkworm *Bombyx mori* is very interesting.¹⁷ The first two abdominal segments in the caterpillar normally have no legs; some *E* alleles, however, produce larval thoracic legs on these abd.I and II, some produce thoracic legs on all segments, and one produces thoracic legs on abd.I and abdominal legs on abd.II. In the flour beetle genus *Tribolium* a mutant of the *Antp*-type and one of the *pb*-type is known.

Finally, the most primitive insect known (to me) to exhibit a homoecotic trait is the German cockroach, *Blattella germanica*.¹⁸ This X-ray induced, dominant mutation is *Pro-wings*, characterized by lateropos-

teriorly directed enlargements of the pronotum which resemble a pair of diminutive wings.

Ross points out that the occurrence of "pro-wings" in one of the most primitive (heterometabolous) pterygotes (winged insects) is of special interest in connection with the presence of paranotal lobes or wing flaps on the prothorax of the "oldest" (in uniformitarian terms) known fossil pterygotes. Here again therefore, if evolution were really involved, there would apparently be a case for degeneration rather than one for "improvement." The same holds for an example enthusiastically mentioned by Goldschmidt,¹⁹ namely the minute rudimentary wings in the very aberrant termitophile fly *Termitoxenia*, which would be identical to the homoeotic wings intermediate between halteres and wings both in "wing to haltere" and in "haltere to wing" mutants in *Drosophila*. Again, if this has anything to do with evolution it points largely to degeneration.

Genetic Properties

Most homoeotic mutants in the fruit fly seem to be point mutations, although they are often connected with chromosomal aberrations. It is striking, however, that a relatively large number of them, at least 11, are all located in the same region of the right arm of the third chromosome, between loci 47± and 58.8. Goldschmidt²⁰ mentioned this fact as supporting his hypothesis that there are no "genes" but that the chromosomes themselves act as units in the genetic control of normal development. But at that time (1938) homoeotic mutations were known in this 3R-region only; now they are known to be distributed over all four chromosomes, often in lone positions.

Denell²¹ suggested that the unusual clustering of genes of similar (viz., leg, and antenna-changing) function around the locus 47-48 may be due to their being derived from a single "ancestor gene" through gene duplication and subsequent diversification of function; in addition, such clustering might be necessary to make possible their coordinate control.

The chromosome region concerned has frequently been found to be the end or the beginning of a chromosomal inversion involving various homoeotic alleles. Other homoeotic mutations appear to be involved in chromosomal translocations. Again other homoeotic mutations are combined in a pseudoallelic series like the *bx* complex.

The *podoptera* group is genetically the most complicated one and was most extensively studied by Goldschmidt. (See reference 15) It embraces a number of different, very variable hereditary strains in which the wings are transformed into leg-like, three-jointed appendages. In no case is this effectuated by a single mutation, however. Four types are distinguished, all multifactorial, with factors on all chromosomes and each with a major factor on the second chromosome; moreover, in most cases the *pod* effect is dependent on heterochromatic chromosome regions.

Mittwoch²² has suggested an interesting parallel between the *pod* effect in *Drosophila* and sex differentiation in mammals. Both cases involve an undifferentiated rudiment to which two possible developmental

routes are open: from the wing imaginal disc either a wing or a (homoeotic) leg is formed, while the mammalian gonad anlage produces either a testis or an ovary, heterochromatin playing a crucial role in either case. Certainly, no evolutionist would suggest an evolutionary relationship here; on the contrary, only an interesting "developmental convergence" can be claimed.

A next genetic feature of homoeotic mutants is that frequently their penetrance and expressivity are strongly influenced by modifying genes: "suppressors" or "enhancers." In some cases (e.g., *tuh*) the homoeotic effect even entirely depends on two seemingly unrelated mutations. In the group of *opht* effects, the homoeotic transformation always requires an eye-reducing gene in addition to the actual homoeotic factors which produce the wing outgrowths in the eye area. (See reference 13)

Interestingly, homoeotic organs may be secondarily altered by other homoeotic genes; in such cases the effect of the "secondary" gene is superimposed on that of the "primary" gene. For instance, at low temperatures *pb* changes the mouth parts into arista; *ss^a* (changing the arista into a tarsus) is also associated with the arista-producing effect of *pb* towards tarsus-production²³ (see Figure 8). In *Ns/Pc* flies, *Ns* changes the entire antenna into a complete midleg, while *Pc* changes this midleg immediately into a fore-leg.²⁴ For other examples see my 1975 review.

Some homoeotic mutations which drastically influence the segmentation pattern and polarity of the fly must exert primary effects at a very early embryonic stage, namely when the determination of imaginal disc precursor cells appears to occur (the stage of "blastoderm" formation in the 2½ hrs. old embryo). This is supported by the fact that a drastic mutation such as *bx* can be phenocopied by ether treatment and heat shocks at this early stage.

This leads me to expect that there will be homoeotic mutants which exhibit so-called "maternal effects," which means that the homoeotic effect depends on the genotype of the mother, namely the genotype of the egg, not that of the zygote nucleus. However, such mutants are very rare, probably because they usually would lead to lethal development.

I should cite one example of a homoeotic maternal-effect mutant, one which is related to the *bx* phenocopies just mentioned and has supposed evolutionary significance. Professor Waddington,²⁵ another pioneer in homoeosis, subjected 2½-3½ hrs. old wild-type eggs to ether vapor and selected the flies developed from these eggs for the tendency to produce *bx* phenocopies.

In two different selection lines, flies with slightly enlarged halteres gradually appeared among the untreated individuals and were found to contain an allele of *Ubx*, possibly due to independent chance mutations. In one of the lines in addition a much more extreme *bx* phenotype, due to several genes, appeared in high frequency among the untreated individuals.

These pseudo-Lamarckian acquirements are beautiful examples of "genetic assimilation," the process by which the genotype takes over the role of a certain

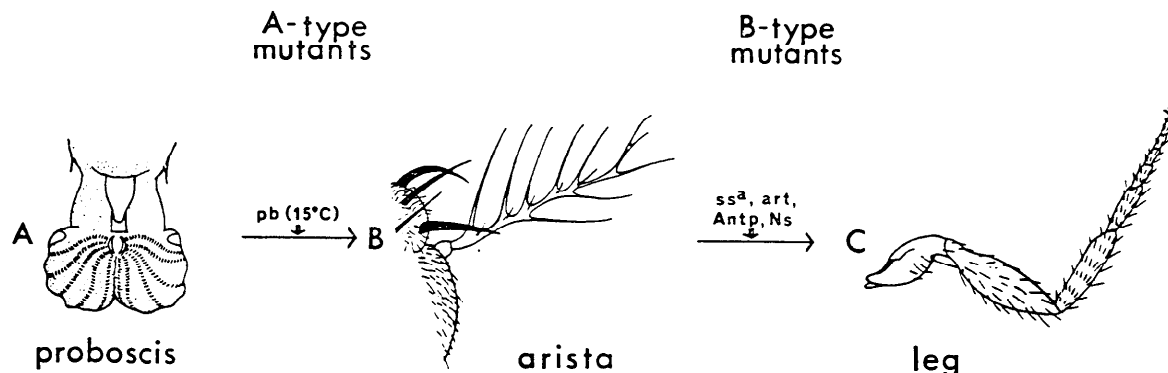


Figure 8. Diagram of a "transformation series" controlled by homoeotic genes. The A-type mutant *proboscipedia* (*pb*) changes, at low temperature, the mouth parts into aristae, while the B-type mutants *aristapedia* (*ss^a*), *aristatarsia* (*art*), *Antennapedia* (*Antp*) or *Nasobemia* (*Ns*), which normally change an arista into tarsus, in combination with *pb* directly produce tarsi out of the mouth parts.

environmental factor in producing a given phenotype. The "assimilated *bx*" stock is known as *He^{*}*. Its phenotype is partially due to a number of genes acting directly on the individuals containing them, and partly to a recessive X-chromosome condition which causes a maternal effect. Probably a gene or group of genes around locus 33 is involved. Waddington suggested that the condition had arisen by mutation during the course of selection but rightly emphasized that the possibility cannot be excluded that it was present in very low frequency in the initial population.

Developmental Properties

One of the most elegant tools in the developmental analysis of homoeotic mutants involves the technique of genetic mosaics. I consider here two types of mosaics:

(1) Genetically marked tissue patches on flies; such patches are cell clones arising as a result of either (a) gynandromorphism due to the elimination of one X chromosome during a cell division in the early development of a female, leading to an XO (i.e., male) cell clone in further development; or (b) somatic crossing-over (SCO); this can be induced at any stage of development particularly by means of X, UV, or γ irradiation; when the appropriate genetic "markers" are used SCO in any cell will lead to a clone of phenotypically different cells derived from the affected mother-cell. These cells are hemi- or homozygous whereas the background tissue is heterozygous for the recessive marker allele(s) used.

The technique can be used for two purposes. First, the homoeotic mutations are used to mark induced clones in order to study the developmental behavior of small homoeotic patches in otherwise normal organs. It has been shown that such patches invariably develop autonomously, i.e., according to their homoeotic genotype, unless SCO is induced at very late stages when the cells probably are definitively determined for wild-type development; see further my 1975 review.

Secondly, the technique has been used to study the morphogenesis of homoeotic organs by means of

genetic markers affecting body color or chaetal color or shape. It was used particularly by Postlethwait and Schneiderman²⁶ in their study of *Antennapedia*. They described an experiment to establish whether the homoeotic area in the antenna is the progeny of a single cell or whether the homoeotic transformation occurs in a population of cells.

If marked patches are induced prior to the "determinative" event, then in the former case some antennae would have their homoeotic part entirely included within the induced patch, whereas in the second case in some antennae the marked patch would overlap the antennal and the homoeotic part against an unmarked overlapping background. (If the patches are induced after determination, they would in both cases be confined to either antennal or homoeotic areas.)

In this way it could be established that, firstly, the homoeotic determination occurs in a population of about ten cells and, secondly, that this takes place in the early third larval instar. Moreover, it seems that upon this determination the presumptive leg cells show an increased growth rate more characteristic for growth in the leg disc, whereas the presumptive antennal cells maintain a growth pattern more typical of the antennal disc.

(2) In some homoeotic mutants, which produce their effects at varying expressivities, the affected organ may form a "phenotypic mosaic" consisting partly of normal, partly of homoeotic tissue. Postlethwait and Schneiderman discovered in *Antp* antennae that very specific antennal parts were replaced by very specific leg parts only. They suggested that the two cell types respond to an identical set of "positional cues" which are "interpreted" by the developing cells either in a "leg-like" or an "antenna-like" way, depending on whether the homoeotic mutant comes to expression in a given cell or not.

I conducted a similar study²⁷ in homoeotic haltere mutants. Using *bx* and *pbx* has the advantage that only part (viz., the anterior or the posterior part, respectively) of the haltere is transformed, so that at each proximodistal level adjacent haltere and wing

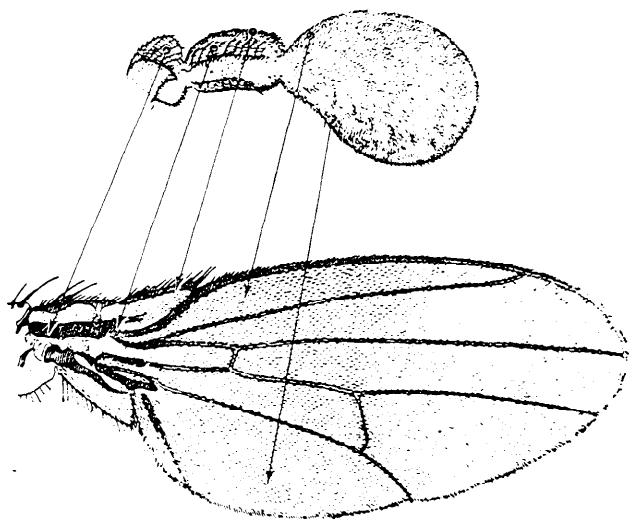


Figure 9. The homology between haltere (above) and wing structures (below) as determined by site-specific transformations in homoeotic halteres of *bithorax* and *post-bithorax*. The segmented structure can be fairly clearly found back in the wing. The groups of sensilla correspond accurately.

structures can be compared (see Figure 9), while the borderline between them may vary along the antero-posterior axis. Close examination of *bx* and *pbx* halteres made it possible to establish exact homologies between certain haltere and wing structures (and even small sensilla groups).

I mentioned that the homoeotic determination in the *Antp* antennal disc must occur in the early third larval instar. Other techniques to establish the time of determination are:

(1) *The phenocritical phase.* This is the time at which the phenotype of a mutant animal begins to deviate from that of the wild-type; obviously this cannot occur before the time of gene action. For instance, I studied the outgrowths in *oph* eye discs which produce the wing bulges in the adult eyes, and found that they are not visible until shortly before the middle of the third larval instar. (See reference 13)

(2) *The phenocopy-sensitive period.* Some phenocopies are produced at specific developmental stages only and Goldschmidt suggested that therefore they are indicative of the time of determination. (See reference 20) One must bear in mind, however, that the nature of the phenocopying agents is quite unspecific and the mechanism of action is unknown.

(3) *The temperature-sensitive period (t.s.p.).* The penetrance and expressivity of homoeotic mutants usually are very sensitive to changes in temperature. Heat and cold shocks usually are only effective during certain developmental stages which are therefore thought to indicate the time of determination. This t.s.p. may be at any stage but usually occurs in the third instar. Some mutants are heat-sensitive, others are cold-sensitive, and *pb* is both: it changes the mouthparts into aristae at low, and into tarsi at high temperature.

Grigliatti and Suzuki²⁸ made an interesting observation in their t.s.p. study in *ss^{240a}*. "Shifts up" (i.e., from low to high temperature) at successive stages during the t.s.p. led to aristae having homoeotic proximal parts which gradually increased distally while the size of the remaining arista decreased.

"Shifts down" at successive stages led to the reverse pattern, but always the proximal part was homoeotic and the distal part normal arista. Presumably, the size of the homoeotic part of the arista is proportional to the fraction of the t.s.p. spent at low temperature.

Apart from temperature, few other environmental factors have been examined for their effects on homoeosis. It is peculiar that very large effects may be exerted by very trivial factors like the supply of fresh yeast to the larvae, simple aging of the larval culture, and the age of the mothers. (See reference 13) Chemicals added to the food may either interfere directly with homoeotic development or prolong the larval period and thus affect the growth pattern of homoeotic primordia. (See reference 13)

A more direct influence upon disc growth can be achieved by direct treatment of the discs followed by *in vivo* culturing. I have bathed homoeotic discs in various colchicine solutions and then transplanted them into host larvae, where they undergo metamorphosis along with the host. According to the results, colchicine, which is best known for the fact that it will arrest mitosis, may under certain circumstances exert a mitosis-enhancing effect, as was found by many other authors (See my 1975 review).

I also used the transplantation technique to construct "fate maps" of the wild-type and *oph* eye discs by means of disc fragmentation. (See reference 13) I showed the presumptive eye area to be located in the flat part of the disc, surrounded by head cuticle primordia, and probably to be entirely capable of wing formation.

I also cultured very young eye discs in adult, wild-type hosts for some weeks (where they terminate larval development) and then transplanted them back into full-grown wild-type larvae. (See reference 13) During metamorphosis the discs produced homoeotic wing tissue. This could not have been induced in the disc by the larval environment (of which it was deprived). Therefore, I concluded that it developed autonomously.

Similar experiments had been completed by other authors with the same results, although not at such an early stage. It has been shown that even the overall development of normal imaginal discs is independent of the larval internal environment. The discs autonomously determine an intrinsic developmental program depending on a phase of proliferation, no matter whether this takes place *in situ*, in a metamorphosing larval host, in an adult host, or *in vitro*. This is an important point in view of Goldschmidt's ideas of homoeosis to be discussed below.

Finally, I mention some examples of homoeotic regeneration. Pantelouris and Waddington²⁹ extirpated whole wild-type and *He** wing discs to study the regulative response of the animal. They suggested that in some cases the remaining wing disc or the homoeotic haltere disc on the operated side, respec-

tively, partially regenerated the missing disc. It seems however, that in cases of apparent regeneration the wing disc was not completely removed and that the small remaining disc fragment, through cell proliferation, had produced the regenerated structure.³⁰

In fact, several researchers³¹ have shown that certain disc fragments can indeed regenerate missing structures, although in a polarized way: complementary disc fragments, after similar additional proliferation, only duplicate, in mirror-image fashion, the primordia they contain.

For instance, when the (normally attached) eye and antennal discs are separated, cultured in adult hosts, and then injected into mature larvae, eye discs regenerate the antennal disc whereas antennal discs only duplicate the same tissue. This holds for both wild-type and homoeotic (*ss^a*) discs: *ss^a* eye discs may, through growth, regenerate antennal structures including homoeotic tarsi, while *ss^a* antennal discs may produce homoeotic tarsi in duplicate. If discs of the temperature-sensitive mutant *ss^{a40a}* are isolated and cultured after the t.s.p., the phenotype of an antenna, arisen by regeneration or duplication, turns out to depend entirely on the temperature of the *in vivo* culture and therefore to be independent of the original t.s.p.³²

Hypotheses of Homoeosis

(1) *Evocators*. The first hypothesis of homoeosis was proposed by Goldschmidt in his 1938 and 1940 books, mainly on the basis of a developmental timetable given for the wild-type and *ss^a* leg and antennal discs already in 1929. He suggested that at different times during larval development different "evocators" (inducing substances) are released, which determine those discs which have become "ripe" (competent for "determination") just at the time of release of each evocator.

For instance, at a certain time the leg discs would have become "ripe"; at that time a tarsus evocator would be released into the larval body fluid, which would determine the leg discs for tarsus development. Other discs are not determined by the tarsus evocator, either because they are already determined or because they are not yet "ripe."

In the *ss^a* mutant the growth rate of the antennal disc would be changed in such a way that the disc now becomes competent at the time of release, not of the arista evocator but of the tarsus evocator, so that the arista primordium does not acquire arista but tarsus quality.

This hypothesis was seriously attacked by Marguerite Vogt.³³ First, her own studies on the *ss^a* discs disproved the old time-table of 1929 and therefore removed the main foundation of Goldschmidt's hypothesis. Secondly, she rightly argued that the observation that 2½ day-old *ss^a* antennal discs implanted into normal larvae still produced homoeotic legs would constitute no argument for accelerated disc development if the latter were autonomous—which it indeed proves to be. Goldschmidt later recognized the validity of Vogt's arguments. (See reference 15) All the evidence now available is contradictory to the pres-

ence of "evocators" in the larval body fluid which would diffuse into and determine the discs. I have conclusively shown by my own experiments in 1970 that homoeotic discs can develop autonomously in wild-type host larvae.

(2) *Switch genes*. It is more plausible to look for the cause of homoeotic transformations in the genetic regulation mechanisms **within** the discs. This is what Waddington³⁴ did. He pointed out, for instance, that in the case of *ss^a* the arista primordium within the antennal disc cell growth occurs along two distinct alternatives, the "arista developmental pathway" or the "tarsus developmental pathway," each controlled by a large number of "morphological" genes (arista genes and tarsus genes, respectively).

These pathways never merge but are strictly "canalized"; that is, their respective genes constitute coherent genetic systems. In the wild-type arista primordium the subsystem of arista genes is "turned on," while the subsystem of tarsus genes is "turned on" in the wild-type tarsus anlage of the leg disc.

Now Waddington suggested that the homoeotic genes act as "switch genes" or "key genes" which in a given disc or disc part turn on a different genetic subsystem, thus switching development into another developmental pathway. The function of the wild-type allele of a homoeotic gene like *ss^a* might be that of repressing developmental pathways typical of homologous organs.³⁵ A collateral problem would be why the *ss^a* gene (either normal or mutant) is active in the arista primordium only (see below).

A similar but somewhat more tangible model to suggest an explanation for these problems has recently been designed by Kiger³⁶ for the *bx* complex locus. His ingenious though speculative model is similar to the famous general model of genetic regulation by Britten and Davidson.³⁷

He suggested that morphological genes belonging to one subsystem are each controlled by a contiguous "expressor gene"; all the expressor genes of one subsystem would produce identical expressors, which as a class would be subject to the same control, namely by the homoeotic "key gene." This gene would produce a protein with different functional states, depending on the genotype, so that it can selectively activate different expressor classes. I will not go into this further (See my 1975 review), but refer to Figure 10.

(3) *Positional information*. This concept was formulated by Professor Lewis Wolpert.³⁸ He has suggested that there may be a universal mechanism whereby genetic information is translated into spatial differentiation patterns. This mechanism would be based on the specification of the position of a cell with respect to one or more "reference points" in a developing system. This specification of position yields "positional information," which could be thought of as a scalar quantity, even shaped as a simple gradient of some physical or chemical factor.

I have formulated some rules³⁹ in such terms to account for duplication and regeneration in cultured disc fragments (See also reference 31). Imaginal discs are thought to differ not in the specification but in the

model of homoeosis

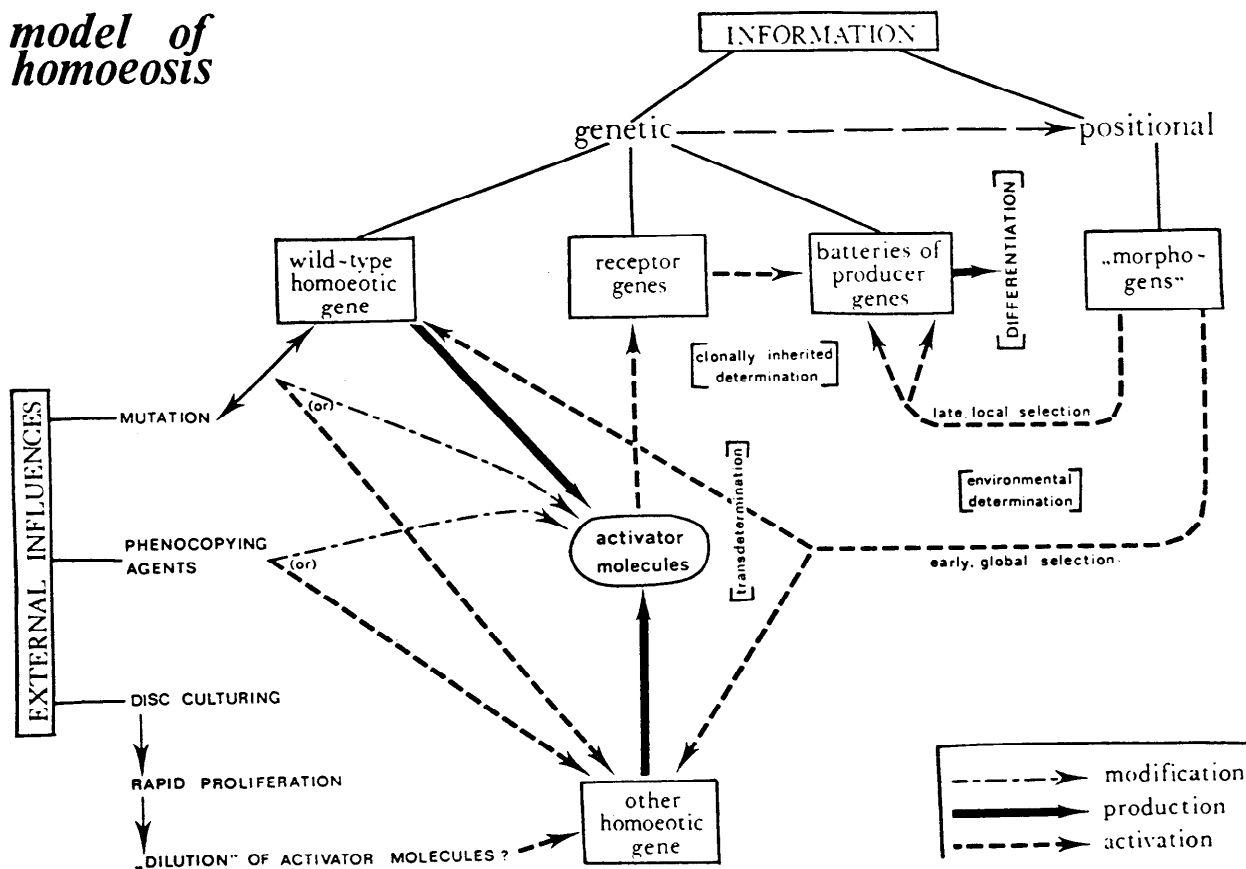


Figure 10. Diagram unifying several views on homoeosis. Developmental information is thought to be at least of two types: (a) genetic information, including the homoeotic genes ("integrators"), "receptor genes"; and batteries of "producer genes"; (b) positional information thought to be provided by "morphogens" of unknown nature.

At an early stage positional information (also under control of the genome) may differentially activate the integrators in the various imaginal discs or disc parts. An integrator may produce activator-RNA molecules which activate a specific type of receptor gene; each receptor gene controls an adjacent producer gene; all producer genes controlled by one type of receptor gene form a battery.

Batteries may either correspond to sets of "morphological" genes together producing a given structure, or to "bistable control circuits" overlapping several imaginal discs. Activation of certain batteries leads to a clonally inherited type of cellular determination, whereas the determination of the ultimate supracellular differentiated pattern is of an environmental type thought to be due to positional information. External influences produce homoeotic phenomena.

Both mutation of a homoeotic gene and phenocopying agents may modify the activator molecules and/or lead to activation of a different wild-type homoeotic gene by some sort of negative regulation. Imaginal disc culturing usually leads to rapid cell proliferation by which hypothetical "determination carriers" (activator molecules?) might be "diluted"; this might lead similarly to the activation of a different homoeotic gene.

interpretation of positional information; homoeotic mutants are therefore thought to alter the latter, not the former.

One of the most elegant illustrations of the putative significance of the concept seems to be provided by the phenotypic mosaics studied by others (See reference 26) for *Antp* and by myself (See reference 27) for *bx* and *pbx*. The precise site-specific nature of the homoeotic structures seems to imply that leg and wing cells respond to the same set of positional values as do antennal and haltere cells, respectively; the interpretation of these values would then depend on the homoeotic genotype.

In addition, it is possible that the presumptive imaginal discs are specified by positional information in the very early embryo.³⁹ This implies that the discs would be provided each with a specific mode of interpretation of the identical set of positional values within

them, and this on the basis of their position in the early embryo.

(4) *Control circuits.* Stuart Kauffman⁴⁰ has recently proposed a new model for genetic regulation of development in higher organisms, which he then applied in particular to homoeotic phenomena. He observed that for regulated genes and processes at least one "control variable" has a state which determines the outcome of the process regardless of the states of other regulatory variables. Regulated genes always seem to be governed especially by such "canalizing functions" (i.e., capable of determining the behavior of the regulated process).

Secondly, Kauffman introduced "forcing loops": gene A "forces" gene B if A is canalized and in that state canalizes B. In turn B may force C, and so on, while the last element of the chain may have a forcing feedback on A. Such a "forcing loop" maximally has

two steady states, a stable one insensitive to external regulatory events and having each element in its canalized state, and a sensitive, metastable one having each element in its non-canalized state.

This hypothesis has been extensively worked out for genetic regulation in bacteriophages but it is not self-evident that it applies to eukaryotes. It is particularly the determinative states of mature imaginal discs, however, that might possibly be due to "control circuits" assuming stationary states, somewhat as Waddington postulated alternative developmental pathways, and Wolpert alternative interpretations of positional information.

Kauffman suggested that each disc is characterized by a specific combination of control circuit states, and argues that, in transdeterminative events (see above) and in homeotic mutants, one control circuit changes from the less stable to the more stable state, or sometimes perhaps *vice versa*. He adduces quite a few corroborating experiments which I cannot go into here (See my 1975 review).

Although the model is highly speculative, it is stimulating because it indicates new ways of research on homeosis, such as determining how many control circuits there are, searching for pleiotropic effects in homeotic mutants, and testing the relative trans-determination frequencies in them.*

Homeosis and Evolution

Now that the present knowledge of homeotic phenomena has been summarized, Goldschmidt's view of evolution can be evaluated as far as it concerns homeotic mutants. I feel that two interesting conclusions can be drawn.

(a) Goldschmidt's criticism of neo-Darwinism as an explanation for macroevolution is still as valid and as destructive as it was in his days. Absolutely no newer data have been collected that could be used to counter his strong objections to the synthetic theory.

(b) However, his hypothesis of homeosis used as strong evidence for his own alternative view of evolution has turned out to be as invalid as neo-Darwinism. Both his assumption of the non-genetic basis of homeosis and that of evocators released in the larval body fluid at various times have been discarded. Moreover, I will show that according to present knowledge of the action of homeotic mutants, they could not have any role in a supposed macroevolution.

Other critics of classical neo-Darwinism today seem to be in the same position. For a number of years the so-called "neutralist theory," virtually related to some

older ideas of Goldschmidt (although this is hardly recognized), has been propounded by geneticists such as Kimura, King, Jukes, and Ohta.⁴¹ These theorists criticize the view that natural selection is the only or basic force in evolution in much the same way as Goldschmidt did or as creationists do. They propose an alternative theory, however (stating that many mutations are neutral from the standpoint of natural selection and that gene frequencies in populations change by "random genetic drift" in limited populations), which appears to be at least as untenable as the classical synthetic theory as an adequate explanation even for microevolution.⁴² If geneticists do not agree on mechanisms of microevolution they are even much farther from any genetic theory that could account for macroevolution.

The cause of all this confusion is the unfounded presupposition that evolution has taken place at all.⁴³ Take the example of the argument from comparative anatomy, so eagerly used by Goldschmidt. Many creationists have already pointed out that similarities ("homologous patterns") do not necessarily indicate common ancestry; they might equally well point to a common design and a common Designer.

For those who accept the creation model, a study of homeotic phenomena more and more reveals an inconceivably complicated and impressively well-ordered ground-plan which the Creator has provided in such complex animals as the insects. Read, for instance, the 1973 and 1974 papers by Kauffman, and, if his model be valid, try to conceive how such an intricate, sensitive, compliant, and neatly regulating system could have even developed by natural selection of random mutations.

Then compare this with what is now labelled by some as the "naive" view Goldschmidt held regarding the action of homeotic mutations. Of course, he knew little of them in his day, but what I mean to say is that evolution always seems to be more conceivable the less is known of the extreme complexity of the living systems concerned. Moreover, such systems may genetically *vary* indeed—but this is altogether a different problem from the question of how they did *originate*.

I will come back to this problem in a moment but first I must turn to a second pillar of the evolutionary doctrine, namely paleontology. Just consider the complex animals involved—the insects. Morris recently wrote:

If the evolutionary origin of the higher animals is obscure, the origin of insects is completely blank. Insects occur in fantastic number and variety, but there is no fossil clue to their development from some kind of evolutionary ancestor. . . . The most remarkable feature about such fossil insects as are known is that they are very similar to those living now.⁴⁴

Thus, first there seems to be hardly any microevolution within the insects, and secondly, their macroevolutionary origin is a complete enigma. It is very interesting that exactly this problem of the sudden appearance of higher systematic categories has also brought some paleontologists to the assumption of evolutionary "saltational mutations." The evolutionary-geneticist

*Note added in proof. Recent work of García-Bellido's group in Madrid (See reference 53) has supplied a fifth hypothesis on the action of homeotic genes. By clonal analysis they have shown that growing imaginal discs are successively divided into various "compartments": first into an anterior and posterior, then into a dorsal and ventral, and a central and peripheral compartment, etc., implying that after a "compartmentalization step" cell clones are henceforth restricted to either compartment and do not overlap anymore. These researchers have adduced many arguments (e.g., the phenotypic mosaics and "transformation series" mentioned above; see Figures 8 and 9) that homeotic genes are involved in the "compartmentalization process" and the subsequent growth program of the respective "compartments."

Sewall Wright commented on Goldschmidt's hypothesis:

From a descriptive standpoint, it appears that this [Goldschmidt's] interpretation of the paleontological record [viz., as a succession of macromutations] has a large element of truth. *It is borne out by Simpson's quantitative studies of paleontological data* which led him to the concepts of tachytely (rapid origin of higher categories), horotely (ordinary progress) and bradytely (virtual cessation of evolution) as almost qualitatively different processes (1944).

Goldschmidt and Willis⁴⁵ boldly attribute the origin of higher categories to single mutations of appropriate magnitude. Under this view the major course of evolution is simply that of the succession of the exceedingly rare viable mutations of this sort. . . . *The difficulty which most geneticists have felt with this view is that it seems to be asking for something like a miracle at each major step.*⁴⁶ (Emphasis added)

Wright preferred to view evolution as an irregularly shifting state of hereditarian, selectional, and ecological balances, and particularly as due to random genetic drift in small populations, a notion still popular in the modern "neutralist" theory. He also gave an important place to:

. . . major mutations (homoeotic for example) which, while not adaptive at first occurrence, are not too injurious or are protected sufficiently by low penetrance, to be carried at low frequencies by the species as a part of the field of potential variability which may ultimately be used.⁴⁷

The paleontologist who most strongly acclaimed Goldschmidt's ideas was the well-known German scientist Otto H. Schindewolf, in his book *Grundfragen der Paläontologie*.⁴⁸ On the basis of his extensive study of fossil organisms he came to the striking conclusion that the neo-Darwinian concept of random mutation and natural selection was completely inadequate as an explanation for macroevolution. He wrote (I translate):

We are convinced that people in the evolutionary field will once come to the opinion that the thoughtless and exclusive extrapolation of the microevolutionary mechanisms to macroevolution was an error with serious consequences.⁴⁹

He then argued that if this extrapolation were correct the realm of organisms would show the following characteristics: (a) it would appear as a continuity of forms without conspicuous gaps; (b) due to random mutation it would develop into an inarticulate, multidirectionally scattering chaos of forms; (c) it would show many overlapping and polyphyletic "circles of adaptional characters," and (d) evolution would be very slow and gradual, not periodical and saltational.

Schindewolf then showed extensively that, in fact, on all these points the contrary situation is exhibited by the fossils and encountered in nature, and concluded that, in order to account for the present organismal kingdoms as they really are, it is inevitable to assume macromutations with a complex effect. He

therefore turned to genetics, namely to Goldschmidt, and wrote:

The presentations given here have grown from an independent analysis of the paleontological material. *The more surprising and gratifying are for me the far-reaching correspondences between our (Goldschmidt's and my) views.* "Schindewolf's theory is practically identical with that of Goldschmidt," as D. D. Davis recently (1949) concluded on the basis of my statements from 1936. I consider these convergencies from very different starting points as a welcome indication that I am on the right road. . . .

With this explanatory approach Goldschmidt has encountered various objections from other geneticists. In these disputes paleontology cannot interfere. From my own standpoint I can only add that *Goldschmidt's inferences entirely meet the requirements which the fossil material, as for me, seems to make*, and that he as the first geneticist has suggested an overall explanation which does justice to the actually historical, evolutionary data.⁵⁰ (Emphasis added).

What Homoeotic Mutants Mean to Creationists

Is it not interesting that about 1950 two bright and famous scientists, both in separate fields (the most important fields for evolutionism!), namely paleontology and genetics, independently reached the same conclusion? **Neo-Darwinism can not possibly account for macroevolution!** And they proposed the same solution: saltational mutations, as the only solution. From this realization two questions arise immediately:

(1) Have their objections to the classical synthetic theory been invalidated? Not in the slightest sense; both their paleontological and genetical arguments are still as significant as when proposed.

(2) Have their views on macromutations as essential in macroevolution then been validated? Not in the slightest sense; the views have been forgotten. Sewall Wright, who *adduced them* in 1950, did not even mention them in his extensive two volumes⁵¹ of 1969. Lewontin did not mention them in his recent standard work⁵²—he did not even mention Goldschmidt! The point is: the idea of saltational evolution has simply been even worse than neo-Darwinism.

Just look at the homoeotic mutants, and see what problems they are for macroevolutionists. I have already noted that evolution always seems to be more conceivable the less is known of the extreme complexity of certain living systems. Genetic mechanisms that explain how such systems vary do not necessarily explain how these systems originated. It is now evident that the wild-type alleles of homoeotic genes have an important role in normal genetic regulation and development. The crucial question, however, is where the homoeotic genes came from rather than how they favorably mutate.

I can imagine how genetic duplication could lead to two adjacent, identical genes which subsequently could differentially mutate. A possible example is the 47± locus in the third chromosome of *Drosophila*. But this only explains how a second, *related* homoeotic

mutant could arise, not how the first homoeotic gene of that type in that chromosome region arose.

And what is worse, homoeotic genes seem very essential in controlling large batteries of either morphological genes (Waddington, Kiger) or genes in "control circuits" (Kauffman) or the "compartmentalization" of imaginal discs (García-Bellido), so that no development is at all conceivable without homoeotic genes.

Besides the problem of the very origin of homoeotic genes, the question arises how mutation of homoeotic genes could contribute to any supposed evolution. There are some very severe objections to such a conjecture, which Goldschmidt might have realized already, in part:

(a) Homoeotic organs yield two large, related disadvantages to the organism: first, no single homoeotic organ is known that is functional and therefore useful to the organism. In many cases, the homoeotic organ is even essentially destructive; e.g., all mutants of the *pb* type impede feeding and may cause an early death. Secondly, the animal is left without the original organs which were replaced by the homoeotic organs; e.g., *pod* flies cannot fly.

(b) What is needed in macroevolution is the origination of essentially new organs; but homoeotic organs are never "new" organs but always copies of organs found elsewhere in the animal. Homoeotic genes seem to "choose" between alternative developmental pathways which are all practicable in principle.

Thus, mutations of homoeotic genes would only be able to "switch on" an unusual battery of producer genes" if these genes were already available, i.e., if the organ they produce is already formed somewhere else in the body. It is absolutely invertebrate and a contradiction in terms to maintain that intricate, well-ordered gene batteries could ever arise by random processes; let alone the question: through mutation of what could they arise?

(c) Homoeotic mutations are not "directional," i.e., they do not result in any appearance of higher levels of organization. In fact, I know of no mutation that could be reasonably considered to create a "higher-levelled" insect. On the contrary, most mutants should be called definite "steps back."

If evolution had taken place, a *bx pbx* individual should be called a return to the more primitive four-winged insects. Most mutants of which the names end on *-pedia* would imply a return to the evolutionary stage when all appendages were a simple parapodium, because the "legs" produced are often nothing more than rather amorphous, though clearly segmented appendages.

Now, indeed, such fall-backs could be called atavisms, and atavisms have often been considered as strong indications of evolution. But creationists have frequently pointed out that such arguments are not valid because they often lead to ridiculous inferences. Take the homoeotic examples: do the *Cbx*, the *oph*, or the *tuh* mutants imply that *Drosophila* descended (respectively) from an animal with four halteres, or with wings in the eyes, or with genital structures on the face?

Conclusions

On the basis of present knowledge of homoeotic phenomena, I come to the conclusion that they are not evidence for any evolution whatsoever. On the contrary, these phenomena are an example of how one simple gene mutation can disturb, not just one small morphological feature only, but the expression and regulation of dozens of other genes. Goldschmidt and Wright were probably correct when they stated that homoeotic mutants, because they often have a very low penetrance and expressivity, may be maintained for some time in a population. But all the facts are against the assertion that such a subthreshold state of the mutant might eventually result in a (a) functional, (b) original, as well as (c) "higher-levelled" organ. To consider this still as a possibility is just wishful thinking. In fact, nobody is doing this anymore as far as I am aware.⁵³

As is the case in so many biological areas: the more data are accumulated in a certain field, the more the evidence originally used to support evolutionism shrinks away.

However, if this is so, one question always remains: although their alternative ideas have been discarded, what to do with the severe criticisms of Goldschmidt and Schindewolf regarding classical neo-Darwinism? Their refutations have definitely not been denied! Today, more geneticists than ever emphasize in contrast to neo-Darwinism that "the true nature of natural selection is most often that of an avid conservative extolling the virtue of *status quo*."⁵⁴

Creationists have emphasized this for a long time. With great interest they follow, and sometimes participate in, the present discussion within "evolutionary genetics" as to whether microevolution (which is a misleading synonym for "genetic variation") depends largely on the natural selection of favorable mutations, or largely on the random spreading and fixation of neutral mutations. (See reference 52) But they feel more and more convinced that this discussion has no relevance whatsoever to macroevolution, i.e., the evolution of orders, classes, and phyla.

On this point creationists fully agree with the older evolutionists such as Goldschmidt, Schindewolf, and also Nilsson,⁵⁵ who also dared to hold the same position. Creationists feel confident that as knowledge of the impressive complexity of biological systems increases, then it will become more and more evident how naive evolutionary theorists are who consider such systems to have originated by random processes.

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GEOLOGICAL FORMATIONS NEAR LOCH ASSYNT COMPARED WITH THE GLARUS FORMATION

CLIFFORD L. BURDICK*

In the spring of 1975 I was able to visit Europe, lecture on Creationism, and also to observe a few geological formations. A general report on the trip has been given already in the *Bible-Science Newsletter*.¹ There is, however, one point which is perhaps worth while to enlarge on here.

Loch Assynt Formations

I had the opportunity to visit the thrust formations near Loch Assynt, Northern Scotland; and a short time later the Glarus formation, often alleged to be an overthrust, near Schwanden, Switzerland. Both of these formations are described in many books on geology; and it is often assumed that what applies to one, as far as origins are concerned, applies to the other. That assumption is open to challenge.

The Scottish formations, shown in general arrangement in Figure 1, are the Moine, Ben More, and Glen

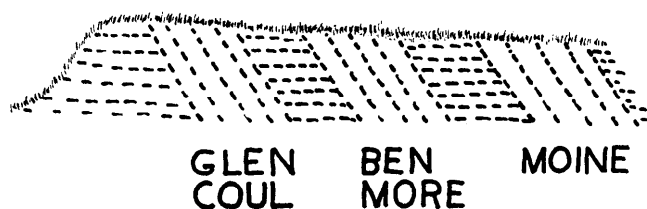


Figure 1. This shows, in outline but not in detail nor necessarily to scale, the Moine, Ben More, and Glen Coul thrusts near Loch Assynt in Northern Scotland. The vertical plane of the drawing may be thought of as along a line of north-west and south-east orientation; the formations shown extend typically over a little more than five miles.

Coul thrusts. They consist of metamorphosed schists and granitic Cambrian and Precambrian. The physical evidence of thrusting is certainly there. As for paleontological evidence, there is little of it; for the rocks are not of the type or age in which one would expect to find many fossils.

Apparently compression from the south-east caused the thrusting. The Moine thrust is farthest to the south-east, then the Ben More, and still farther to the north-west the Glen Coul thrust. The thrust angle may vary from 15-20 degrees as the strata lie over the horizontal strata. The thrust outcrops zig-zag mainly in a northern direction.

In summary, the conclusion that these formations are actual cases of thrusting was reached from physical evidence, not from fossils. So certainly thrusting, on a modest scale such as this, has occurred. It is interesting to compare the thrusting on a small scale which Howe observed after an earthquake.²

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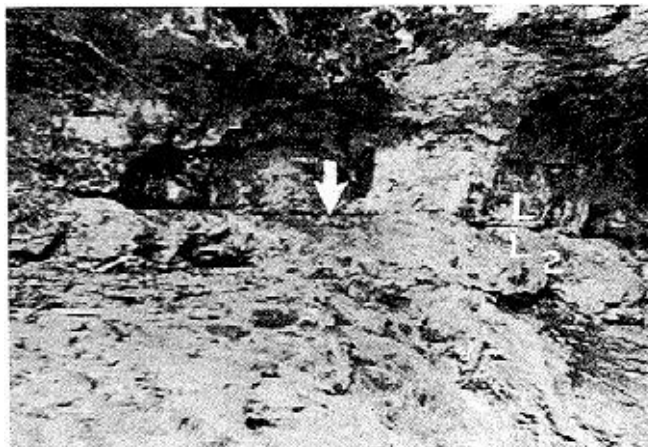


Figure 2. This is a photograph of the alleged Glarus overthrust, near Schwanden, Switzerland. The arrow points to the actual line of the contact. It will be noticed that the petrology and structure are much different above and below the contact. Also, there is no ground-up rock, mylonite, or breccia at the knife-blade contact. L and L₂ indicate positions of two layers of limestone, separated by a thin layer of water-deposited clay, apparently undisturbed.

The Glarus Formation

At the Glarus formation, conditions are much different. The contact is very sharp, exposed to the south, and almost horizontal. Figure 2 is a photograph of a portion of the formation; the arrow shows the actual contact. Dr. Walter Lammerts has already studied and described this formation;³ I wish merely to note some differences between it and the Scottish formations.

First, this formation was classed as an overthrust on the basis of paleontological evidence. As Billings wrote:

Parts of some of the great overthrusts in the Alps are so devoid of slickensides, gouge, breccia, and breccia and mylonite that they passed unnoticed and were for a time mapped as sedimentary contacts. It was only after paleontological evidence was obtained . . . that the existence of the great faults was recognized.⁴

At the bottom is slate, classified as Eocene. Above that are two thin layers of limestone, indicated by L above the contact, and L₂ below (See Figure 2). Above that, in turn, is the Verrucano, a coarse-grained arkosic schist, described as Permian.

The Verrucano and the slate are metamorphic rocks; this fact may indicate some movement, which also might have caused heating. But at the actual line of contact there is no evidence of sliding or such motion, as Billings said. Between the layers L and L₂ of limestone is a thin layer of water-deposited clay, apparently undisturbed. On the basis of this fact, apparently whatever happened to the lower (L₂) and upper rocks (L) happened separately, and that certainly one did not slide over the other.

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.

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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,"¹ 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.²

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."³ Since practically all components of living systems are optically active, optical activity is a fundamental physical property of life as we know it.⁴ 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.

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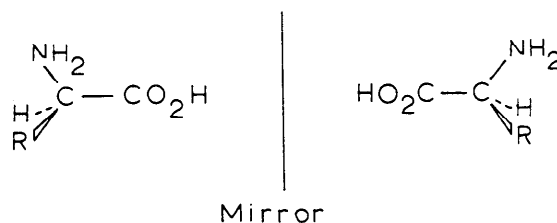


Figure 1. The two enantiomers of an amino acid.

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 explanations⁵ may exist:

1) a mechanistic theory^{6,7} involving chance and natural selection;

2) a teleological theory⁸ involving design and special creation;

Although several hypotheses have been suggested in support of the mechanistic theory,^{9,10} at present no generally accepted hypothesis accounts for this amazing phenomenon.¹¹⁻¹⁴ 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.¹⁵

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.¹⁶

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.¹⁷

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.¹⁸

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,¹⁹ 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.²⁰ 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.²¹⁻²⁴

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.²⁵⁻³⁰ 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.³¹⁻³⁴

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.³⁵⁻³⁸

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.³⁹ 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, ΔG , associated with the formation of a racemic modification at constant temperature and pressure is given by: $\Delta G = \Delta H - T \Delta S$, where ΔH is the change in enthalpy, T is the absolute temperature, and ΔS is the change in entropy.⁴⁰ 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.⁴¹ 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⁻¹ mole⁻¹. 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⁻¹ mole⁻¹.

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⁻¹ mole⁻¹ 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⁻¹. 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. $\Delta G = \Delta H - T \Delta S$

	ΔH	ΔS	ΔG	Spontaneous Process
A.	0 ^a	+	—	racemization
B.	0 ^a	—	+	racemization
C.	—	+	—	racemization
D.	—	—	+ ^b	racemization
E.	—	—	— ^c	resolution
F.	+	+	+ ^c	resolution
G.	+	+	— ^b	racemization
H.	+	—	+	racemization

^aFor ideal solutions.

^bFor dilute aqueous solutions, $T \Delta S > \Delta H$.

^cFor 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, ΔH and ΔS , may have opposite signs. If ΔH is negative while ΔS is positive (racemization), then ΔG will be negative and racemization will again be spontaneous (Table 1, C). If ΔH is positive while ΔS is negative (resolution), then ΔG will be positive and resolution will not be spontaneous (racemization will be spontaneous, Table 1, H).

On the other hand, if ΔH and ΔS have the same sign, then the relative absolute magnitudes of the two terms (ΔH and $T \Delta S$) become significant. For real dilute aqueous solutions, the absolute magnitude of ΔH 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⁻¹ mole⁻¹ 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 ΔH would be expected to have a large absolute magnitude, and could be the dominant term in the equation. In this case, if ΔH and ΔS 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.⁴² 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.

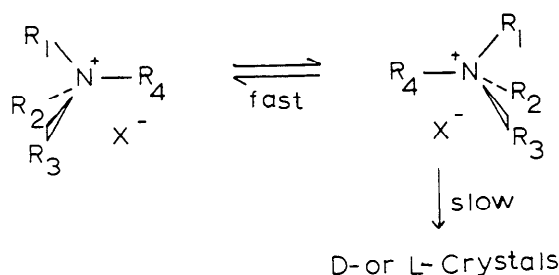


Figure 2. Stereospecific crystallization.

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.^{43, 44} 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.^{45, 46} 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,⁴⁷ fossil shells,⁴⁸ fossil bones,⁴⁹ and during thermal polymerization of amino acids.⁵⁰

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*."⁵¹ (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.[†] 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.⁵² He suggested that selection of one enantiomer from a racemic modification by a growing α -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.⁵³ 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."⁵⁴ 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."⁵⁵ Thus, maintenance of configurational integrity is essential to the survival of an organism.⁵⁶

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.⁵⁷ 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 α -helix composed of D-amino acids in such a hypothetical system should have the same chance for survival as does a right-handed α -helix composed of L-amino acids in the actual systems.⁵⁸

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 α -helix at higher degrees of polymerization.⁵⁹

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.

[†]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."⁶⁰ 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.⁶¹

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."^{62, 63} 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."⁶⁴ 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,"⁶⁵ 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.^{66, 67} 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.⁶⁸

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.⁶⁹

This degeneration applies to more than just the inanimate solid state. Similar statements concerning degeneration of man and animals^{70, 71} have also been made: "The intake in any way of any disordered material would destroy the ordered perfection of the newly created creatures."⁷² "Man was created perfect. . . . Like the atom, he came from the hand of God a 'finished product'."⁷³ "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."⁷⁴ 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."⁷⁵ 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,⁷⁶ 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 α -carbon of isoleucine, which has two asymmetric carbons) to its diastereomer, alloisoleucine (See Figure 3), has been determined under various laboratory conditions.⁷⁷ 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.⁷⁸

Racemization of amino acids proceeds at measurable rates only at elevated temperatures (85-225°C).⁷⁹ 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.⁸⁰

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 α -carbon. Some evidence has suggested that buffer concentration, peptide bonds, and the inorganic matrix may also affect the rate.^{81, 82}

Racemization of amino acids is presumed to follow first order kinetics, and to proceed via an enol stabilized carbanion intermediate.^{83, 84} 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

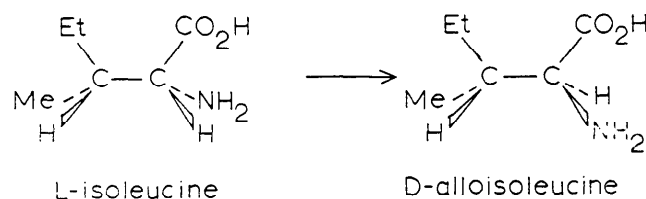


Figure 3. Epimerization of isoleucine.

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 4.4×10^6 years.⁸⁵ It has been noted, however, that a 5° increase in average temperature will double the rate of epimerization.⁸⁶ 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.⁸⁷

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)⁸⁸ 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.⁸⁹ The Precambrian Gunflint Chert, estimated at two billion years old, contains isoleucine, but little or no alloisoleucine.⁹⁰ A Precambrian asbestos sample and unheated Miocene sediments show "little or no alloisoleucine."⁹¹ 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.⁹² Unstable amino acids have been reported in sediments older than Pleistocene.⁹³ Amino acids in Mesozoic and Paleozoic shells, and in some fossil corals, may include "material of more recent origins."^{94, 95}

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.⁹⁶ 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.⁹⁷

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.⁹⁸

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.⁹⁹

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."¹⁰⁰

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.¹⁰¹

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.¹⁰²⁻¹⁰⁵

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.

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CHARLES LYELL CENTENNIAL

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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 . . ."¹ 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."²

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

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†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.

Principles. Henslow told Darwin that as naturalist on the ship he would need to know the facts presented in the book, but warned him against accepting the "theory" given to explain the facts. But Darwin did accept the "theory," and by so doing changed the course of history.

Lyell, Darwin — Similar Men

Neither Lyell nor Darwin had formal training in science. Lyell's training was in the classics at Oxford, while Darwin's only earned degree was in theology at Cambridge.

Another similarity between Lyell and Darwin is that both have been accused of trickery in promoting their views in the world of science, where objectivity is supposed to be preeminent. Professor C. D. Darlington, a strong evolutionist, characterized Darwin as employing "a flexible strategy which is not to be reconciled with even average intellectual integrity."³

Similarly Stephen Jay Gould of the American Museum of Natural History, another strong evolutionist, says that Lyell "relied upon two bits of cunning to establish his uniformitarian view as the only true geology."⁴ He enumerates them as follows:

1. Lyell set up a "straw man" to demolish. By that time all the serious scientific catastrophists—who held the geologic view opposed to his own—had discarded a supernatural view of catastrophes. That is, they did not attribute catastrophes to acts of God but to natural causes. Also, they already accepted a greater age for the earth than could be reconciled with Biblical chronology.

But Lyell made it appear that he was overthrowing supernaturalism and the concept of a young age for the earth. Actually, the scientific catastrophists commended Lyell for these things because the catastrophists themselves were opposing the theologians and laity who still held Biblical views about these matters.

2. Lyell proposed a "hodgepodge of claims" in four categories.

- (a) "Natural laws are constant [uniform] in space and time." Gould acknowledged that this is not a statement of fact but an *a priori* claim made as a working basis for interpreting the past.

- (b) "Physical processes now operating should be employed in explaining the past." Again this is not a fact, but methodology; and the scientific catastrophists did not mind very much, for they already had given up looking upon catastrophes as acts of God.

- (c) "Geologic changes are slow, gradual, and steady." Here was something which could be examined, and Lyell's view did not always seem to fit the facts. For example, Agassiz' glacial theory, which seemed to have many supporting facts and which was widely accepted at that time, was not in accord with Lyell's view.

- (d) "The earth has remained fundamentally the same since its formation." The admirers of Lyell try to forget this one for, as Gould stated, "... who wants to expose the false steps of a hero?" This is not in accord with evolutionary "theory," but Lyell is a hero of the evolutionists.

Drawing another similarity between Lyell and Darwin, one might point out that Darwin's admirers

try to forget his pangenesis "theory," in which he proposed that all parts of the body of an animal send "pangenes" to the reproductive cells and thereby provide a reproductive pattern for the next generation.

Gould wrote that Lyell believed mammals might be found in the "earliest" geologic deposits. Of course, in recent times, human footprints *have been found* abundantly together with Cretaceous dinosaur tracks in the Paluxy river bed in Texas, and apparently also in Cambrian trilobite beds in Antelope Springs, Utah. Even in the Cambrian and below the Cambrian in the Grand Canyon and also in similar deposits in Venezuela and British Guiana fossil, gymnosperm and angiosperm pollen has been discovered; while according to the evolutionary scheme there should not have been any pollen-bearing plants on earth for hundreds of millions of years after the Cambrian time.

At first Darwin was a disciple of Lyell, but in the end Lyell was a disciple of Darwin. But it took time, for as one of Darwin's biographers expressed, as a gentleman Lyell resented the idea of coming from a monkey or ape ancestry.⁵ That is one problem Darwin did not have. In the sixth chapter of his *Descent of Man* he stated plainly several times not only that human beings came from monkeys but even which kind of monkeys he thought were ancestral.

And as man from a genealogical point of view belongs to the *Catarrhine* or Old World stock, we must conclude, however much the conclusion may revolt our pride, that our early progenitors would have been properly thus designated.⁶

The *Simiadae* then branched off into two great stems, the New World and Old World monkeys; and from the latter, at a remote period, Man, the wonder and glory of the Universe, proceeded.⁷

Misconceptions of Evolutionists

Evolutionists seem to be under two main misconceptions, at least, as to the basis for the conflict between evolutionism and Christian faith.

1. They think a basic issue is personal pride in ancestry. If this can be overcome, they feel, much of the difficulty will vanish. To help, many of them affirm that man did not "evolve" from monkeys and/or apes, but from a common ancestor with them. This is supposed to be preferable and people should not mind so much "evolving" from tree shrews, fish, worms, etc. But when queried as to the appearance of man's closest ancestor with apes, it is admitted the reference was made only to *living* apes and our closest common ancestor with living apes was an ape.

2. Some evolutionists believe the problem is resolved if Christians realize that science has no answer as to the nature of the "first cause." Label this "God," they suggest, and there is no more conflict.

Such ideas merely reflect the ignorance of many evolutionists regarding the matter of Bible-based Christian faith. A fundamental doctrine of Christian faith is the atonement or redemption through the sacrifice of Christ upon the cross. Due to the historical fall of man in the Garden of Eden, all human beings are sinners.

God demands perfection. We cannot be perfect. There is only one way out of the dilemma, and that is

to have a perfect substitute take our place. This Christ did, being Deity and being sinless.

But if presumed evolution is true, then man has developed very gradually from the beast, there were no two distinctly first people, and man is improving

instead of having fallen from a perfect creation. If supposed evolution is true there is no occasion for salvation. Christ becomes a martyr instead of the Savior, a man ahead of his time instead of the Redeemer. This is the issue.

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THE FORMATION OF CROSS STRATIFICATION: A NEW EXPLANATION

DOUGLAS E. COX*

Cross stratification has been invariably associated with a sedimentary cause, yet it exhibits significantly different features from those of sediments formed experimentally. Features of cross stratification are contrasted with those of sediments, and it is shown that cross stratification must have a completely different origin. A possible non-sedimentary process forming stratification of surface rocks involves the release of pressure on rocks being elevated from great depths of burial under water. Shattering due to expansion of diffused water disintegrates the rock in successive layers, forming stratified sand. In this new explanation of cross stratification, it is shown how such a process can account for the unique features of cross stratified rocks found in nature.

The Nature of Cross Stratification

The phenomenon of cross stratification has long been considered a sedimentary form of stratification, as the synonyms "current bedding," "torrent bedding," "turbulent bedding" and so forth indicate. The label "false bedding" is another synonym now considered obsolete, although still in use among English geologists, that may reflect an early suspicion that there was something incongruous about it. But that cross stratification is sedimentary in origin seems to have been universally assumed by modern geologists.

A full list of synonyms given by Shrock¹ included "cross bedding," "foreset bedding," "false bedding," "oblique bedding," "diagonal bedding," "inclined bedding," "current bedding," "torrential bedding," "flow-and-plunge structure." All these terms refer to the same geologic phenomenon. Some are merely descriptive, others imply a specific kind of sedimentary environment of formation.

In this paper, since the mode of formation is the subject in question, a non-genetic term will be used: cross stratification. Shrock gave the following definition of cross stratification, which he refers to as cross lamination:

Cross-lamination is the designation now generally used for that structure, commonly present in granular sedimentary rocks, which consists of tabular, irregularly lenticular, or wedge-shaped bodies lying essentially parallel to the general stratification which themselves show a pronounced laminated structure in which the laminae are steeply inclined (as much as 33°) to the general bedding.²

Examples of this kind of stratification are shown in Figure 1.

In this definition a genetic environment is cited: the cross laminations are said to occur in "granular sedimentary rocks." It is cross stratification that distinguishes these rocks as sedimentary.

The main reason for identifying this form of stratification with a sedimentary origin seems to be that no other cause has been imagined. No non-sedimentary geologic process that forms a pattern of stratification seems to be going on at the present time, and past causes in geology are limited to processes that exist today, according to the principle of uniformitarianism.

The uncertainty about the nature and origin of cross stratification, apparent from the obsolete label "false bedding," arises from the contrast between this form of stratification and other forms, sometimes designated "true bedding."

The fact is, in geology, there are two forms of stratification with distinctly different characteristics, and why this is so has never been understood. Both "false bedding" and "true bedding" have some similar features. Both consist of successive planar surfaces that are referred to as stratification. Both may exhibit inclined strata, and both kinds occur in rocks and unconsolidated sands, in apparently similar environments.

In the geologic literature it seems that one form is often confused with the other, and both forms are associated with one environment of formation, and a common origin. This has created a lot of problems in geology. In this article an attempt is made to distinguish between these two forms of stratification, and an explanation of the source of confusion is presented.

A few definitions are necessary. In this article the term "cross stratification" means the natural pattern of stratification that is exhibited in undisturbed sand and sandstones, to which the term is usually applied in geology. This pattern occurs in the unconsolidated materials covering vast areas of the continents.

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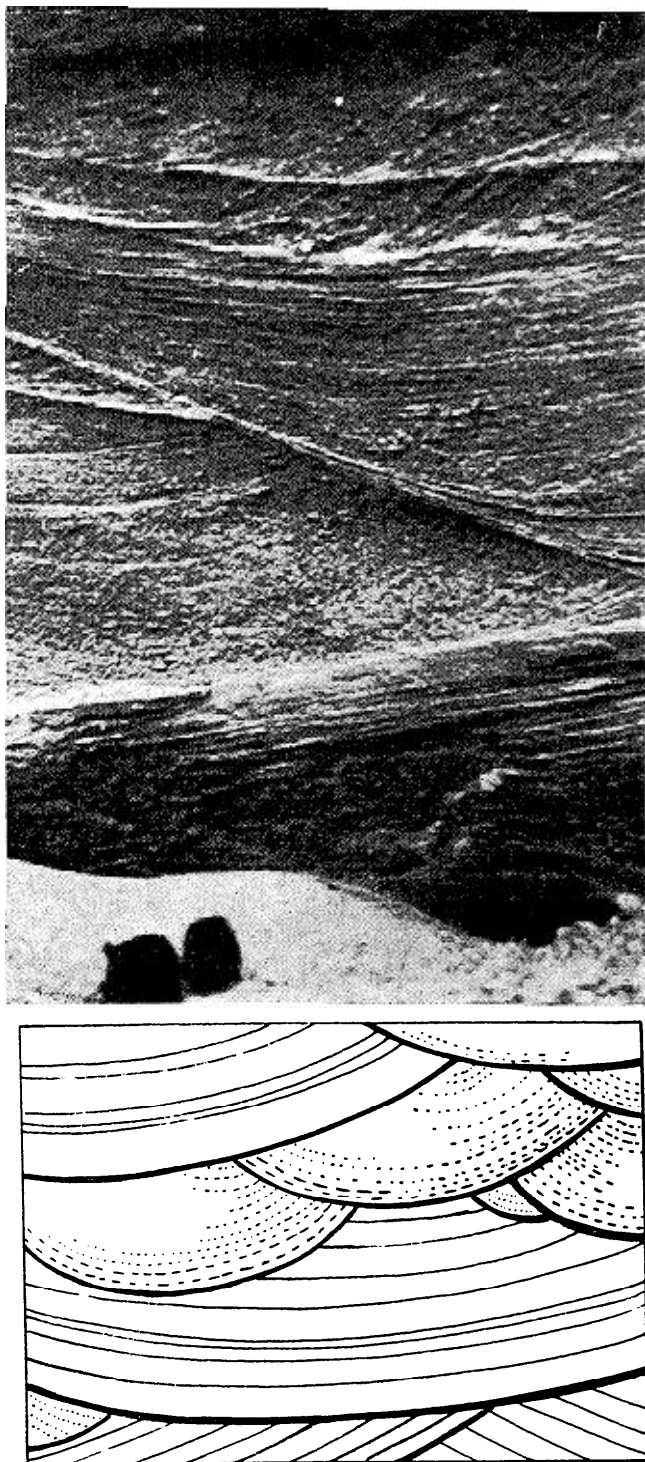


Figure 1. This shows typical cross stratification in sand. Above is a photograph of cross stratification exposed in a pit. Below is a drawing made by Valerio Racca from another photograph of cross stratification exposed at Campbellville, Ontario.

Sedimentary stratification, for the purposes of this article, will refer to patterns of stratification that are formed by *observed* depositional processes in nature and in experiments. The pattern of stratification formed by these observed processes may include in-

clined bedding, but this is not necessarily included in the term "cross stratification" as it applies in this article, unless the features of the sedimentary pattern include *all the other features* of cross stratification that occur in natural formations.

As will be pointed out, inclination of the strata is by no means the only feature of natural cross stratification that has to be explained.

Sedimentary Origin Assumed

Let us now consider some of the reasons for the identification of cross stratification with a sedimentary origin. In the sand and gravel formations exhibiting this pattern there are rounded stones and pebbles, that supposedly have been rounded by abrasion of the surfaces over long ages of time. This would mean that the strata in which these stones and pebbles occur was also water-laid, and therefore of a sedimentary origin.

It seems evident that the rounded stones have been worn by abrasion, since there are many of them in the beds of streams and rivers. Streams that dig channels through the unconsolidated layers of the earth often expose the pattern of cross stratification in sand and gravel, and the stones in these layers fall into the beds of the streams.

Actually they are quite round before they fall in, yet it seems that they are being rounded by the action of the water. There is an association of the action of the currents with the smoothness of the stones, that has often been mistaken for cause and effect.

Similarly the pattern of cross stratification in the sand and gravel is associated by proximity with the stream and currents that exposed it by erosion of the banks. Sometimes it is supposed that the streams have not only exposed the pattern, but have actually formed it. And indeed currents do redeposit sand in sand bars in the bed of the river, that may have inclined strata.

Geologists have identified the pattern of cross stratification found in sands before their erosion with the pattern formed by deposition in the streams, a sedimentary pattern. There seemed to be no reason to distinguish between the two. This is a quite convincing association (although it by no means constitutes proof of a sedimentary origin for cross stratification), and it is not really surprising that cross stratification has been assumed to be sedimentary.

Stratification seems to be proof enough of a sedimentary origin in geology. Currents in streams produce inclined bedding in dunes and ripples. These patterns are labeled cross stratification, and associated with patterns with which they bear little resemblance. The association of natural cross stratification (as defined in this article) with these sediments has led to the association of the phenomenon with a sedimentary origin.

The assumption has not been questioned, no alternative cause for stratification being known, and continued use and application in geology has made it pretty difficult to see the weakness of this assumption. However, sometimes in science it is necessary to put even the most firmly established "facts" to the test, resulting in the detection of error.

A Closer Look

Let us now consider some of the distinguishing features of cross stratification, and compare these with characteristics of sediments. Shrock³ identified three common forms of cross stratification; tabular, lenticular, and wedge-shaped. These are illustrated in Figure 2.

In a paper on the classification of cross stratified phenomena in 1953, McKee and Weir⁴ identified three main classes of cross strata; simple, planar and trough. A more elaborate system, based on six criteria and developed from that of McKee and Weir was proposed in 1963 by Allen, who suggested:

... a better understanding of cross-stratification can be reached if cross-stratified units are classified using six objective criteria. Briefly, these are as follows: (1) whether the cross-stratified unit is a single set, or a coset formed of two or more similar sets, (2) the physical size of the set of cross-strata, (3) the character of the lower bounding surface of the set of cross-strata, (4) the shape of the lower bounding surface of the set of cross-strata, (5) the relation between the cross-strata in the set and the lower bounding surface of the set, and (6) the degree of lithological uniformity of the cross-strata.⁵

Allen identified 15 different types of cross stratification based on these criteria, and suggested how each of these might have been formed in a sedimentary environment.

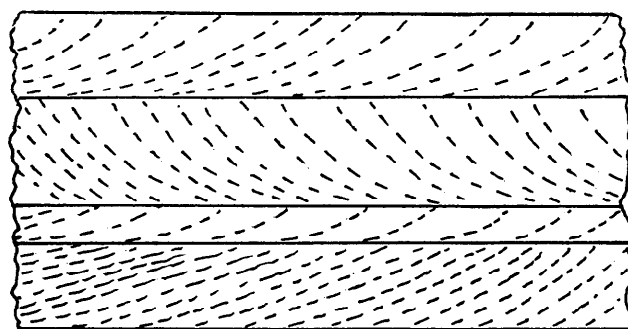
A typical pattern of cross stratification would include smooth arcing planes arranged in sets of lenticular form. Sets are generally horizontal, and the pattern consists of series of sets, bounded above by intersecting concave planes that form lower boundaries of overlying sets.

The cross strata in a set are generally inclined at an angle of about 30° to the horizontal. It may vary considerably, sometimes reaching 60° or even curving around beyond the vertical. In these instances it is often described as "contorted," since geologists find it difficult to understand how these could represent an original pattern. Just how such contortion of the stratification could have been caused is not clear.

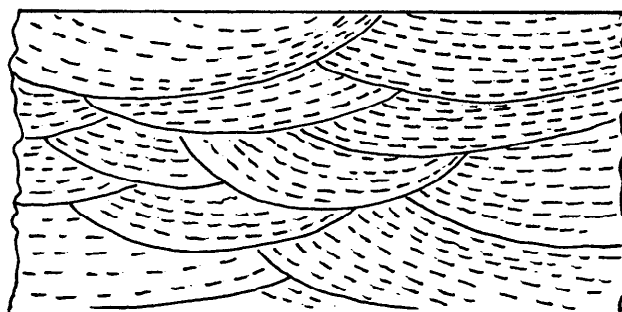
Inclined strata in a set curve around at the lower boundary of the set toward the angle of the lower boundary. Inclined concave upwards planes in cross strata provide a reliable "way-up" criteria in geology. The radius of curvature of planes in a set increases downwards.

In cross stratified sands and gravel, the pebbles and stones are embedded in such a way that the strata do not wrap around the embedded object, but jut up against the surfaces. There is no thickening of the strata on the lee or downslope side of embedded objects, or turbulence effects that could indicate current deflection during deposition of the strata caused by stones or pebbles.

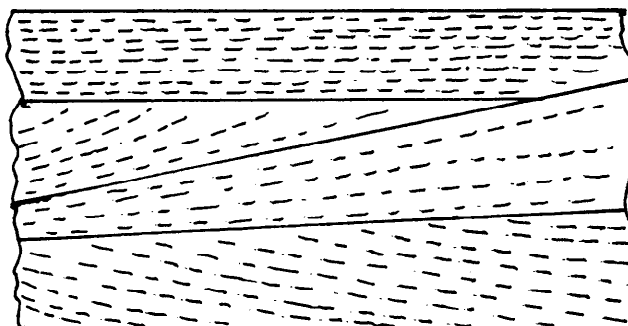
These are arranged in the planes of stratification, usually with flat surfaces and long axes parallel to the bedding, and they often lie in the boundary of a set. The configuration of the strata around pebbles and



(a) Tabular



(b) Lenticular



(c) Wedge-shaped

Figure 2. The three common classifications of cross stratification: (a) tabular, (b) lenticular, and (c) wedge-shaped, are illustrated, as labelled.

stones in sand and gravel resembles precisely that of cross stratified sandstone in the vicinity of concretions.

The shape of grains in the cross stratified sands is extremely angular. According to glacial theorists, cross stratified sands of the Quaternary were formed supposedly by outwash streams from the melting glaciers, that redeposited glacial till. These sands are described by Reineck and Singh:

An important feature of glacial sediments is the presence of numerous labile minerals, e.g. feldspar, ferromagnesian minerals as unaltered, angular grains even in silt and clay-sized fractions. The sand fraction is characterized by extremely angular sediment grains. . . . Sand grains of glacial sediments show characteristic surface features if studied by the electron microscope. Such features show abundantly conchoidal fractures, minor striations, imbricate breakage blocks, and small-scale indentations.⁶

This description applies to particles in typical cross stratified sands, that are called "glacial sediments" by the authors. The present study concerns the question of whether these sands ought to be designated as sediments at all. Of course glacial theorists assume that they are, since the so-called glacial theory is an attempt to explain the environment of the formation of these sands with the pattern of cross stratification, as well as other features associated with them.

The scale of cross stratification may vary greatly, and it is known to occur in a vast scale in some sandstones, with foresets measuring hundreds of feet. In unconsolidated sands the foresets are commonly of the order of a few inches to a few feet.

These are some of the features of cross stratification, which may take many forms. A different set of characteristics apply to "true" or sedimentary bedding, the pattern produced in observed sediments such as those formed by experiments in the laboratory.

Some Laboratory Experiments

Experiments by McDonald⁷ on the formation of dunes by precipitation of sands suspended in currents showed that there was a sorting of the sediment according to grain size. The larger particles were deposited before finer sized grains, and in the dunes and ripples formed by experiment the inclined strata of the dunes contained a graduation in particle size from large at the top to fine at the bottom.

Other common characteristics of sediments formed in currents are greater thickness of deposition on the lee side of embedded objects, and deflection of the current around the embedded object creating turbulence. The thicker strata on the lee side are caused by slowing down of the current as a result of its deflection by the object.

The scale of dunes and ripples formed experimentally is quite limited. Their size cannot be increased by faster current flow, because this would only serve to erode them away. Changes of speed and direction of the currents destroys many of the structures formed by precipitation, as Middleton⁸ found out while investigating the phenomenon of antidunes.

Power in 1961 had supposed that some cross bedding had been formed by antidunes, but Middleton concluded that this was unlikely. The sediments he produced exhibited very faint laminations, low angles of inclination of strata, in lens-shaped sets. The structures formed in his experiments did not look anything like the pattern of cross stratification common in nature.

Attempts to preserve the antidunes by stopping current flow suddenly merely resulted in their destruction. As Middleton stated,

When the flow was suddenly stopped (as might happen in nature due to a diversion of the flow through a break in the bank of a stream) the antidune bed-forms were rapidly destroyed as the flow waned, and the final bed-form was a somewhat irregular but nearly flat surface partly covered with small ripples. Although the antidune bed-forms were destroyed the internal structure was still partly preserved.⁹

Sedimentologists have had great difficulty in pro-

ducing sedimentary patterns resembling those in natural cross stratified sandstones and sand. These experiments were designed to confirm ideas about how the different structures in cross stratification can be interpreted in an environment of sedimentation.

Usually these involve currents, and shallow, swift flowing streams or flood plains in which an abundant supply of precipitate is available, conditions that should be comparable to those created in flume experiments. Yet a completely different kind of structure is invariably produced. Matthews described results of flume studies in 1961 by Simons et al:

With low current velocity, small ripples were formed. As velocity increases, the height of the ripples increases. With still greater velocity, the shape of the ripples begins to flatten down. With even greater velocity, a planar bed form is achieved and no sediment is deposited. This picture is the transition from tranquil to rapid flow regime. Finally, with still greater stream velocity, antidunes are formed. Sediment accumulation on antidunes occurs on the updrift side of the bed form; the antidune may actually migrate upstream with continuing sedimentation.¹⁰

However, as was evident from the results of Middleton's studies, there is still no evidence that typical patterns of cross stratification, like those of natural cross stratified sand and sandstone, can be formed in any sedimentary environment. Kukal has stated;

Current stratification is one of the most frequent primary sedimentary structures. In the literature, many attempts at its genetic interpretation are recorded. Unfortunately, none of these attempts has been successful. . . .¹¹

Sedimentary Origin Questioned

In view of these completely different sets of characteristics of the two patterns of stratification, that is, cross stratification and sedimentary, it would be quite rash to assume that cross stratification is really a sedimentary phenomenon.

Geologists have begun to distinguish between "recent" and "ancient" sedimentary environments, because it does not seem that cross stratified formations are actually being formed at the present time. The particular conditions for the formation of cross stratified patterns have not been determined, and yet cross stratification is thought to be sedimentary anyway.

It could be that the two patterns have a quite different origin. If not a sediment, it would be reasonable to consider a non-sedimentary and non-depositional origin for the pattern of cross stratification. Such a cause might involve an alteration of a previously homogeneous rock, producing a pattern of stratification. Since cross stratification is a common characteristic of unconsolidated material, this might well be a disintegration process that acted on surface rocks in the past, but which is not acting anywhere in geology at the present time.

A Possible Alternate Explanation

A possible process by which a pattern of stratification could have been formed, apart from a sedimentary

environment, involves a disintegration process accompanying the release of former high pressure. Former deep burial of the continents under water, followed by elevation to the surface, could cause such a lowering of pressure. Because of the influence of the principle of uniformitarianism, the effects of pressure have all too often escaped the attention of geologists.

In laboratory experiments over the years a great deal has been learned about the behavior of materials under pressure. Some investigators have studied the various effects of the release of high pressure.

In one such experiment, that may prove to be quite significant for geologists, although unrecognized as such until now, samples of quartz and glass were subjected to high pressure in the presence of water, and the pressure was subsequently released. Possible conditions to which rocks would be subject, if they were raised from great depths of burial under water, were simulated.

The investigators, Poulter and Wilson,¹² were not at all interested in the geologic applications of their investigations, but were actually concerned with the problem of shattering of windows in high pressure apparatus. These men found that if pressure was released rapidly, there was fracturing of the material due to expansion of the occluded water within the solid.

Water had diffused into the glass and quartz at high pressure, and when the pressure was released it diffused out again. If there was not sufficient time for the water to escape, it began to expand inside the solid, causing sudden disintegration. This experiment is discussed below by Hamaan:

Poulter and Wilson found that glass and fused quartz are permeable to a number of liquids at pressures of the order of 10,000 atm. Ether, ethyl alcohol and water diffuse into the materials under these conditions and diffuse out again if the pressure is slowly released. If, on the other hand, the pressure is released rapidly the liquids are unable to escape in time and their expansion within the solid causes it to fracture. When the pressure is applied rapidly and immediately released there is no breakage because the liquid has had insufficient time to diffuse into the solid. The fact that the fractures are caused by liquid trapped within the solid, and not by internal strains arising from hydrostatic pressure, is proved by the absence of any breakages when the pressure is applied by paraffin oil or glycerol. The effect was confirmed by Bridgeman, who found that a heavy-walled, glass capillary, sealed at each end and compressed in water, will break into layers like onion skins when pressure is released.¹³

A similar effect would apply in geology if there had been former high pressure on the rocks of the earth's surface, due to great depths of burial under water, and rapid elevation of these rocks again to the surface.

Some sediments, such as dolomite, seem to have been formed at great depths and pressure. This chemically precipitated rock does not form at ordinary

pressures and temperatures, but only under deep burial and high pressures.

Where this rock occurs on the continents today, it is evidence of former high pressure and deep burial. The subsequent elevation of these sediments to the surface would be accompanied by release of pressure. If this release of pressure was rapid enough, it could provide an environment where the generalizations based on the experiments by Poulter and Wilson would apply in geology.

Other Possible Effects of Pressure

In rocks and sediments formed under pressure some pressure-related effects such as diffusion would be evident, especially during the precipitation of sediment. Water would be present in the rock during precipitation. As grains of sediment accumulated some water would have been trapped in the rock.

At high pressure there would also be some water diffused in the crystals of the rock. Some materials such as quartz, in solution with water, and carbonates, may have been diffused to some extent in the rocks as well. These penetrate throughout the rock by diffusion at high pressure, and when pressure is lowered they crystallize, causing the sediment to solidify.

As pressure is released when rocks are raised again to the surface, some changes occur due to adjustment of diffusion equilibria. Some minerals cannot remain diffused at the lower pressure, and become precipitated. Concretions have evidently been formed in this way, and various other effects in the rocks.

Water may remain diffused after the rocks have become quite solid, since it is much more compressible under pressure. A considerable amount of water may be squeezed in between the molecules and inside the crystal lattices of the rock.

Some of the water within rocks at high pressure may consist of water of hydration, that is present in many rocks. Adjustment of pressure may cause a change in the equilibrium amount of water of hydration. As pressure decreases there may be some water precipitated because of this.

What Happens When Pressure Is Released?

Water diffused in rocks at high pressure is expelled when the pressure is released. The rate at which the pressure is released, as Poulter and Wilson showed, has quite an effect on the manner in which this diffused water is expelled.

As pressure decreases there would be transport of the diffused water upwards through the rock, just as the diffused water in the quartz and glass samples slowly diffused out during gradual release of pressure. The water must move to regions of low pressure. In rocks it would have to exit at the surface.

Near the surface, the diffused water may become precipitated and occluded within the rock before there was time for it to diffuse out. This could occur during a continuous release of pressure, as when the rocks were being gradually raised from the depths. Pressure at the rock surface would be continually lower than inside the rock. More water would be expelled, that would not have sufficient time to diffuse out gradually.

Near the topmost surface of the rock there is a considerable pressure built up because of the expansion of this occluded water. It is a compression in the plane of the rock surface. In these conditions there could be shattering such as that reported by Poulter and Wilson, resulting from pressures within the solid due to expansion of the occluded water, but on a much greater scale.

In a quartz-rich, consolidated rock this shattering would be a form of brittle fracture. Some characteristics of brittle fracture may help geologists to understand how such a process could have produced the unique features of cross stratification.

Consistent with the idea of brittle fracture in compression, it was supposed by Griffith that the material is filled up with tiny cracks and flaws, called "Griffith cracks." Stress at the tips of these cracks causes them to grow. Research by Brace and Bombolakis determined that the most stressed crack is inclined at an angle to the plane of compression of about 30° . According to these investigators;

In compression the most severely stressed crack is inclined at about 30° to the axis of compression. Such cracks, when either isolated or placed in an array, grow along a curved path which becomes parallel with the direction of compression. When this direction is attained, growth stops, unless applied compression is increased considerably. Cracks in certain *en echelon* arrays start to grow at much smaller applied stress than that required to enlarge an isolated crack.¹⁴

When this information is applied to the shattering of a rock surface because of expansion of occluded water near the surface, it is clear that innumerable tiny cracks in the surface would bend into the direction of compression. These cracks would become parallel to the rock surface.

This would cause shattering of a thin lamina of the rock surface. The rock would be converted into particles of sand, having angular shapes, and exhibiting conchoidal shapes and striations.

Sand of this type is characteristic of the unconsolidated cross stratified formations in geology. The striations on the particles result from abrasion with other particles in stress during the disintegration of the rock surface.

Nature and Results of Shattering

McClintock and Walsh,¹⁵ in their investigations of Griffith cracks in rocks under pressure, supposed that these would close up in compression, and considered the effects of friction on the surfaces of these cracks. In the surface of the rock, pressure of the expanding water would build up until the friction and forces of molecular cohesion were overcome.

At a limiting "brittle strength" for the material, shattering occurs with explosive suddenness. It is characteristic of brittle fracture that disintegration is rapid. Schiedegger wrote;

Brittle fracture is the only type of fracture that occurs in completely brittle substances. It is that type of fracture which is theoretically best understood. It is characterized by a high

velocity of propagation, producing a bright, smooth fracture surface. . . .

The high velocity of the spread of a crack in brittle fracture can be explained by noting that the only work required for the latter is that necessary to overcome the cohesion between the atoms on either side of an existing crack. This work is so small that it can be supplied by the elastic energy stored in the material just prior to its disintegration.¹⁶

Once a particle in the rock surface has been dislodged, shattering in the surrounding area would be rapid because of the rate of release of confining pressure in the surface of the rock.

Immediately upon disintegration of a thin lamina another surface of the rock would be exposed. Pressure of occluded water would begin to build up in this surface also, and shattering would occur producing another thin lamina that is parallel to the first.

Continuous disintegration of successive laminae in this way would produce a series of layers of sand particles from the previously homogeneous rock. They would exhibit a pattern of stratification that was not sedimentary in origin. The phenomenon would proceed downward from the surface, the lower strata being the last formed.

This pattern of stratification would result from the release of pressure on rocks being raised from great depths of burial under water. According to this new explanation, the features of cross stratification, as found in natural sands and sandstones, are the effects of this pressure-related disintegration.

Results to Be Expected

Let us now consider whether such a disintegration process could produce two of the characteristics of cross stratification: (a) inclined strata, and (b) concave upward shape. According to the new explanation offered here, disintegration starts when a particle is dislodged in the surface of a rock because of compressive stress in that surface caused by expansion of the occluded water.

Then it would be reasonable to suppose that the disintegration of the rock would spread radially outwards from the first dislodged particle. Since this would take a few moments, there would be a tendency for the shattering of the next surface to begin before the process of shattering of the previous surface had been completed. It would spread outward in an ever widening circle centered at the point of origin.

The next surface would begin shattering, and successive surfaces, while the previous surfaces were still in the process of disintegration. A consequence of this would be that the shape of the rock surface would change during shattering. The penetration of disintegration would be enhanced by higher pressures a little lower in the rock, where less water has had opportunity to diffuse out. The shape of the strata formed by disintegration, as a result would be concave upward.

Inclined strata, particularly the common 30° inclination of cross stratification, would result from shattering proceeding laterally at the most preferred angle for disintegration in compression.

These two features of cross stratification, then, are both indicative of a process of disintegration. The scale of the pattern might vary considerably in a disintegration, and might depend on such things as water content of the original rock, rate of release of pressure, and degree of consolidation during shattering. In sandstones there must have been lithification of the disintegrated rock by crystallization of diffused silica or carbonates. This evidently preserved the pattern in the grains.

Propagation of the disintegration would end at the bedrock underlying the unconsolidated material, and a corollary of this explanation is that the features of the bedrock surface would represent a typical plane of the disintegration as it proceeded downward through the cross stratified material. It would be comparable in shape to any such surface that could be traced in the cross stratified sands.

The surface of the bedrock below these materials in fact does exhibit concave depressions, with smooth surfaces, and angles of inclination similar to the structures in the cross stratified sands above.

Also it is frequently scratched and grooved, as a result of the movement of sand and boulders across it. The motion of the disintegration product, according to this explanation, probably occurred at the time of shattering and would have been caused by expansion in the lateral plane.

The unconsolidated sands and gravels, with the pattern of cross stratification, have embedded in them many pebbles and stones and boulders. These are usually rounded and smooth, and are embedded in the strata, without any evidence of turbulence around them, that could have resulted from currents present during the precipitation of the sand and stones. There is no thickening of the bedding on their down-slope sides, where they occur in inclined strata. This would be expected if there was a current present at the time of their deposition.

The absence of these effects is quite incompatible with a sedimentary origin of these structures. Those who accept a sedimentary origin explain inclination of the bedding by postulating that a current was present. Lack of turbulence effects indicates no current was present. The source of this contradiction lies in the assumption of a sedimentary origin for the pattern of cross stratification, and the stones and pebbles associated with it in sand and gravel.

The Question of Embedded Stones

According to the disintegration explanation, there is no need for the effects of currents to explain cross stratification. However, it is necessary to account for the roundness of the stones, and their variety of composition, and how they could have been formed in the environment of disintegration.

It is proposed that the stones have become rounded in basically the same manner in which concretions become rounded, which have similar appearance, composition, and configuration in the strata. Concretions have evidently been formed by the reconstitution of the constituent minerals of the sediment.

As would be expected in the deposition of sediments, the material comprising a sedimentary rock

is a mixture, formed at great depth in some instances. At the time of the deposition of the sediment, when the rock was unconsolidated, there was apparently some ionization, as well as diffusion of the materials comprising the sediment.

The pressures existing in the environment of sediment deposition resulted in certain diffused and ionized minerals remaining in the rock at equilibrium. As pressure was changed, however, the equilibrium also changed. Precipitation of certain diffused minerals within the sediment would occur as the pressure dropped, when the rocks were elevated from the depths. In this environment inside the rock, the concretions formed by precipitation of diffused material, to maintain diffusion equilibria.

The sediments, precipitated in an unconsolidated condition, must have hardened during the release of pressure. Cementing material diffused throughout the rock at high pressure crystallized when pressure decreased, lithifying the rock. At the same time there was precipitation of some of the minor constituents of the rock in concretionary centers.

Sometimes it seems that the whole rock is reorganized into concretions. These appear to "grow" by a process of purification of the individual centers, as precipitate was attracted into them and other matter was expelled.

Possibly electro-static forces attracted precipitate from the environment into concretionary centers. Ions could migrate, in these conditions where there would be diffusion and ionization within the rock, like electrons in a conductor. So while concretions formed within rocks being hardened because of a lowering of pressure, they became rounded because of differences in pressure between their interiors and exteriors.

Possibly the pressure inside concretions was greater than in the surrounding matrix, because matter was being squeezed into them by forces of electro-static attraction, and diffusion equilibria were causing some minerals to be expelled from the rock, while their growth would have been restricted by the hardness of the rock in which they were being formed. Presumably concretions are round and have smooth surfaces as a result of such possible changes.

Differences in pressure within concretions might be the reason they would be left intact when the matrix disintegrated around them, during the shattering process. The stones and boulders would be formed by the shattering of the rock around concretions, which are left intact, embedded in the sandy strata. Since they have not been dropped into their positions from above, and there have been no currents associated with their origin, there would be no reason for dents in the strata around them or turbulence effects, that would be necessary in a sedimentary environment.

The disintegration explanation developed here clarifies these problematic questions in accounting for the features of cross stratification.

This treatment of the origin of stones and boulders, suggesting a concretionary process of reconstitution of a rock, and shattering of the matrix around them in successive layers from the top downward, solves the difficulty of accounting for the stones and boulders in cross stratified formations. They are not water-worn,

and have not been transported, either by glaciers or streams. A variety of otherwise almost insoluble difficulties are accounted for with this disintegration explanation.

The presence of disintegrated boulders, "sand balls," and so forth in the cross stratified materials, which could not have been transported into their positions or worn round by abrasion, is explained. They have been formed in place. Many of these will exhibit a pattern of cross stratification inside, a result of disintegration. Rocks identical to the bedrock below are abundant in the gravels, since they have been formed by a reconstitution of the bedrock.

The pattern of cross stratification may show successive sets with inclined strata oriented in different directions, and there need not be any preferred orientation in a cross stratified formation. This is easily explained in the disintegration explanation, yet a sedimentary origin could occur only if currents reversed repeatedly, without destroying the pattern in underlying beds.

Conclusions

In conclusion, it has been shown that a process causing stratification may have acted on rocks of the earth's surface in the past, that is not sedimentary. Such a process would have been overlooked by geologists because of the principle of uniformitarianism, according to which past causes are limited to those found acting at the present time.

This form of stratification involves the rapid release of former high pressure on surface rocks. According to the new explanation, cross stratification, as found in natural sands and sandstones, is an effect of the shattering that accompanied release of high pressure when the continents were raised from great depths of burial under water.

The amount of pressure involved was sufficient to cause diffusion effects in recently precipitated sediments. With the new explanation a complete reinterpretation of the significance of the phenomenon of cross stratification is possible, opening the way for new insights into the recent history of the earth.

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MATHEMATICIANS DO IT AGAIN¹

DAVID J. RODABAUGH*

Creationists have often argued, rather qualitatively, that if evolution had really happened, the many gaps in the "fossil record" would be most improbable. That is true. The purpose of this paper is twofold: to obtain somewhat more quantitative estimates of the improbability, and to calculate from the presence of gaps in the fossil record being given empirically, the probability that evolution occurred. It is shown that that probability is vanishingly small; one may as well say that, the gaps being admitted, it is impossible that evolution occurred.

Bayes' Theorem

Given the fact that there are still many large gaps in the fossil record, what is the probability that the evolution model is valid? An approach to answering this type of question may be made by using Bayes' Theorem.

Some special notations are needed. The symbol $p[A]$ denotes the probability of the event A. The

symbol $p[A|B]$ denotes the probability of event A given that event B has already happened.

For example, if F represents a gap that has been filled and E represents the evolution model then $p[F|E]$ denotes the probability, assuming the evolution model, that this gap has been filled. On the other hand $p[E|F]$ denotes the probability, given that a certain gap has been filled, that the evolution model is valid.²

In this use of Bayes' Theorem, it is assumed that either the evolution model (denoted E) or the creation model (denoted C) is valid; but both cannot be valid. That is, the following is assumed:

$$p[E] + p[C] = 1. \quad (1)$$

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A probability of 1 means that an event is absolutely certain and a probability of 0 means that an event is impossible.

Let A represent some event where both $p[A|E]$ and $p[A|C]$ are known. According to Bayes' Theorem, then,³

$$p[E|A] = \frac{p[A|E]p[E]}{p[A|E]p[E] + p[A|C]p[C]} \quad (2)$$

and

$$p[C|A] = \frac{p[A|C]p[C]}{p[A|E]p[E] + p[A|C]p[C]} \quad (3)$$

To apply Bayes' Theorem, an event is needed where both $p[A|E]$ and $p[A|C]$ can be estimated.

There are many gaps in the fossil record. In fact, the absence of transitional forms is characteristic of the fossil record as it is known now.⁴ Of course, interest here is not in conditional probabilities given a single gap, but in those probabilities based on the existence of a number of gaps.

Bernoulli Trials

For this reason, another concept from probability theory is needed. Let us assume the probability that an event B will occur is p and the probability that it will not occur is q. And it is assumed, of course, that one or the other will happen so $p + q = 1$. The event B might happen exactly r times out of n total trials. Such a total event (the occurrence of B exactly r times out of n total attempts) is called a Bernoulli Trial.⁵ The probability of such an event is

$$C(n,r)p^r q^{n-r} \quad (4)$$

where $C(n,r)$ is the binomial coefficient $n!/(r!(n-r)!)$.

Let G denote the existence of a particular gap and F denote the existence of transitional forms in what might have been a gap. If evolution is true, then many transitional forms between a given order and some presumed ancestral order should be expected. That is, $p[F|E]$ should be nearly 1 and $p[G|E]$ should be nearly 0.

However, if the creation model is valid then there should be significant gaps in the fossil record. In other words, $p[F|C]$ should be near 0 and $p[G|C]$ should be near 1. For the sake of argument, the values in Table 1 are assumed.

Table 1

MODEL	$p[F \text{model}]$	$p[G \text{model}]$
CREATION	.001	.999
EVOLUTION	.999	.001

Gish has fully documented 13 major gaps in the fossil record.⁶ (He alluded to many others as well.) Let A be the existence of these 13 major gaps in the fossil record. By letting $r = n = 13$ in Equation 4, and using Table 1, then

$$\begin{aligned} p[A|E] &= (.001)^{13} = 10^{-39} \\ p[A|C] &= (.999)^{13} = .9870777151 \end{aligned} \quad (5)$$

Let us now suppose that, before examining the evidence of these 13 gaps, evolution is assumed to be 99 per cent certain: i.e. $p[E] = .99$; $p[C] = .01$. Then, by Bayes' Theorem (Equation 2),

$$p[E|A] = 1.003 \cdot 10^{-37} \quad (6)$$

where A is the existence of these 13 gaps. Incidentally, $p[C|A] = 1 - p[E|A]$ would be represented by 36 nines after the decimal point before a digit other than nine would occur! In other words, the evolution model is essentially invalidated by the record.

G. G. Simpson⁷ has stated that nowhere is there any trace of a fossil that would close the gap between *Hyracotherium* (supposedly the first horse) and its supposed ancestral order Condylarthra. He continued,

This is true of all the thirty-two orders of mammals. . . . The earliest and most primitive known members of every order already have the basic ordinal characters, and in no case is an approximately continuous sequence from one order to another known. In most cases the break is so sharp and the gap so large that the origin of the order is speculative and much disputed.⁸

Now, G. G. Simpson is a committed evolutionist (though one wonders how committed after admissions like the above). Let B be the existence of gaps between the 32 orders of mammals and the supposed ancestral orders. Then by having $r = n = 32$ in Equation 4, and using Table 1,

$$\begin{aligned} p[B|E] &= (.001)^{32} = 10^{-96} \\ p[B|C] &= (.999)^{32} = .9684910768. \end{aligned} \quad (7)$$

Let us again suppose that, before examining the evidence of the 32 gaps, Mr. Secular Scientist was 99 per cent certain of evolution. That is, Mr. Secular Scientist felt that $p[E] = .99$ and $p[C] = .01$. What should be Mr. Secular Scientist's reasoned conclusion after studying the fossil history of mammals? By Bayes' Theorem he must conclude

$$p[E|B] = 1.022 \cdot 10^{-94} \quad (8)$$

In other words, the probability of the validity of the evolution model given the gaps in the mammalian orders is about 1 in 10^{94} . Mr. Secular Scientist, if he is a totally rational man, must then abandon the theory of evolution. The only problem is, if he abandons evolution, the only alternative is special creation. To believe that would be to lose his title as Mr. Secular Scientist. After all, to be known as Mr. Sacred Scientist or even Dr. Sacred Scientist, in this "secular age" is an almost unbearable stigma (to some)!

Actually, the situation is much more dramatic than presented to this point. For evolution to have occurred there must have been transitional forms. Gaps are an almost impossible burden for the evolutionist. Transitional forms are, however, not nearly as serious for the creationist as gaps are for the evolutionist. A more accurate table might well be Table 2.

Table 2

MODEL	$p[F \text{model}]$	$p[G \text{model}]$
CREATION	.01	.99
EVOLUTION	.999999	.000001

In this case, $p[E] = .999$ would imply

$$p[E|A] = 1.138 \cdot 10^{-75} \quad (9)$$

and

$$p[E|B] = 1.378 \cdot 10^{-189} \quad (10)$$

where A and B are the events described earlier in this section.

While significant gaps remain in the presumed evolutionary history of all orders, let us suppose that 50 orders are examined and that significant gaps remain in 48 of them. This means that $r=48$ and $n=50$ in Equation 4. Then using D for this event and assuming Table 1, with $p[E] = .9$, then

$$p[E|D] = 9.424 \cdot 10^{-138} \quad (11)$$

And by assuming Table 1, and $p[E] = .999999$, then

$$p[E|D] = 1.047 \cdot 10^{-132} \quad (12)$$

This means that, even if Mr. Secular Scientist begins by assuming that evolution is 99.9999 per cent certain, then after an analysis of the event D, he must conclude that evolution has only a 1 in 10^{132} chance of being valid.

A summary of these and similar results is given in Table 3.

Table 3

n	r	TABLE USED	p[E]	p[E event]
13	13	1	.99	$1.003 \cdot 10^{-37}$
32	32	1	.99	$1.022 \cdot 10^{-94}$
50	48	1	.9	$9.424 \cdot 10^{-138}$
50	48	1	.999999	$1.047 \cdot 10^{-132}$
13	13	2	.999	$1.138 \cdot 10^{-75}$
32	32	2	.999	$1.378 \cdot 10^{-189}$
13	13	2	.999999	$1.140 \cdot 10^{-72}$
32	32	2	.999999	$1.379 \cdot 10^{-186}$
50	48	2	.999999	$1.620 \cdot 10^{-278}$

Therefore, even with the beginning assumption that evolution is a virtual certainty, a conditional probability analysis of the fossil record results in the conclusion that evolution is a demonstrable absurdity.

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PANORAMA OF SCIENCE

Cambrian and Other Early Pollen in the Literature

Some years ago in an article in the *Quarterly* the finding of fossil spores and pollen in Cambrian or pre-Cambrian rock in the Grand Canyon was described.¹ The plants which had produced the spores seemed to have been of kinds like those common today. Repeated checks showed no reason to suspect error or contamination. Yet scientists were skeptical of the report, including even some creationists who believe, on other grounds, that modern plants did indeed exist when the rocks were formed.

About the same time, although the report was noticed only later, other geologists made a similar find in Venezuela. Their work has since been summarized in the *Quarterly*.²

The geological literature is very extensive; and there is much more geological work completed than is reported in journals. It seemed worth while to do some hunting in the literature. Russell Brubaker, a student at Munich, has been very helpful in the search. And indeed there are reports of such modern-like spores in ancient rocks from India, Australia, Sweden, and Russia. The reports from India are the most extensive at the time of this report.

Jacob *et al.* found spores and other remains in the middle and upper Cambrian Neobolus shales of the Salt Range of Kashmir, and Cambrian of Spiti.³ As well as spores, etc., they found "... a few fragments of woody elements. ..." Work extended to the Suket shales, which contained well preserved specimens of *Fermoria*, and the Semri series of lower Vindhya. Since they encountered "scepticism," they took "... all

possible precautions . . .", and the results were "... repeatedly checked."

Ghosh and Bose, in two articles, found "... woody elements . . .", and reported that of 30 slides "... each contained abundant carbonized wood elements and spores. . .".^{4,5} In fact, they found quite a variety of "... microfossils, for example woods of conifers, cuticles of grasses, angiospermous wood elements, etc. . .". They concluded that it is "... fairly safe to suggest that the vascular land plants were in existence even as early as the lower Cambrian. . .".

Authors reporting on the work in Australia claimed only to extend the vascular plants back to the Silurian.⁶ The authors seemed to consider, however, that the fact that the index fossil monograptus was found along with the remains of the plants is very important. This article has some excellent illustrations.

The spores from Sweden were reported, oddly enough, in *Science*, an American journal.⁷ The things found were similar to those mentioned already.

Similar finds in Russia have been described in articles cited in the items mentioned here and published in *Nature*. But copies of the reports have not been obtained yet. Also, the articles in *Nature* contain a number of other references which are still unavailable.

It should be mentioned that, because of the findings in India, some doubted whether the strata involved were really so old. But Coates *et al.*, after careful investigation, reported that the strata are "... Cambrian or older. . .".⁸

Jacob *et al.* summed the matter up well.

The discovery of the remains of vascular land plants from Vindhya and other Cambrian sediments in India and elsewhere is of far-reaching significance in stratigraphy and in unravelling the early phylogeny of the vascular plants, on which an entirely new light is now being thrown, necessitating a re-orientation of certain well-established ideas.

What is to be done next? A number of teams, in different parts of the world, have reached the same conclusion: that plants of fairly modern types existed when the rocks called Cambrian or thereabouts were formed. Will people be convinced any better by yet more evidence? The evidence available now on this matter is stronger than that which led physicists to take up Einstein's general relativity about 1920. Is geology to be the only science in which evidence does not matter? Some of these findings are about 30 years old; yet no hint of them can be found in popular textbooks, in particular. Truly, there are none so blind as those who will not see.⁹

—Contributed by Clifford L. Burdick

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The Liver: Bomb Disposal Squad

A really remarkable article was published in the June 1975 issue of the *Scientific American* (pp. 22-30) on how the liver inactivates drugs, and detoxifies pollutants of the environment.¹⁰ The word "evolution" never occurs in this article, and though the authors do not suggest teleology, such an explanation would be most logical in view of the remarkable abilities of various parts of the liver to protect an individual from harmful substances in the environment.

Briefly stated, the liver is the largest organ in the body, weighing three pounds in the adult. It is the primary receiving depot, chemical processing agent, and distribution center for almost everything that enters the body through the walls of the alimentary tract.

Amino acids are made into proteins, glucose is converted into glycogen and stored, and equally important, drugs are detoxified. The liver also produces bile which aids in the digestion of fats, and is a factor in excretion of transformed substances and water soluble wastes.

It is the biotransformation of drugs and toxic substances which is of most interest to creationists. This is accomplished by several remarkable enzyme systems that can metabolize a wide variety of structurally unrelated drugs, toxic agents, and environmental pollutants, even those entering through the lungs and skin.

Drugs and other foreign compounds are metabolized in the liver by a rather small number of reactions: oxidations, reductions, hydrolysis, and conjugations. The net result is conversion of lipophilic or fat soluble substances into hydrophilic ones which can be removed readily from the blood by the kidneys, and excreted.

Thus the alkyl side chains of barbiturates and some other drugs are oxidized to form alcohols. The polycyclic hydrocarbons of cigarette smoke and other

drugs are converted by insertion of a hydroxyl group into the ring.

Deamination is the method by which amphetamine is oxidized to a harmless compound, the NH_2 being removed and an oxygen atom being substituted for it. Codeine undergoes oxygen dealkylation, the OCH_3 being converted to OH and HCHO removed.

Other drugs are inactivated by reduction such as the conversion of prontosil into sulfanilamide and $\text{C}_6\text{H}_3(\text{NH}_2)_3$ by the addition of two NH_2 radicals. Hydrolysis, or the addition of an OH radical, and conjugation are two very important methods used by the liver to inactivate compounds. In the case of sulfanilamide an active drug is formed from prontosil but this is deactivated by conjugation with acetic acid. As the authors stated:

... clearly the enzyme systems that catalyze these reactions were not invented by the mammalian organism in order to cope specifically with drugs or novel pollutants. Their basic physiological role has presumably been to metabolize endogenous substrates: substances normally present in the body.

Thus various liver enzymes oxidize steroid hormones, cholesterol, and fatty acids. The compounds resulting from these oxidations are then conjugated and excreted.

Newborn infants are far more susceptible to many drugs than are adults. Barbiturates and morphine given to a woman during childbirth can be stored in the infant's tissues and cause respiratory depression and even death.

There are marked individual variations in the metabolism of drugs that are handled primarily by the liver enzymes. This can cause a real problem in the prescription of the correct dosage rate which is safe and yet gives the desired therapeutic effect in the individual patient.

The most important enzyme of the oxidases is cytochrome P-450, a complex of protein and the iron containing ring structure that functions as the oxygen binding component of hemoglobin. It gets its name from the fact that in the reduced form it binds carbon monoxide and then absorbs light most intensely at a wave length of 450 nanometers.

The extent of the absorbance peak is the basis of quantitative studies of this enzyme. It accepts electrons passed along by several intermediates, is reduced to the ferrous state, binds oxygen and delivers it to oxidize the drug and usually also produce water. It then reverts to its original ferric state.

The cytochrome P-450 mixed function oxidase system is now recognized as having a central role in the body's defense against chemical agents whether they are normal body constituents or toxic substances or pollutants from the environment. Activity is greatly increased by exposure to a wide variety of environmental agents, over 200 steroid hormones, drugs, insecticides, carcinogens and other foreign chemicals being capable of increasing its action because they are potentially harmful to the human or animal system.

Phenobarbital decreases the effects of other drugs by hastening their inactivation. It has also been found

that trivial skin exposure to some chemicals such as plasticizers for paints, and the polychlorinated biphenyls in lens immersion oils, various lubricants, and heat exchange fluids can have significant and perhaps harmful biological effects in man.

Also a number of chemicals to which human beings are regularly exposed have been identified as chemical cancer inducing substances. Benspyrene, benzanthracene and similar polycyclic aromatic hydrocarbons, are among the most generally present carcinogens. They are present in tobacco smoke, in polluted city air, and in charcoal broiled and smoked foods. They cause a derangement in the cytochrome P-450 activity. Clearly there is a limit to the defense mechanisms of the human body.

The complexity of the various defense systems in the liver as the authors point out have clearly not been invented (or "evolved") in the mammalian organism "in order to cope specifically with drugs or novel pollutants." What then is their origin?

Creationists would say that they afford a marvelous demonstration of how God utilizes the enzyme systems which primarily function to metabolize substances normally present in the body, as a defense system to protect man from the effects of his now imperfect environment. For in the original garden of Eden only the primary functions of these systems would be needed.

But with His foreknowledge of the adverse environment to which sinful man would be exposed, the need of some protective mechanism would be obvious. Accordingly these basic enzyme systems were given the added function of protecting man from the various toxic materials and air pollutants, largely the result of his own activities.

Such a concept may also help explain the gradually decreasing lifespan of the patriarchs. For as the environment became increasingly loaded with toxic

materials, the ability of the protective enzyme system to effectively shield man from it would gradually decrease.

—Contributed by Walter E. Lammerts



Physiological Thermoregulation in Plants

A recent *Science* report should be of interest to botanical creationists. The article is "Heat Production and Temperature Regulation in Eastern Skunk Cabbage" by Roger M. Knutson¹¹ He described physiological thermoregulation under field conditions for a common plant found throughout much of northeastern North America.

The spadix was found to maintain an internal temperature 15-35°C above air temperatures over the range -15 to 15°C. Interestingly, the small (2.5-9.5 g) spadices consumed oxygen at a rate approximately that of similar sized homiothermic animals, e.g. shrews and humming birds.

It appears that the tissue of the spadix is not frost-resistant, and destructive freezing is avoided due to the property of heat generation in response to cold temperatures. Unlike most other plant (and animal) tissue, colder temperatures increase metabolic reactions yielding increased heat. This is similar to the way homiothermic or "warm-blooded" animals maintain warm body temperature during cold exposure.

The belief that random events can bring about the "evolution" of any complex physiological function involves a great deal of faith. That such an event could reoccur in mammals, birds and plants by chance is beyond logic. Indeed the facts of nature are ample evidence of a Creator and only through "willful ignorance"¹² do some members of the scientific community reject the evidence.

—Contributed by E. N. Smith

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BOOK REVIEW

The Troubled Waters of Evolution by Henry M. Morris 1974. Creation-Life Publishers, San Diego, California. 217 pages. Price \$2.95.

Reviewed by H. L. Armstrong*

In this work the author's aim is not so much to state the case for Creationism, although indeed that is

done incidentally. Rather he exposes the appallingly bad case which is the best that can be made for "evolution." If the facts are faced, "evolution" is indeed in troubled waters. There are those, of course, who try to conceal the trouble by chanting: "Great is Evolution"; just as long ago the mob chanted: "Great is Diana of the Ephesians."

First of all, the author considers present conditions: the present state of opinion. He notes that earlier in

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this century Creationism "went underground" so to speak; but that more recently it has come up again, in part in the form of such organizations as the Creation Research Society and the Institute for Creation Research.

Next is considered the ways in which evolutionary dogma has permeated almost every aspect of life in the last 50 years or so. As is pointed out, even a writer on mathematics may feel that he has to drag in a pointless, and quite unproven, assertion about "evolution," or primitive man, or something of the sort. And the influence which the "evolutionary" viewpoint has had on philosophy, on education, on politics, yes, even on religion as it is taught in many churches, is an aspect only too apparent.

It would be natural to inquire: "What is the source of this all-pervading dogma?" The stock answer would be: "Darwin." But in fact, it is pointed out, Darwin really contributed very little. As a matter of fact, he really "had greatness thrust upon him."

The same kind of notion had been around for years before the *Origin* was published. Indeed, most of the notions which went to make the *Origin*, and which are still around today, can be traced at least to Greek philosophers (and, it is suggested, maybe farther back).

What, then, is the nature of the troubled waters of "evolution"? The trouble lies in this: that the "theory of evolution" goes against both actual observation and against general principles of science.

As for observation, the tendency observed in living beings is a conservative one: they tend to remain the same, generation after generation, except for possible very minor changes. To extrapolate minor variations into changes between kinds is certainly not warranted by the evidence, to say the least. And when random changes, or mutations, do occur, they are always harmful, or at best neutral, never naturally beneficial.

Nor are there any creatures which are evidence for "evolution." There are no living "links." (In other words, the "missing link" is really missing.) For instance, if horses and cows came from some common ancestor one would expect to find a continuous range

of creatures extending between them. But, of course, there is nothing of the sort.

Neither are there dead "links." There are no fossils which might connect the various kinds. In fact, the "fossil record," which is so often adduced as evidence for "evolution," becomes, if considered in an unbiased way, evidence against it.

The general principles referred to earlier are, of course, the two laws of thermodynamics. For according to those laws, the tendency everywhere is toward conservation with degeneration. There is no evidence for any "principle of spontaneous improvement," although evolutionists are compelled, in effect, to suppose, quite without evidence, that there is some such principle.

The author, an engineer, is fully familiar with thermodynamics, and has used thermodynamic arguments in a telling way very often. Nor have evolutionists found any defense against thermodynamics, other than to suppose things for which there is no evidence whatsoever.

Toward the end of the book, the subject of the influence of belief in "evolution" on other matters is taken up again. In fact, the influence is a very wide one. Just to mention two examples, there is the way in which many writers on ecology seem to think that they have to drag in something about "evolution."

Also, the current absurd outburst of utterly unfounded speculation about living beings, and especially intelligent ones, beyond the earth, would probably never have begun had those concerned not been persuaded that life and intelligence had to "evolve," necessarily.

The book is concluded with some practical suggestions as to what a creationist (and a Christian) may do when surrounded by evolutionists.

There are indices of topics, of proper names, and of citations of Scripture. In a bibliography some further works are suggested.

This book should be quite intelligible to any reader, and it is a valuable source of truth about the weaknesses of evolution.

LETTER TO THE EDITOR

No Haste to Demote Piltdown Man Observed

With reference to the statement in the Annual Issue of June 1974, page 22, second column,¹

One can almost picture men in museums over the world hurrying with gray paint and a brush to paint out that imagined branch of the human tree on the day the hoax was exposed. The next day, Piltdown Man had never existed.

In August of 1954, I visited the Denver Museum of Natural History, and there in the Hall of Man, Piltdown man was displayed as prominently as ever, without the least hint that months before that the Piltdown Man hoax had been discovered.

Piltdown Man may well be covered over with gray paint by now, but there was surely no hurrying in this instance to make a correction. Perhaps some member in the Denver area can inform us as to, if and when the paint job was done, and as to why it was not done earlier in that year.

Reference

¹von Fange, Erich A. 1974. Time upside down, *Creation Research Society Quarterly*, 11 (1):13-27.

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CREATION RESEARCH SOCIETY

History The Creation Research Society was first organized in 1963, with Dr. Walter E. Lammerts as first president and editor of a quarterly publication. Initially started as an informal committee of 10 scientists, it has grown rapidly, evidently filling a real need for an association devoted to research and publication in the field of scientific creationism, with a current membership of about 500 voting members (with graduate degrees in science) and over 1600 non-voting members. The *Creation Research Society Quarterly* has been gradually enlarged and improved and is now recognized as probably the outstanding publication in the field.

Activities The Society is solely a research and publication society. It does not hold meetings or engage in other promotional activities, and has no affiliation with any other scientific or religious organizations. Its members conduct research on problems related to its purposes, and a research fund is maintained to assist in such projects. Contributions to the research fund for these purposes are tax deductible.

Membership Voting membership is limited to scientists having at least an earned graduate degree in a natural or applied science. Dues are \$8.00 (Foreign, \$9.00 U. S.) per year and may be sent to Wilbert H. Rusch, Sr., Membership Secretary, 2717 Cranbrook Road, Ann Arbor, Michigan 48104. Sustaining membership for those who do not meet the criteria for voting membership, and yet who subscribe to the statement of belief, is available at \$8.00 (Foreign, \$9.00 U. S.) per year and includes subscription to the Annual Issue and Quarterlies. All others interested in receiving copies of these publications may do so at the rate of the subscription price for all issues for one year: \$11.00 (Foreign, \$12.00 U. S.).

Statement of Belief Members of the Creation Research Society, which include research scientists representing various fields of successful scientific accomplishment, are committed to full belief in the Biblical record of creation and early history, and thus to a concept of dynamic special creation (as opposed to evolution), both of the universe and the earth with its complexity of living forms.

We propose to re-evaluate science from this viewpoint, and since 1964 have published a quarterly of research articles in this field. In 1970 the Society published a textbook, *Biology: A Search for Order in Complexity*, through Zondervan publishing House, Grand Rapids, Michigan 49506. Subsequently a Revised Edition (1974), a Teachers' Guide and both Teachers' and Students' Laboratory Manuals have been published by

Zondervan Publishing House. All members of the Society subscribe to the following statement of belief:

1. The Bible is the written Word of God, and because it is inspired throughout, all its assertions are historically and scientifically true in all the original autographs. To the student of nature this means that the account of origins in Genesis is a factual presentation of simple historical truths.

2. All basic types of living things, including man, were made by direct creative acts of God during the Creation Week described in Genesis. Whatever biological changes have occurred since Creation Week have accomplished only changes within the original created kinds.

3. The great Flood described in Genesis, commonly referred to as the Noachian Flood, was an historic event worldwide in its extent and effect.

4. We are an organization of Christian men of science who accept Jesus Christ as our Lord and Saviour. The account of the special creation of Adam and Eve as one man and woman and their subsequent fall into sin is the basis for our belief in the necessity of a Saviour for all mankind. Therefore, salvation can come only through accepting Jesus Christ as our Saviour.

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