EXPLAINING THE ORIGIN OF LIFE

Explaining the origin of life is one of the enduring problems for a naturalistic view of nature. Several conjectures have been offered to explain how life might have originated without an intelligent designer.

One of the most prominent conjectures of the origin of life has been the familiar “primordial soup” hypothesis, in which it is postulated that simple organic molecules might form in the atmosphere, and accumulate in the ocean, where they would react to form living systems. This idea is currently out of favor, for a variety of reasons. First, the scenario requires incompatible chemical conditions for the various constituents necessary for life. Second, there is reason to believe that the Archaean atmosphere contained sufficient atmospheric oxygen to destroy most organic molecules in the atmosphere before they reached the ocean. Third, there is no evidence of such an organic-rich chemical soup in Archaean rocks. Fourth, the “primordial soup” hypothesis relies too heavily on random molecular collisions, which are highly improbable in an ocean.

The insufficiency of chance molecular collisions led theorists to propose that certain surfaces might act to concentrate organic molecules where chemical interaction would be more highly probable. Clay surfaces have been suggested, but pyrite is more commonly proposed as the type of surface needed. The conjecture of life arising from chemical reactions on a surface has been whimsically termed the “primordial pizza” hypothesis. A variety of scenarios can be included under this theme, including so-called “ hypercycles, ” “ surface metabolism, ” and “ RNA world. ” All these scenarios seem to assume some kind of self-organizational property of the materials that compose a living cell. Self-organization means that if the chemicals needed for life are all present in a small space, under the appropriate physical and chemical conditions, they will spontaneously assemble themselves into a living cell.

The notion of self-assembly of molecules into cellular components is currently a subject of scientific scrutiny. Do the chemical properties of molecules tend to drive chemical reactions in such a way that life results? One prominent origin-of-life theorist affirms that, under the proper conditions, the spontaneous formation of a living cell is “inevitable.” A similar claim is implied in the notion of a “fully gifted creation.” According to this proposal, God “fully gifted” the creation in the beginning,
so that no further divine input is necessary. This implies that, under the 
appropriate conditions, without any activity by an intelligent agent, 
organic molecules will form and spontaneously self-assemble to produce 
life. Can such an idea be tested experimentally?8

Chicken soup might provide such a test. Chicken soup is widely 
available in sealed containers, where undesirable oxygen and other 
chemical contaminants are excluded. Each tin of chicken soup contains 
a concentrated mixture of the organic molecules needed for life. Thus, 
the conditions postulated for the origin of life are present in each tin of 
chicken soup. If these molecules were actually “fully gifted” with 
chemical properties that drive their reactions toward producing life, or if 
the production of life is “inevitable” under such circumstances, one would 
surely expect to find some form of life in at least some tins of chicken 
soup. If a vertebrate source proves unsatisfactory, perhaps one could 
experiment with an invertebrate source such as clam chowder, or some 
other material. Pyrite or other material could be included to provide a 
potential surface for facilitating chemical reactions. Perhaps different 
temperature regimes could be used. Regardless of the details, it seems 
possible to test the idea that molecules possess sufficient properties of 
self-assembly so that life can arise spontaneously.

A note of caution may be in order, however. If molecules actually 
possessed such properties, would we expect to observe death from 
“natural causes?” If molecules naturally tend to self-organize into living 
systems, what circumstances could cause them to lose this chemical 
property and permit death? What would happen if an organism were to 
die, say from physical trauma? At the very least, one would expect the 
constituents of the dead organism to spontaneously re-assemble them 
selves into some form of simple life. I am not suggesting that a dead 
elephant should re-assemble into a living elephant, but rather that at least 
some of the molecules of a dead elephant should re-assemble into some 
“simple” form of life such as a bacterium or protozoan. This might happen 
many times, or perhaps only in the anoxic environment of the deep tissues. 
The fact that we do not see such results strongly suggests that molecules 
do not possess the postulated properties required for self-assembly of a 
living cell.

L James Gibson
ENDNOTES


A R T I C L E S

RECENT DEVELOPMENTS IN NEAR EASTERN CHRONOLOGY AND RADIOCARBON DATING

Michael G. Hasel
Institute of Archaeology
Southern Adventist University

WHAT THIS ARTICLE IS ABOUT

The chronologies of Mesopotamia and Egypt are often cited as a basis for substantiating a long history and prehistory for the development of civilization in the Near East. This article provides a state-of-the-art appraisal of ancient Near Eastern chronologies in Mesopotamia and Egypt. It focuses on recent developments in both fields by assessing the current astronomical and historical bases for these chronologies and addressing the relative nature of chronology before the second millennium B.C. It documents the trend over the past sixty years to shorten the historical chronology of the Near East. This causes a widening gap between historical dates and the most recent data from $^{14}$C samples. This data has major implications for lengthening certain historical and prehistoric periods. The impasse between the historical methods of dating and $^{14}$C dating will then be evaluated.

The chronologies of Mesopotamia and Egypt are often cited as a basis for substantiating a long history and prehistory for the development of civilization in the Near East. It is often on the basis of the archaeological evidence that the arguments are made for the reinterpretation of the biblical chronological data (Kitchen 1966:36-37; Geraty 1974:16; Archer 1979:361; Blocher 1984:215-219; Stek 1990:223-225; Thompson 1991:228-229; Taylor 2000:98; Guy 2003:8). Recent archaeological and anthropological research has produced new data for the chronologies of Mesopotamia and Egypt. This study will evaluate: (1) whether the Egyptian and Mesopotamian history is set in an absolute framework; (2) some recent developments in the study of these chronologies and the trends for either lengthening or shortening the chronology; and (3) the relationship between $^{14}$C dating and Near Eastern chronologies and how this relationship is currently understood. The purpose of this essay is to provide a state-of-the-art discussion of Near Eastern chronology...
and its interface with $^{14}$C dating in order to assess the framework upon which scholars place the events of early history.

**MESOPOTAMIAN CHRONOLOGY**

The chronology of Mesopotamia is often spoken of as being “fixed” by astronomical observations. That is, when a scribe recorded a king’s name in conjunction with a datable natural occurrence, such as an eclipse, that date may be referred to as *absolute* or “exact”. For example an inscription from the tenth year of the Assyrian king Aššur-Dan III refers to an eclipse of the sun, and by precise astronomical calculations it can be determined that the eclipse must have occurred on June 14/15, 763 B.C. (Glass 1984:92; Millard 1994:2). Because of the existence of eponym lists which provide a complete sequence of events in the reigns of various Assyrian kings (Ungnad 1938a; 1938b; Millard 1994) it is possible to derive from this one fixed date an absolute chronology extending back to 910 B.C. It is important to observe that “when attempting to go back further in time than the first millennium, however, one encounters problems” for “it is not possible to simply extend the absolute dates of the first millennium back into the second millennium” (Glass 1984:92). The second millennium dates are decidedly *relative*. Furthermore, two historical gaps of unknown duration occur between the sixteenth and twenty-fourth centuries B.C. the former “at about 2000 B.C., the latter about 1600 B.C.” so that “specific incidents and entire eras remain unanchored in *absolute* time” (Glass 1984:92; his italics). Before that “only approximate dates are possible: time estimations are derived from purely archaeological evidence, from paleographic data...and by all too-few radiocarbon dates” (Knapp 1992:716).

One reason that Mesopotamian historical chronology during the second and third millennium B.C. has faced increasing complexity concerns the cycle in which astronomical movement occurs. The discovery of the Venus tablet by Henry Austin Layard, and translated by Rawlinson and Smith (1870) received considerable attention (the history is documented by Langdon, Fotheringham and Schoch 1928:28-44; cf. Reiner and Pingree 1975) for mentioning the year formula for year 8 of Ammisaduqa. That tablet has become one of the key pieces of evidence to fix the chronology of the early second millennium B.C. by astronomical means (Poebel 1942; Rowton 1960; Huber 1987:5). Since the planetary movements of Venus occur in cycles of 56 or 64 years (Ungnad 1940), they offer a
series of possible dates rather than an agreed upon single date (Knapp 1992:716). Kugler (1912) concluded that the following years were candidates for Ammisaduqa Year 1: -2040, -1976, -1856. He settled for a middle chronology date of -1976, but later on preferred an -1800 solution (Kugler 1924; 622-627; Huber 1987:5). The next year five dates (-1976, -1920, -1856, -1808, -1800) were considered by Langdon, Fotheringham and Schoch before they settled on -1920 (1928:61-62; Huber 1987:6). Hence, experts differentiate between three and up to five distinctive chronologies for the second millennium: the ultra-high (Landsberger 1954),\(^1\) the high (Goetze 1951; 1957; Thureau-Dangin 1942; Huber 1982; 1987),\(^2\) the middle (Kugler 1912; S. Smith 1940; 1945; Rowton 1962),\(^3\) the low (Albright 1956; Cornelius 1956; cf. Aström 1987),\(^4\) and the ultra-low (Weidner 1945-51).\(^5\) These competing chronologies allow for up to 226 years of flexibility.

<table>
<thead>
<tr>
<th>Ultra-High Chronology</th>
<th>Hammurapi reign</th>
<th>1930-1888 BC</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Chronology</td>
<td>Hammurapi reign</td>
<td>1848-1806 BC</td>
</tr>
<tr>
<td>Middle Chronology</td>
<td>Hammurapi reign</td>
<td>1792-1750 BC</td>
</tr>
<tr>
<td>Low Chronology</td>
<td>Hammurapi reign</td>
<td>1728-1686 BC</td>
</tr>
<tr>
<td>Ultra-Low Chronology</td>
<td>Hammurapi reign</td>
<td>1704-1662 BC</td>
</tr>
</tbody>
</table>

Given the complexity of astronomical and historical reckoning for the period under discussion some experts have suggested that alternative methods be used for formulating the chronology of ancient Mesopotamia. While none would presume to limit or diminish the value and usefulness of historical chronology, \(^{14}\)C dating has been suggested as a means to verify or supplement historical reckoning (Rowton 1960; Mellaart 1979; Hassan and Robinson 1987).\(^6\)

Mesopotamian Chronology and \(^{14}\)C Dating. Several attempts have been made to correlate \(^{14}\)C dating with the historical chronology of Mesopotamia (Rowton 1960; Mellaart 1979; Hassan and Robinson 1987; Schwartz and Weiss 1992). Arguments for a middle and ultra-high chronology have been posited.\(^7\) The most extensive correlation of \(^{14}\)C dating and historical chronology was published in 1979 by James Mellaart. Mellaart outlines three basic chronological schools, which according to our terminology would have been the ultra-high, middle, and low chronologies. In his view “historical chronologies are a unique record from the past, they cannot and should not be ignored, but they have not come
down to us in such a perfect state that only one chronological interpretation — the middle chronology — is possible. In the 1950s this may indeed have seemed the best choice: in 1979 it is not” (1979:11). Thus he proposes to utilize calibrated \(^{14}\)C dates which would support the ultra-high chronology (1979:11).

The \(^{14}\)C dates Mellaart cites are derived primarily from timber samples. The first dates for Shamshi-Adad come from his temple at Tell Rimah followed by Dinkha IV C which Mellaart claims is contemporary with the stratum at Tell Shemshara in which an archive of the period of Shamshi-Adad was found (1979:12). They were published as follows:


The second set of dates derives from samples found in the Acemköy palaces. The burnt debris of the destruction contained, among others, bullae of Shamshi-Adad (1979:12). The other four dates come from two Kültepe Ib period buildings in western Anatolia. The dates for Shamshi-Adad I were published as follows:

BM-? Beycesultan V 3450 +/- 150 BP 1950-1920 +/- 150 BC \(B\) (1962) II.

Radiocarbon dates for the Ur III period are supplied from several sites. The date from Warka is taken from a sample of reeds attributed to the reign of Ur-Nammu. The date for Nippur Level IV is attributed to the reigns of Shu-Sin and Ibbi-Sin. The sample from Godin III is attributed to the beginning of the Ur III period, while the sample from Selenkahiye seems to date squarely within the Ur III period. The dates corresponding to the Ur III period were published as follows (1979:13):

H 141-120/166 Warka 3820 +/- 85 BP 2330-2210 +/- 85 BC \(R\) (1965) 7:188.
P-1798 Selenkahiye IV 3730 +/- 57 BP 2125 +/- 57 BC \(AAAS\) (1973) 23:156.

Number 56 9
Problems of Correlation. Based on these dates Mellaart concludes that “the so-called dilemma [between historical chronology and $^{14}$C dating] then is a myth, a creation of supporters of the middle and low chronologies” (1979:18). However, his conclusions have met with vigorous resistance among Assyriologists and Egyptologists (Kemp 1980; Munn-Rankin 1980; Weinstein 1980). Before addressing these criticisms it is first necessary to make several general observations:

The first issue is the dating of the stratigraphy of Kültepe II and Ib. Mellaart’s $^{14}$C dates from Kültepe imply that the two strata (II and Ib) together have spanned a period of three or four hundred years (2010-1720 B.C.; 1979:13). However, from historical records, economic transactions from the trading colonies at the site, it is known that these periods of occupation could not have lasted longer than 175 years (Larsen 1976). Mellaart recognizes the problem but provides no explanation. He maintains that the $^{14}$C dates support Shamshi-Adad’s reign on the ultra-high chronology (ca. 1953-1921 B.C.), but the 300-year span suggested by the dates (2010-1720 B.C.) could also support a middle or low chronology. Mellaart also does not seem to be aware that there are actually five possible historical solutions to the information given on the Venus Tablet. He does not mention the “actual” high chronology accepted most widely (Goetze 1951; 1957; Thureau-Dangin 1942; Huber et al. 1982; 1987; Tuman 1987; cf. Munn-Rankin 1980:129) and instead argues for the ultra-high chronology of Landsberger (1954) which remains virtually unaccepted. His extreme position is forced because of the $^{14}$C dates. Rather than attempting to solve the real problem of correlation he disregards the fact that the ultra-high chronology does not conform to the possible dates of the Venus cycle.

Mellaart has been criticized by historians and archaeologists as well (Kemp 1980; Munn-Rankin 1980; Weinstein 1980). According to the Assyriologist Munn-Rankin (1980:128) Mellaart makes the incorrect assumption that absolute dates can be assigned to third millennium dynasties by reckoning back from the first dynasty of Babylon. She points out that prior to the Third Dynasty of Ur, there is a paucity of independent evidence against which to assess the King Lists. The situation seems more complex than Mellaart admits.

Mellaart also makes the assumption that the Kassites ruled for 576 years after the destruction of Babylon by the Hittites. Munn-Rankin argues that this is incorrect (1980:128). This number is only given on
King List A, dated to the seventh century B.C., and in no text is the beginning of this dynasty explicitly connected with the raid of Muršili I (Brinkman 1968). The end of the Kassite dynasty has most recently been dated to 1155 (Brinkman 1976; cf. 1980).

Mellaart does not seem to be well acquainted with the complexities of reckoning chronological sequences from historical information. At one point he states that the only Near Eastern countries from which there are King Lists are Egypt and Babylonia. He does not seem aware that the historical reckoning of the period prior to 1450 B.C. is based primarily on the Assyrian King Lists (Poebel 1942; Weidner 1926; 1945-51; Gelb 1954) and that the Mesopotamian chronology hinges on Assyrian records for its chronological framework (Knapp 1992; Grayson 1992a; 1992b). Furthermore, the Akkadian King List remains the essential source of historical reconstruction for the third millennium B.C. (This is precisely the period he is assessing.)

Mellaart should be commended for his attempt to correlate the two apparently contradictory sources of information for the dating of early Mesopotamian periods. However, it seems apparent that this most recent attempt to reconcile 14C dating and historical chronology fails to provide any conclusive new evidence. The 14C dates were consistently too high for even the “ultra-high” chronology which completely lacks support from the Venus data and archaeological stratification. This is the case for other periods as well. Moreover, revised 14C dates would suggest that the Uruk period, which conventionally begins around 3500 BC, “may have to be pushed back four or even five hundred years” (Crawford 1991:18; cf. Moorey 1987). The question remains whether the numerous variables and problems have been solved to the point where 14C dating can be viable for the historical chronology of the ancient Near East. 9

EGYPTIAN CHRONOLOGY

The chronology of Mesopotamia and much of the remainder of the ancient Near East has been linked with Egyptian absolute dating (Knapp 1992:716). During the historic/dynastic period written sources in Egypt include king lists, royal annals, and biographic treatises (Redford 1986; Kantor 1992; Ward 1992). In the early twentieth century, W. F. Petrie, the recognized founder of Egyptology and the archaeological principles of stratigraphy and superimposition, published the beginning of the historic/dynastic period (Dynasty I) at 5510 BC (Petrie 1906:175). His
conclusions were based primarily on “the authority of the Turin papyrus and of Manetho,” for “it is only reasonable to accept those lists as substantially accurate” (Petrie 1906:175). Other noted Egyptologists later placed Dynasties I and II at 3425-3000 BC (Weigall 1910: xvii) or 3400-2980 BC (Breasted 1916:419). It is significant that the most extensive adjustments have occurred in the Old Kingdom where relative dates allow for more change due to the length of the First Intermediate Period. However, the last century of Egyptological research, expanded by incredible amounts of new data from excavations and textual studies, has raised serious questions not only for the length of the historic periods, but also for the absolute nature of early dates. Several serious questions have been raised which necessitate revisions for the traditional absolute chronology prior to the Egyptian New Kingdom (Ward 1992:55).

**Manetho as an Authority for Egyptian Chronology.** During the third century B.C. a “history of Egypt” was written in Greek by a priest named Manetho (Waddell 1940; Helck 1956). It seemed almost certain that Manetho had compiled his history from some of the same lists that modern historians use for the reconstruction of Egyptian chronology (Knapp 1992:716). In spite of early reliance on Manetho (Petrie 1906; Weigall 1910; Breasted 1916 and others) and attempts to legitimize it as dependable (Helck 1956), an increasing number of errors and inaccuracies have been discovered (Redford 1986:231-332). This has caused some historians to abandon this tradition altogether (Wente and van Siclen 1976:217-218; Ward 1984:155-156) or to show that dependence on Manetho is not necessary, “at least not for the chronology of the new kingdom and later” (Hornung 1987). Because of these problems “his work ceased to be the basis of Egyptian chronology many decades ago” (Kitchen 2000:39). New evidence on the length of reigns and the existence of co-regencies have contributed to the abandonment of Manetho as a credible source.

**New Evidence on the Length of Reigns.** New data about the length of certain reigns have caused revisions. For example, it has been established that Sesostris III reigned for 19 years rather than 39 as previously thought (Simpson 1972; 1984; cf. Kitchen 1992:329; 2000), and Amenemhet IV for 13 rather than nine years (Beckerath 1976:50). During the 19th Dynasty, Merenptah reigned no more than ten years rather than Manetho’s 19 (Bierbrier 1975:118 note 2; on Merenptah’s reign and see Hasel 1994; 1998; 2003; 2004). The general tendency of
new data that has come to light supports a shortening rather than lengthening of the chronology.

**The Question of Coregencies.** The matter of coregencies remains unresolved (Ward 1992:54). One example will suffice. A short coregency between Thutmose III and Amenhotep II is often assumed (see Casperson 1986). Redford (1966:120) allows one and a third years, Wente and van Siclen (1976:227-228) two and a third years as does Murnane (1977:44-57) who insists that this coregency is “remarkably well attested.” Krauss, on the other hand, (1978:174-175) allows for no such coregency. The existence of coregencies would also shorten Egyptian chronology which has tended to place rulers in consecutive rather than overlapping succession.

**Astronomical Bases for Egyptian Chronology.** Finally, the most serious challenge to traditional chronology is the interpretation of astronomical data preserved in Egyptian texts (Neugebauer 1929; 1974; Hayes 1970; Barta 1979/80; Krauss 1985; Leitz 1989). This is a complex matter that has likewise given rise to a high, middle, and low chronology (Kitchen 1987; 1992; 2000). Like Mesopotamian chronology, the later dates of the New Kingdom are much more reliable than earlier dates because of more Egyptian documentation (Ward 1992:55), but unlike Mesopotamia “no relevant account of a solar eclipse survived from ancient Egypt” (Brein 2000:54). Dates are based largely on the calendrical system, whether this was according to agricultural (Neugebauer 1938), lunar, stellar (Krauss 1985), or civil years (Gardiner 1945; Parker 1950; Barta 1983).

The beginning of the Egyptian lunar year was tied to the heliacal rising of the star Sirius (αpd.t was rendered Sôthis by the Greeks; Ward 1992:58-59; Krauss 1998; Brein 2000:53). The lunar and civil years were not opposed or in competition with each other (Ward 1992:57). The sidereal year (presided over by Sirius) is slightly more than a quarter-day longer than the civil calendar. Thus modern scholars have called the civil year the “wandering year” (Barta 1979/80; 1983; Beckerath 1986) since it regularly progressed backward so that the civil New Year’s Day eventually fell on every first day of the sidereal year. The resulting period of 1460 years (365 x 4) is called the “Sothic Cycle”. In reality the “Sothic Cycle” is somewhat shorter and scholars now use a figure of 1456 years (Hornung 1964:18; Ingham 1969). “Only six references to the heliacal rising of Sirius suitable for astrochronology survived in Egyptian sources” (see the references by Brein 2000:54-55).
Several factors influence dating by the rising of Sirius. The *arcus visionis* is the angle between Sirius and the sun when the star is first observed. The point of observation is not the horizon. Modern calculations show that the angle is 7.5 degrees, with Sirius 2 degrees above the horizon and the sun 5.5 degrees below it. The time of observation will cause variations in this angle and hence also the chronological conclusions drawn from assuming a 7.5 degree angle. Another problem in reckoning time concerns the *tetraeteris*, the four-year phase during which the heliacal rising was observed on the same day of the year. Every four years the phase moved backward one day and it is not possible to determine in which of the four years of the *tetraeteris* a given observation took place (Ward 1992:58).

The most significant variable for astronomical calculations was *where* in Egypt such observations took place. As one moves south along the Nile, for every degree of latitude the heliacal rising is observed one day earlier. In terms of absolute chronology this means a reduction by four years per day per degree of latitude (Ward 1992:59). Due to this realization Egyptologists have proposed three possible locations for the observation of the heliacal rising of Sirius, namely Memphis or Heliopolis (Leitz 1989), Thebes (Ward 1992:59), and Elephantine (Krauss 1981; 1985; 1998; Franke 1988). Since there are about six degrees of latitude between Memphis/Heliopolis and Elephantine (Brein 2000:55; Krauss 1985:38-49), these three locations in turn have established three possible chronologies (Kitchen 1987; 1992:324-325; 2000), a high chronology (Sothic sighting in Memphis/Heliopolis; Leitz 1989; Ward 1992), a middle and low chronology (Sothic sighting from Thebes; Hornung 1964:20-21; Kitchen 1987:42-43) and an ultra-low chronology (Sothic sighting at Elephantine; Krauss 1985; 1998; Wells 1985; Franke 1988).

The effect for the 12th Dynasty would be divergence of 42 years (Kitchen 1987:45). W.A. Ward of Brown University maintains that due to these factors “precision is impossible when the sightings of the lunar crescent, for example, are individual interpretations of purely sensory data.” In fact, this respected Egyptologist states that the “‘precision’ assumed by present-day scholarship is an illusion” (1992:62). While the astronomical evidence is important for Egyptian chronology, the most recent assessment is that “at the moment it seems impossible to gain reliable fixed absolute dates of Egyptian history by means of astrochronology alone”
“these merely help to limit the options in fine detail” (Kitchen 2000:39).

From these observations it must be understood that Egyptian chronology before the New Kingdom is increasingly relative. This has resulted in a great deal of adjustment over the past century as new evidence has come to light. The tendency, on the basis of new archaeological and historical evidence has been to drastically shorten the chronology of dynastic Egypt. As outlined above, this may be due to the adjustment in the length of reigns, in assuming co-regencies, and on the basis of astronomical data.

Based on this new archaeological and textual evidence, today the date for the beginning of the Egyptian historical period falls anywhere from 3050 (Kemp 1989:14) to as low as 2950 B.C. (Beckerath 1997:187). In other words, the chronology of dynastic Egypt has been reduced from Petrie’s original suggestion by as much as 2,560 years while Breasted’s chronology has been reduced more than 400 years by this new evidence in a total time-span that lasts only 2,346 years (see chart below; Taharqa was the last Egyptian king of Upper and Lower Egypt, 664 BC, Kitchen 2000:39). This is a significant reduction in time. One
should not underestimate its significance for further refinements. The
discovery of a single new monument may cause untold further refinement

Radiocarbon Dating and Egyptian Chronology. Since the
inception of \(^{14}\)C dating in 1949, attempts have been made to correlate
\(^{14}\)C dates with the well-known historical dates in ancient Egypt. The
publications stating positive results by Willard Libby, the inventor of the
method (Libby 1955; 1963), were optimistic but, in the end, gained little
support among Egyptologists (Hayes 1970; H. S. Smith 1964; Edwards
1970; Long 1976). This was due to more precise historical dates in the
Egyptian New Kingdom (Kitchen 2000:39) and significant differences
between the \(^{14}\)C dates and the historical dates for the Old Kingdom
(Bowman 1990:16). Several factors accounted for this. First, early \(^{14}\)C
dates reflected a half-life assigned to them by Libby (5568 +/- 30 yrs. BP; 1955).
This was later adjusted to 5730 +/- 40 years BP (Hole and Heizer 1973:252; Schwartz and Weiss 1992:189). Second, calibration had not yet
been introduced (Bowman 1990:43-49; Clark and Renfrew 1973; John-
son 1973; Clark 1978; Pearson 1987), nor had it been refined (Shaw 1985; Hassan and Robertson 1987; Stuiver and Pearson 1986; Stuiver et
al. 1998).

Even after these important adjustments were introduced and cali-
brations refined, the present status has not changed significantly. The
impasse continues between Egyptologists, Assyriologists, and those
working in \(^{14}\)C dating.\(^{11}\) According to the recent state-of-the-art articles
from the Near East Chronology Symposium held in Jerusalem, Israel
published in Radiocarbon (2001), the \(^{14}\)C dates still vary significantly
from historical dating. Bruins and van der Plicht (2001) show in a detailed
case that high-quality stratified \(^{14}\)C dates from Early Bronze Jericho are
“100-300 years older than conventional archaeo-historical time estimates”
(Bruins 2001:1151). Braun (2001:1279) concludes from another study that
also resulted in high \(^{14}\)C dates that “the logical outcome of an acceptance
of these new dates [from the southern Levant and Egypt] puts such a
strain on chronological correlations between the \(^{14}\)C data and the archae-
ological record, that the entire system would no longer be tenable if
accepted.” Despite the cautionary remarks by Braun, Bruins (2001:1151)
submits that “the new \(^{14}\)C evidence is overwhelmingly in favor of an
older Early Bronze Age and older dates for Dynasties 1-6.”
In fact, it is precisely the $^{14}$C dates that have increased the estimates of ages in prehistoric periods. Bruins and van der Plicht (2001:1330) write:

As a result of $^{14}$C dating, the latter periods have indeed ‘become’ much older. In the 1950s and early 1960s, when Albright (1960) wrote the above time assessments, it became quite fashionable to assign the Chalcolithic on archaeological estimates to about 4000-3100 BC and EB-I to about 3100-2900 BC. However, $^{14}$C dating has changed the picture completely! The Chalcolithic is now understood to have begun almost 1000 years earlier, close to 5000 BC-I. The transition between the Chalcolithic and EB-I has also been pushed back by many hundreds of years to somewhere in the early to mid-4th millennium.12

This statement demonstrates that the most recent calibrated $^{14}$C data from the ancient Near East continues to push the prehistory of the region further back in time. Bruins supports this trend and goes on to suggest that $^{14}$C data should act as a corrective to early dynastic Egyptian history. In a paper presented to the American Schools of Oriental Research Bruins went over the recent publication of $^{14}$C dates from 170 samples from building materials associated with the pyramids (Bonani et al. 2001:1297). The samples related to the Great Pyramid of Cheops, sent to two different labs, resulted in 45 % of calibrated dates ranging from 2783-2715 with a 95.4 % probability (Bruins 2003). Since this remains 200-300 years higher than the modern dates of this ruler, Bruins suggested that the $^{14}$C dates be used as a corrective to Egyptian chronology and that Egyptologists should consider reverting to the chronology of Breasted proposed nearly a century ago.

In contrast, the present essay documents an increased caution among Egyptologists, Near Eastern archaeologists, and historians concerning the relative dates of the third millennium in Mesopotamia and Egypt. The revision proposed by Bruins ignores a century of scholarship and new data that has led to a significant decrease in the early dynastic history of Egypt during the past 40 years. This reduction points to the possibility that further refinements may yet come.

The dilemma between $^{14}$C dating and historically based chronology has not been resolved. But the more serious question that has not yet been adequately addressed is this: If $^{14}$C data remains imprecise and exceedingly high for the early historical periods and correlations fail where astronomical dates for verification exist, does this not cast serious
doubt as to their value for the prehistoric periods when “they deviate increasingly from actual calendar dates: from a 200-year error around 1000 B.C. up to a 900-year error around 5000 B.C.” (Knapp 1992:715)? This question is one that will need to be addressed in the continuing debate over the relationship between Near Eastern chronology and $^{14}$C dating.

ENDNOTES

1. The ultra-high chronology proposed by B. Landsberger (1954) has not gained much support (Hallo and Simpson 1971:103; Dever 1992:11). The difficulty is that this chronology does not correspond well with the evidence of reigns at Alalakh (Albright 1956) or with the current consensus of Hittite chronology (Astour 1989). Most importantly, it does not agree with any of the solutions required by the Venus Tablets. No solutions are said to be available between 1947 and 1848 (Rowton 1960: 98). Thus it has been pointed out by almost all involved in the discussion that this chronology is far too high to be considered possible (but see Mellaart 1979).

2. The high chronology was first suggested by D. Sidersky (1941) and continues to be supported and defended (Goetze 1951; 1957; Thureau-Dangin 1942; Huber et al. 1982; Huber 1987; Tuman 1987). Most recently Huber (1987) has made a convincing case for this position on the basis of statistical analysis. According to Huber, “If we assume that one of the four Venus chronologies is correct, the odds favoring the Long chronology over the other three are about 1000 to 1. If we drop the assumption that one of them is true, we can still assert that the long one is correct, with a probability of error below 1%” (1987:5). Tuman (1987) has also argued on the basis of astrological omens and lunar eclipses that the long chronology must be correct. Others have argued strongly against the high chronology (Rowton 1960; Kitchen 1987). The statement made by Tiglath-Pileser I that the temple of Anu and Adad, built by Shamshi-Adad, son of Ishme-Dagan, had become dilapidated after 641 years provides an important Distanzangabe. Figuring back from Tiglath-Pileser’s sixth year and adding 641 should result in the date of Shamshi-Adad’s first year (Na’aman 1984:117-118). The problem is that this does not correlate well with either the ultra-high or high chronologies (Rowton 1960:110; Na’aman 1984). Furthermore, Rowton has shown that the high chronology requires totals (of years) which on the generation count are far in excess of the average (1960:100-101). Nevertheless, the high chronology remains possible on the basis of the Venus Tablets and continues to be a viable option.

3. The Middle Chronology has the most supporters (Kugler 1912; S. Smith 1940; 1945; Rowton 1960; 1962; Porada et al. 1992; Schwarz and Weiss 1992). Some believe that the middle chronology is a convenient compromise or balance between two extremes (Mellaart 1979). However, such statements can be rather misleading. The majority of scholars who have written on the chronology of Mesopotamia have opted for this position (S. Smith 1940; 1945; Rowton 1960; 1962; Porada et al. 1965; 1992; Schwartz and Weiss 1992). There are valid reasons for choosing the middle chronology. The chronological statement by Tiglath-Pileser I supports it (Na’aman 1984:122). Some have argued that the negative evidence against other chronologies also need to be considered (Rowton 1960:110-111). Certainly it has valid support from the Venus Tablets and other synchronisms of the period, especially Egypt (Kitchen 1987).

4. The low chronology was first proposed by W. F. Albright (1942) and followed by others (Cornelius 1956; cf. Aström 1987; Dever 1992). Albright sought to revise the “apparently stabilized” (1942:28) Babylonian chronology on the basis of the Khorsabad King List which appeared in that same year (Poebel 1942). While previously defending
the then low chronology of S. Smith (1940), Albright saw the need to further lower the chronology based on the new list. He correlated the reigns of Asshur-uballit I of Assyria (dated by the Khorsabad King List to 1362-1327 B.C.) and Amenhotep IV of Egypt (1942:30). He thus dates the reign of Shamshi-Adad I about 1726 = 20 or ca. 1746 B.C. In an analysis of the Venus Tablets Albright descended another 275 years below Langdon, Fotheringham and Schoch (1928) and placed Hammurapi’s reign at 1728-1686 B.C. He used the usual correlations with Zimri-Lim of Mari (whom Hammurapi defeated in his 32nd year). He later defended the low chronology again, this time going to stratigraphic evidence from the archaeological excavations at Alalakh (Albright 1956). Stratum VI provided the key, according to Albright, since the ceramics from this stratum dated to 1550-1450. In Stratum VII texts were found corresponding to the reign of four kings. Albright assumed that they ruled about 20 years each since all were a direct line of descent (1956: 28). The pottery from Stratum VII dated to the reign of the last king of that dynasty of Alalakh (ca. 1640 B.C.). The middle chronology for Hammurapi (1792-1750 B.C.) would then be excluded because it would push the fall of Alalakh back to about 1700. According to Albright, this was impossible from the standpoint of pottery and seals found in Alalakh Strata VII. Recent studies of Hittite chronology (Astour 1989) and specifically studies on the chronology of Alalakh Stratum VII (McClellen 1989) indicate that the chronological sequence of Woolley’s initial excavations demonstrate certain inconsistencies. Goetze (1951) argues against Albright that the high chronology seems to fit best. Gurney (1974) claims that any of the proposed chronologies would be compatible with Hittite chronology although the middle chronology cannot be invalidated by any new data. In the most recent treatment on Hittite history, the chronological scheme followed fell “within the Middle to Low range” (Bryce 1998:414).

5. The ultra-low chronology has been defended most recently by Weidner (1945-51), though others have suggested it in the past (Böhl 1946). Weidner also produced his chronology shortly after the Khorsabad King List was published (Poebel 1942). Weidner (1945-51) did not have access to Cornelius or Albright’s low chronology at the time of his formulation, but he preferred later to let his dates remain unchanged. The ultra-low chronology seems to have no modern adherents. Nevertheless, unlike the ultra-high chronology, it does fit within the cycle of Venus making it a possible candidate.

6. In the early 1940s the Khorsabad Assyrian King List (Poebel 1942; Weidner 1945-51; Na’aman 1984) and the SDAS Assyrian King List (Gelb 1954) were published which established the contemporary regency of Hammurapi of Babylon and Shamshi-Adad I of Assyria. This forced a downward revision of the historically feasible dates. For the last four decades, the chronological dates seem to have centered on the following four possibilities for Ammisaduqa Year I: -1701 (Thureau-Dangin 1942; Goetze 1951; 1957), -1645 (Smith 1940, 1945; Rowton 1962), -1637, and -1581 (Albright 1956; Cornelius 1956).

7. Rowton (1960) first suggested that 14C dates from Nippur could aid in establishing a preferable chronology. He begins his argument by stating “Libby’s radio-carbon method can be used for relatively close dating when the sample has been put through an especially long run” (1960:97). Using two samples (charcoal and reed mat) from Nippur he begins by making a case for the middle chronology over against the ultra-high, high, and low chronologies. He is careful to use other historical arguments for his case, but refers to the 14C dates in support of his conclusion (1960:110-111). The dates are as follows: Hammurapi accession year = 1757+/-106 (Charcoal); Hammurapi accession year = 1581+/-133 (Reed mat). Rowton cannot be faulted for publishing insufficient data for his time, since he used the best data available. However, the 14C dates which he provides cannot be accepted uncritically for the following reasons: (1) the dates are uncalibrated and, therefore, once calibrated, would not correlate with a middle chronology; and (2) the dates, as they stand, vary significantly enough to allow for a middle, low, or ultra-low chronology. They do not exclusively support the middle chronology. Rowton recognizes this and uses other arguments to account for
the imprecision of the $^{14}$C dates. His main emphasis is to discredit the ultra-high and high chronologies. This seems well founded although the $^{14}$C dates are insufficient to stand alone.

8. Abbreviations: $^{14}$C = American Journal of Archaeology; $^{14}$C = Beycesultan; $^{14}$C = Radiocarbon.

9. Hassan and Robinson (1987) have provided the most recent contribution to the problem. Their study is primarily concerned with the chronology of ancient Egypt (1987:119-126), nevertheless, in their comparisons with Mesopotamian chronology they cite Mellaart with significant changes. They provide no new data for Mesopotamia. Their uncritical acceptance of Mellaart’s conclusions (1987:130) make their study suspect as well.

10. Other variations that fall between 3050 (Kemp 1989:14) and 2950 BC (Beckerath 1997:187) include: 3100/3000 (Kitchen 2000:48); 3000 BC (Murnane 1997:22).

11. For Egypt Weiner et al. (1995) state they are, “mistrustful.... $^{14}$C dating does not often match with historical dating.” Egyptologist J. Weinstein (1989:101; cf. 1980) notes the “incompatibility between...radiocarbon dates and the archaeologic/historic dates of Mesopotamia and Egypt” and submits that “For the Middle and Late Bronze age, Iron age, Persian, Hellenistic, Roman, and Byzantine periods, $^{14}$C dating has only limited value because the technique is less precise than the normally available archaeological and historic materials” (Weinstein 1984:297). For the Aegean and Cyprus, P. Åström submits that they “are not useful for exact dating” (1986:39). R. Merrillees, then director of the Cyprus American Archaeological Research Institute (CAARI), concludes blandly “radiocarbon dates are invoked if they support a particular hypothesis...and dismissed if they do not” (1992:51). These are serious scholars who recognize the inaccuracies and difficulties that still prevail after fifty-five years of refining the method.

12. The support for this increase in time by $^{14}$C dating is summarized by A. Joffe and J. P. Dessel (1995; cf. Gilead 1994; Bourke et al. 2001; Burton and Levy 2001).

REFERENCES


Lux 26:26-34.
Jahr Amenophis I. Studien zur Ältägyptischen Kultur 11:49-57.
of the Royal Society of London 269A:23.
Bierbrier ML. 1975. The Late New Kingdom in Egypt c. 1300-664 B.C. A genealogical
and chronological investigation. Warminster: Aris and Phillips.
Blocher H. 1984. In the beginning: the opening chapters of Genesis. Downer’s Grove, IL:
InterVarsity.
Böhl FMT. 1946. King Hammurabi of Babylon: and the setting of his time (about 1700 B.C.).
Amsterdam: Noord-Hollandsche uitgevers maatschappij.
des Morgenlandes 75:33-55.
Boese J, Wilhelm G. 1979. Assur-dan I, Ninurta-apil-ekur und die Mittelassyrische Chrono-
Radiocarbon 43:1297-1320.
Ghassulian Chalcolithic Period in the Southern Levant: new 14C determinations from
Braun E. 2001. Proto, Early Dynastic Egypt and Early Bronze I-II of the Southern Levant:
Brein G. 2000. Astrochronology and ancient Egyptian chronology (Absolute Chrono-
logy II). In: Bietak M, editor. The Synchronisation of Civilization in the Eastern
Mediterranean in the Second Millennium B.C. Proceedings of the International Sym-
posium at Schloß Haindorf, 15th-17th of November 1996 and at the Austrian Academy,
Vienna 11th - 12th of May 1998. Wien: Österreichischen Akademie der Wissenschaften,
p 53-56.
Brinkman JA. 1964. Mesopotamian chronology of the Historical Period. In: Oppen-


the Occasion of his 65th Birthday. Istanbul: Nederlands Historisch-Archaeologisch Instituut, p 105-111.


Simpson WK. 1972. A tomb chapel relief of the reign of Amunemhet III and some observations on the length of the reign of Sesostris III. Chronique d’Égypte 93/94:45-54.


BIOGEOGRAPHY: FROGS LINK SEYCHELLES WITH INDIA


**Summary.** A new species of frog discovered in western India represents a previously unknown family of burrowing frogs. Based on DNA sequence comparisons, the new family, Nasikabatrachidae, is most closely related to the Sooglossidae of the Seychelles Islands. However, the two groups of frogs are quite distinct genetically.

**Comment.** Geologic evidence links India with Madagascar and the Seychelles during the Mesozoic. This discovery is consistent with the idea that India and the Seychelles were once linked, although there is no fossil evidence to test the idea. However, the biogeography of India presents many anomalies. The fossil record of India shares as many or more families of land vertebrates with the northern continents than with the southern continents. This is true even for sediments deposited when India was supposedly attached to the southern continent of Gondwana and separated from the northern Laurasian continent. The paleobiogeography of India remains enigmatic.

BIRD PHYLOGENY: FEWER MOAS


**Summary.** Moas were large ostrich-like birds that lived in New Zealand, becoming extinct several hundred years ago. The number of species that actually lived in New Zealand has been a question of interest. The first describers of moa skeletons named at least 64 species in about 20 genera. Over the past 25 years, the number of species has been reduced to 11, on the basis that moas were sexually dimorphic and highly variable in size. Nuclear DNA recovered from moa bones indicates that the three “species” in the genus *Dinornis* actually repre-
sent only two groups, one from the North Island and one from the South. This further reduces the number of moa species by one species, and suggests the possibility that further reduction might be justified.

**Comment.** Moas may have been more highly variable morphologically than modern bird species. To what extent this tendency applies to the rest of the fossil record remains unknown. Another problem is the tendency among paleontologists to give a separate name to specimens that are only slightly different, especially if they are found at different fossil localities. Both these points show the need for caution in interpreting patterns of evolutionary relationships based only on skeletal material.

**BIRD PHYLOGENY: WHERE DOES THE HOATZIN FIT?**


**Summary.** The hoatzin is a South American bird with unique traits that make it difficult to classify. Previous reports have allied the hoatzin with cuckoos, pheasants, or turacos. Comparisons of nuclear DNA rule out any relationship with pheasants, and make highly unlikely any relationship with pheasants or cuckoos. Some weak support was discovered for relationship with falcons or doves, but the hoatzin appears not to have any identified close relatives. Previous reports of hoatzin affinities with turacos were based on sequences of mitochondrial DNA with numerous errors.

**Comment.** The hoatzin is a bird of enigmatic affinities, restricted to South America, and without known fossil ancestors. The significance of the previous identification as a turaco was commented on in Origins 52:42.

**CREATION AND “MAGIC BULLETS”**


**Summary.** Creationists have a history of uncritical acceptance of claims that tend to support creation. Several of these spurious claims have been refuted by creation scientists, much to the dismay of the
laity. Creationists should be eager to learn which arguments are sound and which are not, but too many seem eager to find some “magic bullet” that will prove creation and refute evolution once and for all. This is not likely to happen, and is not even necessary. We will never have all the answers, and it is more important to know the limitations of our knowledge than to be able to out-debate someone with views different from our own. Everyone has the same evidence available to him; creationists must learn to interpret the evidence within the Biblical view of earth history.

**Comment.** This is a refreshing statement that should be thoughtfully read by all creationists. If put into practice, the result would surely be an advance in our collective understanding, and an increase in respect among those with whom we disagree.

**DESIGN: IRREDUCIBLY COMPLEX CONVERGENCE**


**Summary.** The cuticle or exoskeleton of arthropods is composed of a polysaccharide, chitin, complexed with proteins and lipids. This material is notable for its low adhesion to surfaces and yet many arthropods are capable of walking on smooth vertical surfaces like glass windows or painted walls. In at least some insects, the ability to attach to smooth surfaces is known to be mediated by an oily fluid. In these two almost identical papers, Kesel et al. show that a different mechanism involving van der Waal’s forces is used by the jumping spider *Evarcha arcuata*. Thousands of tiny fibers, setule, on the feet of these spiders interact with surfaces they contact taking advantage of the weak intermolecular van der Waals’ force. Added together, the estimated 624,000 setule on each jumping spider have the potential to exert a force sufficient to hold 160-173 times the mass of *E. arcuata*.

**Comment.** Geckos are known to use a system for attachment almost identical to that reported for spiders by Kesel et al. In their words, “The attachment systems of spiders and geckoes show astounding similarities.” This is remarkable given the profoundly differ-
ent surface materials found on arthropods and reptiles: chitin and keratin respectively. Presumably, arriving at these similar solutions to the problem of attachment would require very different genetic, developmental and biochemical mechanisms given the profound differences between arthropods and vertebrates.

Explaining morphological similarities in the feet of geckos and jumping spiders as a dramatic example of convergent evolution seems implausible given the mechanism by which attachment occurs in both taxa. The problem is that van der Waals’ forces only act over very short distances. In addition, they are relatively weak. To take advantage of these forces requires both very small hairs and a large number of them. No gradualistic path to what is seen in jumping spider and gecko feet is evident, as gradual reduction in hair size on feet will achieve nothing until size falls below a very small threshold. In addition, even given small hairs already present on the feet, they must exhibit appropriate mechanical properties including elasticity and flexibility to allow efficient surface contact. If they are to achieve sufficient force to hold spiders or geckos on smooth surfaces these hairs must be present at very high densities.

Perhaps it could be argued that a few small hairs on the feet could increase traction with more producing greater traction. Thus natural selection could select for those individuals with more hairs on their feet. This scenario relies on some chance process to produce the very small hairs in the first place and assumes that fewer larger hairs would not be a superior solution to the traction problem. In addition, traction generated using this mechanism has the disadvantage of requiring significant force to detach feet from a surface, something presumably achieved via a modification in how feet are peeled off a surface. Thus the cost of having “sticky feet” that are not sticky enough to allow climbing on smooth surfaces may outweigh the advantages.

Use of tiny hairs to take advantage of van der Waals’ forces when attaching to smooth surfaces appears to be a complex yet elegant solution to a difficult problem. This solution can logically and reasonably be explained within the context of intelligent causes, but presents difficulties when invoking chance modifications coupled with natural selection. The fact that this mechanism is now known in two very different taxa compounds this problem, as no obvious common ancestor could have provided this engineering solution as a genetic heritage and thus it must have evolved multiple times. On the other
hand, an Intelligent Designer would be free to employ the same solution in multiple organisms. (TS)

ENDNOTES


GENE DUPLICATION AND PROTEIN EVOLUTION


Summary. A common explanation for the origin of new genes involves duplication of an already functional gene followed by modification of one copy to produce a novel function. Behe and Snoke examine this concept using mathematical modeling and published rates of gene duplication and mutation. Their model assumes the simplest route to production of new gene function: a duplicated gene free from purifying selection and subject to point mutation, but not recombination. In addition, they consider a biologically relevant number of modifications that must be made in the gene to create a novel function. Because the minimum number of changes necessary for most new functions appears to be greater than one altered amino acid and the number of changes needed in DNA for each altered amino acid varies between 1 and 3, making definitive estimates is difficult, but any reasonable estimate is useful when evaluating the validity of the duplication-mutation model; especially given its widespread acceptance.

Behe and Snoke show that, given liberal estimates, fixation of features requiring changes in multiple residues requires population sizes and numbers of generations that “seem prohibitive.” They thus conclude that gene duplication coupled with point mutations does not appear to be a promising mechanism for producing novel functions in proteins that require more than a single point mutation.
Comment. This paper does not exclude the possibility that other more complex mechanisms involving larger mutations and/or selection of intermediate states acting on duplicated genes may serve as engines of new gene production. The problem is that these other mechanisms appear to be even more complex and thus less probable than the conceptually simple duplication-point mutation model Behe and Snoke examined. While their paper suggests that other potential mechanisms should be rigorously examined before discarding gene duplication and modification as a potential mechanism of evolution, it clearly demonstrates that even the most superficially reasonable sounding Darwinian mechanisms should be carefully evaluated before they are accepted as truly reasonable. (TS)

ECOLOGY: SNAILS REJECT BERGMAN’S RULE


Summary. Body sizes of land snail species in northwestern Europe are generally larger in lower latitudes and smaller in higher latitudes. This is the opposite of the relationship observed in many birds and mammals and summarized in Bergman’s Rule. Bergman’s rule states that species tend to be larger at higher latitudes; a similar pattern has also been noted with higher elevation. No pattern of species size was observed in the Alps, but individuals within a species tended to be smaller at high elevations. The reason for the smaller species in northern latitudes seems to be that the northern snails are generally from families with small body size, while southern snails are largely from families with larger body size. When the effects of phylogeny are removed, no pattern is discernable in body sizes of land snail species.

Comment. Ecological “rules” that apply to some taxonomic groups may not apply to other groups. Differences in body size of European land snails may reflect historical factors such as the body size of the first colonist, rather than due to natural selection acting in parallel ways in independent lineages.
GENE DUPLICATION: A SOURCE OF NEW INFORMATION?


**Summary.** Gene duplication and subsequent divergence is thought to be the source of new genetic information needed for increasing complexity during evolution. Duplication of genetic material was observed as long ago as 1936. The proportion of duplicated genes in an organism’s genome is estimated to range from 17% in certain bacteria to 65% in the plant, Arabidopsis. This is probably an underestimate, because many purported gene duplicates have diverged so much that the sequences no longer appear similar. Gene divergence occurs through random mutation, and the longer two gene sequences have been isolated, the greater the differences in sequence. One gene copy may remain functional, while the other copy accumulates mutations freely. Many duplicated genes become degenerate, non-functional pseudogenes, although some pseudogenes may have a function. Pseudogenes are abundant — mammals have one pseudogene for about every two functional genes. Some gene copies may remain functional and diverge very little. Still other duplicated genes may lose part of their function and become specialized, such as being expressed in different tissues. In rare cases, a new function may evolve, as in the case of the douc langur monkey. This monkey has two copies of a gene for an RNA-degrading enzyme, while other monkeys have only one copy. The extra copy aids the langur digest its specialized diet of leaves. Positive natural selection is thought to be an important factor in creating new gene functions for duplicated genes. Duplicated genes may help provide functional redundancy, which protects organisms against the potentially harmful effects of gene degeneration.

**Comment.** Genes may become duplicated, but it is not so clear that new functions may arise for gene copies. If most genes have been subject to natural selection so that they are functioning efficiently, it is easy to suppose that random mutations accumulating in a redundant gene copy would tend to reduce the functional efficiency, and would be selected against. This would prevent a new function from evolving. If the duplicate copy could mutate free of selection, it seems far more likely to become a non-functioning pseudogene. The chances of a duplicated gene somehow accidentally acquiring a new
function without disrupting other gene interactions seem remote indeed. The high incidence of pseudogenes, and the tendency of genetic systems to degenerate in the absence of natural selection, cast serious doubts on claims that gene duplication serves as the source of new genetic information.

**GEOLOGY: DEEP-WATER LAGERSTÄTTEN ONLY IN THE CAMBRIAN?**


**Summary.** Fossil localities with exceptional preservation of soft-tissued organisms (Konservat-Lagerstätten) are over-represented in the Cambrian and Jurassic. The high incidence of Konservat-Lagerstätten in the Cambrian seems to be associated with a relatively low incidence of deep bioturbation. Cambrian sediments have similar numbers of types of fossil traces, compared to other Paleozoic sediments, but have relatively low levels of traces left by active feeders. Cambrian Konservat-Lagerstätten are mostly found in sediments interpreted as deep water, and their over-representation in the fossil record may be due to a reduced number of active feeders in Cambrian fossil communities.

**Comment.** There may be a pattern in the sequence of depositional environments in which exceptional faunas (Konservat-Lagerstätten) are preserved in the fossil record. Cambrian examples are mostly from sediments interpreted as deep water slope or basins; Upper Paleozoic and Triassic examples are mostly from sediments interpreted as broad coastal delta plains; Jurassic examples are mostly from sediments interpreted as restricted, oxygen-deficient marine basins (Allison and Briggs, *Geology* 21:527-530). These interpretations should be taken into consideration by those working to model the flood. The abundance of Cambrian lagerstätten may suggest they formed during the onset of the Genesis flood, and that this event might have begun as a deep-water catastrophe.
GEOLOGY: DEVONIAN MASS-EXTINCTION LINKED TO IMPACT


**Summary.** Evidence of a mid-Devonian extraterrestrial impact has been discovered in the Anti Atlas desert of Morocco. The evidence includes shocked quartz, anomalous concentrations of heavy metals, a large negative carbon isotope shift, and microspherules. This discovery is of special interest because it coincides with a global mass extinction that may have destroyed up to 40% of genera of marine animals.

**Comment.** No known impact crater is associated with this stratigraphic level. Despite the success of the end-Cretaceous impact hypothesis, scientists have not yet successfully linked any other mass extinction to an extraterrestrial impact. The causes of mass extinctions are still not well understood.

GEOLOGY: METEORITE FRAGMENTS AT THE P/T BOUNDARY


**Summary.** The greatest and most dramatic change in fossil content occurs at the transition of the Upper Permian and Lower Triassic. Much speculation has transpired concerning the cause of the greatest of the “mass extinctions,” with recent discussion focusing on the possibility of an extraterrestrial impact. This possibility is strengthened with the discovery reported here, of dozens of meteorite fragments in end-Permian sediments at the base of the Fremouw Formation at Graphite Peak in Antarctica. Associated geochemical evidence, along with shocked quartz also suggests an extraterrestrial impact. Metal grains are present, similar to those found in end-Permian sediments in China and Japan. However, the lack of a suitable impact crater at the appropriate stratigraphic level causes many scientists to remain skeptical. More evidence is needed to settle the question of the cause of the end-Permian extinction.
Comment. Abrupt changes in fossil content and abundance at certain points in the fossil record are difficult to explain. The usual term, “mass extinction” is descriptive, but not explanatory. One or more catastrophic events seems indicated, but it is difficult to determine what process could destroy so many entire species and higher taxa yet leave the diversity of survivors seen in the succeeding layers. Perhaps the fossil record is not composed of a series of independent events over long ages, but is somehow tied together in a complex catastrophic process that is not yet understood.

GEOLOGY: MOVING HOTSPOTS IN THE PACIFIC


Summary. The Hawaiian Islands form a chain that extends through the Emperor Seamounts, ending near the Kamchatka Peninsula and producing one of the most famous topographical features of the Pacific Ocean. The islands are arranged in two straight lines, subequal in length, that meet at an angle. It has long been held that hotspots are mantle upwellings that are geographically fixed, which implies that the angle between the two island chains was formed by rapid rotation of the Pacific Plate. However, it now appears that the angle is due to movement of the hotspot rather than movement of the Pacific Plate. Rocks cored from some of the Emperor Seamounts produce paleo-latitudinal measurements that indicate they were much farther north than the present-day location of the Hawaiian hotspot. If confirmed, this discovery will change our interpretation of mantle dynamics and plate motions. It may indicate that the earth’s rotation has been relatively stable, and that estimates of large amounts of true polar wander are incorrect.

Comment. It has been difficult to model how the Pacific Plate could change direction so suddenly. This problem is now replaced with the problem of understanding how a mantle upwelling could maintain a constant direction, then suddenly change direction and
maintain that direction. Perhaps there is some mechanism yet to be discovered to account for these islands chains.

GEOLOGY: TRENDS IN CARBONATES


Summary. Carbonate deposits in shallow marine water are known as carbonate platforms. A survey of carbonate platform characteristics through the geologic column reveals a number of trends (carbonate reefs are excluded from this study). Trends include an increase in the range of inferred paleolatitude and a decrease in the relative cover of equatorial shelves. Paleozoic carbonate platforms were generally much larger than those of the Mesozoic and Cenozoic. Platform composition also changes through the geologic column. Microbial and peloidal carbonates generally decline from the Cambrian to the present. Foraminifera became important constituents of carbonate platforms in the Carboniferous, and contributed variably upward through the sedimentary column. Echinoderms are important contributors to carbonate platforms from the mid-Paleozoic to the mid-Mesozoic, being mostly replaced by molluscs in the Upper Mesozoic and Cenozoic. Mass extinctions seem to have no predictable effect on development of carbonate platforms.

Comment. Global flood models need to account for trends in geochemical patterns and accumulation of sediments in addition to the ecological successions. Development of a global model of earth history will be facilitated by extensive data bases such as represented here.

HUMAN ANCESTRY: MITOCHONDRIAL EVE IN DOUBT


Summary. Human mitochondrial DNA (mtDNA) was once thought to be exclusively maternally inherited and thus not subject to recombination. This assumption was called into question by Adwadalla et al.1 on the basis of apparent linkage disequilibrium evident in human and ape mtDNA. In an earlier paper Schwartz and Vissing reported
on a human with paternally inherited as well as maternally inherited mitochondria. In this paper Kraytsberg et al. build off the earlier Schwarts and Vissing paper and demonstrate that mtDNA in this individual with a mixed population of maternal and paternal mitochondria experienced a high rate of recombination. In addition they were able to show that sites of recombination are concentrated in certain “hotspots” within the mitochondrial genome.

Comment. In 1987 Cann, Stoneking and Wilson created a storm of controversy after proposing that, on the basis of mtDNA all humans can be traced back to a single woman, “Mitochondrial Eve,” who lived in Africa about 200,000 years ago. Much of the controversy revolved around how their data were analyzed, but little criticism seems to have focused on the assumptions of maternal inheritance and lack of recombination in mtDNA. While biblical creationists took some comfort in the idea that science has shown that we all share a common female ancestor, they were not pleased with the date placed on “Mitochondrial Eve.” Interestingly, paleoanthropologists were equally discomforted over the dating of “Mitochondrial Eve” but for them the problem was that she was not old enough as they claimed that the last human common ancestor must have lived on the order of 1,000,000 years ago. In addition, the human evolution camp was split into two factions, one that believed humans arose from multiple origins and another that believed humans arose from a single source in Africa. Those who believed in multiple origins did not take lightly the news that molecular data supported the “out of Africa” theory.

Since publication of the Cann, Stoneking and Wilson paper, controversy has raged about the very concept that mitochondrial Eve, a single human female ancestor, could exist. What Kraytsberg et al. have shown is that much of this controversy was predicated on faulty assumptions. A careful reading of the original Cann, Stoneking and Wilson paper shows that the assumption of maternal inheritance was based on work done with cows, not humans. Kraytsberg et al. have dealt the final blow to the second assumption, that there is no genetic recombination in human mtDNA. This calls into question all papers reporting research done under this faulty assumption and serves as a cautionary tale for those who were once overly impressed by the weight of molecular data in informing human history. (TS)
ENDNOTES


HUMAN ANCESTRY: MOST RECENT COMMON ANCESTOR


Summary. The number of ancestors of all living people increases at a rate of $2^n$ with each preceding generation where $n$ represents the number of generations. Thus each individual has 2 parents, 4 grandparents, 8 great grandparents and so on. A similar phenomenon applies to the descendents of each generation although it is harder to model as the number of offspring from any union is difficult to predict. Given the exponential rate at which ancestors increase, if one goes back enough generations, the number of ancestors they have will approximately equal the number of living people at that time. In reality, however, there are complicating factors among which non-random mating between groups figures highly. Rhode et al. show that even given reasonable assumptions and correction for what is known about the history of human populations, the most recent common ancestor (MRCA) of all humans most probably lived in the relatively recent past and quite possibly since the time of Christ.

A differentiation is made between the most recent common genealogical ancestor of all humans and the most recent time in which all currently living people have exactly the same set of ancestors; the identical ancestors (IA) point. This IA point is more ancient than the time of the MRCA, but still surprisingly recent according to the model of Rhode et al. who suggest dates substantially lower than 6,000 years and possibly as recent as 2,158 BC.
**Comment.** It is possible to misinterpret the results of this paper as showing the Biblical Adam and Eve, or Noah and his wife, sons and daughters in law lived in the recent past. This is not what this paper is saying. However, Rhode et al. do show the feasibility of recent common ancestry of all humans and suggests a tighter genealogical link between all people than previously supposed. (TS)

**MOLECULAR EVOLUTION: FALSE PSEUDOGENE**


**Summary.** Studies of abnormalities associated with a gene trans-plant led to the discovery that a pseudogene functions in regulating its functional counterpart. The gene Makarin1 is found on mouse chromosome 6, and is thought to encode an RNA binding protein. It has a pseudogene, named Makorin1-p1, on chromosome 5. A “sex-lethal” *Drosophila* gene was randomly inserted into the mouse DNA, in one case inserting into the pseudogene, resulting in developmental abnormalities. Detailed study revealed that only the paternal pseudogene is expressed as RNA, and that it functions to stabilize the Makarin1 protein. Thus, disruption of the pseudogene reduced expression of the functional gene, resulting in the abnormalities. Thus, both the functional gene and the pseudogene are necessary for normal development, and neither gene can function without the other. This is the first time a pseudogene function has been identified. The number of human pseudogenes (about 20,000) is quite large compared to the number of functional genes (about 30,000 to 50,000). This research suggests the possibility that a role in gene regulation may be a common feature of pseudogenes.

**Comment.** It would be ironic if pseudogenes, which have been claimed as evidence against design, should turn out to suggest further evidence in favor of design by providing another layer of complexity in gene regulation. However, there are different classes of pseudogenes, and it should not be assumed that this research implies all pseudogenes have a function. Degeneration is implicit in creation theory, and it should not be surprising if genes have degenerated.
This research should remind us to be cautious in accepting scientific claims, especially when tempted to extrapolate beyond the data.

**MOLECULAR EVOLUTION: MUTATION RATES AND STRESS**


**Summary.** Different strains of bacteria differ in their mutation rates. When nutrient supply is limited in culture, natural selection favors those strains with elevated mutation rates. Bacterial colonies allowed to reach starvation showed a mutation rate increased ten to 100 times over the typical rate. The explanation seems to be a decrease in activity of the mismatch repair system, allowing an increase in the number of mutations. Stress-induced mutations may provide greater genetic variation, increasing the probability that a favorable mutation will occur and increase the survival chances of the population.

**Comment.** Increased mutation rate would provide more genetic variation for natural selection, and might increase the possibility of useful mutation. However, if the mutation rate goes too high, an error catastrophe could ensue, causing the population to crash. This could favor bacteria that have the capacity to increase their mutation rates during stress, but normally keep their mutation rates low. Increases in mutation rates due to stress have been reported from other organisms as well, suggesting that genetic variability might be higher than average during stressful conditions such as might follow a catastrophe. This effect might help explain the rapid rate of variation and speciation that seems to have occurred after the Genesis flood.

**MOLECULAR EVOLUTION: NATURAL SELECTION TOWARD EXTINCTION?**


**Summary.** Bacteria grown in culture bottles diversified into three types in a nutrient-rich medium. The three types were spatially separated and considered to be specialized with respect to the
generalized ancestral type. A total of six sequential cultures were prepared, selecting one of the specialist types in each case, and the ending culture was tested for its response to the nutrient-rich culture bottle as in the beginning. The final cultures were able to out-compete the ancestral type, showing they had increased in fitness. However, the number of different genotypes decreased as the experiment progressed, showing a genetic loss of ability to diversify. It seems that specialization came at the expense of variability.

**Comment.** This seems to support the suggestion of some creationists that natural selection may improve fitness for specific environments, but does so at the loss of genetic flexibility. This may be due to loss of certain alleles that have lowered value in the specified environment, resulting in a purifying selection. It does not require, or even suggest, that new genetic information has been produced.

**PALEONTOLOGY: CHINESE FLYING DRAGON**


**Summary.** A fossil dinosaur with four wings was discovered in Liaoning Province, China. The fossil, named *Microraptor*, is classified in the family Dromaeosauridae, and was found in the lower Cretaceous Jiufotang Formation. The skull is in poor condition, but the organism may have been a predator. It appears to have had feathers not only on the forelimbs, but also along the hindlimbs and tail, giving the appearance of a four-winged, gliding dinosaur. This is interpreted as a possible evolutionary stage in the development of flight in birds.

**Comment.** This remarkable fossil gives evidence of a rich biodiversity that has no modern survivors. *Confuciusornis*, a true bird with modern feathers, a pair of wings, and overall avian characteristics, is found in the same geological formation. The four-winged fossils, as noted in a commentary in *Science* 299:491, are not ancestral to modern birds.
PALEONTOLOGY: DIVERSITY TRENDS


Summary. Experience with living species indicates that rare species are more likely to suffer extinction than are abundant species. Not much attention has been given to the question of whether this relationship holds in the fossil record. This paper reports on a study of more than 100 subgenera of end-Cretaceous (Maastrichtian) bivalves, with the conclusion that abundant subgenera were just as likely to go extinct as rare subgenera. Neither body size nor feeding mode could be shown to affect survival probability. Survival through a mass extinction must be controlled by factors other than the factors controlling survival in more ordinary times.

Comment. The lack of relationship between abundance and survival seems counter-intuitive, and adds to the enigma of mass extinctions. Whatever physical process that resulted in fossilization and extinction of these taxa must have been global and catastrophic.

PALEONTOLOGY: DIVERSITY TRENDS AND PULL OF THE RECENT


Summary. The number of fossil genera generally trends upward through the geologic column, dramatically so through the Cenozoic. One explanation for the increase in numbers of genera is that counts of fossil genera from the upper part of the record are inflated by knowledge of living species that are missing from the incomplete fossil record. This explanation is known as the “Pull of the Recent.” However, a study of Pliocene and Pleistocene fossil bivalves revealed that 95% of living genera and subgenera have a fossil record in the Pliocene or Pleistocene. Thus the Pull of the Recent can account for no more than 5% of the trend toward increasing diversity through the Cenozoic. The increase in diversity appears to be real.

Comment. Bivalves are well studied, both in the fossil record and in modern environments. Thus, this study serves as a good
indicator of the reliability of the fossil record for durably skeletonized taxa. It also is a reminder that biodiversity patterns in the fossil record can be no more accurate than the taxonomy on which they are based.

PALEONTOLOGY: FEATHERED THEROPODS


Summary. In 1865 Hitchcock described fossil footprints with associated impressions from the Lower Jurassic Turners Falls Formation of Massachusetts. In this paper Martin Kundrát reexamines these trace fossils (ichnias) and concludes that the impressions associated with the footprints were made by feathers on the abdomen of a theropod dinosaur. These “feathers” were filamentous structures distributed along pteryla (feather tracts) in the same way that feathers are distributed on the bodies of many modern birds. Much of Kundrát’s argument relies on extrapolation from the appearance of feathers on modern emus and ostriches just prior to hatching.

Comment. Given recent evidence of an “explosion” of birds in the Upper Jurassic and Lower Cretaceous, any evidence of earlier bird-like features, and especially feathers, is of interest. Unfortunately, Kundrát’s argument follows a torturous path. To demonstrate that the organism that made the impression was a theropod requires him to “partly correct” at least one of his previous observations about this fossil. Further complicating the argument, he contradicts another author’s published observation and invokes wet feathers in the absence of rain. In addition, the organism seems to have adopted a hard to imagine position in which most of it’s weight rested on one side, the torso was raised off the ground and so was the tail. He also relies so strongly on evidence from the pre-hatched chicks of ostriches and emus that he runs dangerously close to invoking the “ontogeny recapitulates phylogeny” fallacy.

Kundrát appeals to Prum’s evolutionary scenario for feathers in which the second stage produces a simple tuft. These tufts then would be the “feathers” that produced the impressions visible on this fossil. If Kundrát’s interpretation is correct, it does seem remarkable that modern looking pteryla would be present along with “proto” feathers.
Given the convoluted nature of the argument made in this paper, these fossils do not appear to be particularly strong evidence in support of either Prum’s scenario or of the early evolution of feathers. If Kundrát’s interpretation is correct, it presents a problem in the timing of feather evolution; the earlier feathers of any type appear, the greater the difficulty in explaining their origin given the reduced time available for their evolution. On the other hand, evolving feathers earlier does allow time for the specialization of feathers found on fossil birds in the Upper Jurassic and Lower Cretaceous. (TS)

ENDNOTES

3. Gierlinski G. 1997. What type of feathers could nonavian dinosaurs have, according to an Early Jurassic ichnological evidence from Massachusetts? Przeglad Geologiczny 45:419-422.

PALEONTOLOGY: SPECIALIZED INTERMEDIATES


Summary. *Ichthyostega* is an amphibian-like vertebrate with some features intermediate between fish and terrestrial vertebrates. The morphology of its ear region has been very difficult to interpret. Computer-assisted tomography (CAT scan) of new fossil material has revealed a highly specialized ear unlike that of either the fish or the tetrapods which it was thought to link evolutionarily. Gill bars indicate that *Ichthyostega* was primarily aquatic rather than terrestrial.

Comment. Distinct specializations that are not transitional between purported evolutionary ancestors and descendants disqualify *Ichthyostega* as a evolutionary link. Proposed evolutionary links are frequently either derived with respect to their supposed descendants, or simply divergent rather than ancestral.
PHYLOGENETICS: EVOLUTIONARY TREE REPLACED BY NET?


**Summary.** Phylogenetic (evolutionary) trees are typically based on sequence comparisons of nucleotides or amino acids. Ribosomal RNA (rRNA) has probably been the most popular molecule for estimating phylogenetic trees, in part because it is relatively easy to sequence. However, trees based on different genes or proteins often produce conflicting trees. The advent of comparative genomics has added a new layer of complexity to the effort to produce phylogenetic trees, and has raised new questions about the reliability of phylogenies based on rRNA. Comparative genomics has indicated extensive lateral gene transfer and selective gene loss, particularly among prokaryotes. An extensive study of 28 protein families concluded that there was no reliable phylogenetic signal present after probable horizontal transfers were removed from the data set. Comparative genomics seems to produce consistent results when comparing closely related species, and consistently separates the major kingdoms of organisms, but seems difficult to interpret when comparing species with intermediate differences. The simple notion of a single Tree of Life that accurately portrays the evolutionary relationships of all species is probably “gone forever.”

**Comment.** Construction of a single tree of life is the holy grail of evolutionary biology. Many types of data have been applied in efforts to construct such a tree, along with increasingly sophisticated methodology. Amino acid sequences, chromosomal banding patterns, DNA sequences, and now complete genome sequences have all been utilized, but the results remain contradictory and frustrating. It is interesting to note that consistent results are obtained with closely related species, but not at higher taxonomic categories. Perhaps this reflects reality — there is not a single tree, but a forest of trees representing multiple independent lineages, each of which has diversified within limits. The latter pattern would fit a model that includes an initial creation, with subsequent diversification.
**PHYLOGENETICS: MANY GENES BETTER THAN ONE**


**Summary.** Gene sequences are often used to estimate the phylogeny of a group of species. Such studies are commonly plagued by conflicting phylogenies based on different genes. This problem was addressed by selecting 106 genes to develop a phylogeny for seven species of yeasts in the genus *Saccharomyces*. Results showed that phylogenies based on single genes were often in conflict, and there was no way to predict which genes would give more acceptable results. When all 106 genes were concatenated and analyzed, a single phylogenetic tree was recovered, which was the same using three different analytical methods. Further analysis revealed that consistent results could be obtained from concatenation of only twenty genes. This result should be tested in other groups of organisms.

**Comment.** Phylogenetic incongruence is well-known. This study involved a group of species in a single genus, and a common ancestry seems highly probable. However, it is difficult to be certain whether the phylogenetic tree recovered is the true tree. This might be expected if the group diversified rapidly from a single ancestral species, rather than sequentially and gradually. It would be interesting to test the hypothesis that species with independent ancestries might exhibit such a high level of incongruence among different gene phylogenies that no clear result could be obtained by concatenating the sequences.

**POPULATION GENETICS OF MICE**


**Summary.** The title of this article is misleading in that mitochondrial DNA in the mice studied, *Peromyscus leucopus*, has not been documented to change. What has been documented is a change in frequency of three mitochondrial DNA haplotypes in populations of mice in the Chicago area. These three haplotypes — M, Mw and A — represent slightly different ways of coding for the same protein, cytochrome oxidase II. The protein products of the gene remain identical because different, but synonymous, codons are used.
**Comment.** While data presented in this paper demonstrate that mitochondrial haplotypes may alter in frequency over the course of a century, why this might happen is left to speculation. The authors suggest that the M haplotype may provide an advantage in an environment that has experienced rapid human population growth. This may or may not be reasonable, but no mechanism by which this might happen is proposed. If changes in this particular mitochondrial DNA gene produced polymorphic proteins, selection would appear to be a reasonable explanation. But for selection to work in this case, differences in mitochondrial DNA sequences would be required to have a direct impact on fitness.

Rapid changes in mitochondrial haplotype frequencies reported in this paper do not document an evolutionary change in *Peromyscus* mitochondria in the sense that the DNA itself changed producing an increase in fitness. All haplotypes were present in specimens collected in both older and more recent groups, although the Mw haplotype occurred at low frequency in both groups. Thus, no new genetic information was generated, but variation already present in *Peromyscus* populations appears to have changed in frequency. Selection may be a reasonable explanation if a mechanism can be proposed for DNA sequences to directly impact fitness. Absent this mechanism, other explanations, including bottleneck effects, founder effects, emigration and immigration may appear equally valid. One tempting alternative explanation may be chance association of the more successful M haplotype with a particularly fit female. Because mitochondria in mammals appear to be inherited maternally, the M haplotype may have ridden along with a particularly advantageous set of nuclear alleles. (TS)

**ENDNOTE**

1. See the annotation under Human Ancestry for evidence against this assumption.
LITERATURE REVIEWS

Readers are invited to submit reviews of current literature relating to origins. Please submit contributions to: ORIGINS, Geoscience Research Institute, 11060 Campus St., Loma Linda, California 92350 USA. The Institute does not distribute the publications reviewed; please contact the publisher directly.

FOLLOW THE EVIDENCE


Reviewed by Henry Zuill

Denyse O’Leary writes professionally about science, religion, and faith, and yet she admits she had no clear convictions on Darwinism and Intelligent Design (ID) before writing By Design or By Chance? Having completed this book, she now describes herself as “post-Darwinian.” While accepting change over time, she finds Darwinism to be an inadequate explanation.

While working on By Design or by Chance?, O’Leary discovered gaps in what many see as rock-solid evidence supporting evolution. Moreover, she accuses Darwinists of unscientific misbehavior. She especially puts ultra-Darwinist Richard Dawkins under the gun for his extreme rhetoric (p 238). While she found evidence for design compelling, she was clearly unimpressed upon discovering Darwinists engaging in the very transgressions of which they accuse creationists.

O’Leary’s writing is engaging and well crafted, rich with well-chosen words that cleanly and cleverly present twists and turns in the history of ideas about origins. For example, she recounts the story of Darwin’s Bulldog, Thomas Huxley, who excitedly and mistakenly concluded that deep-sea ooze was somewhere between non-living and living (p 41-42). She tersely writes, “So, for the first time in history, Darwin’s colleagues had solved the mystery of life. As it turns out, for the last time, too.”

By Design Or By Chance is not highly technical while at the same time avoiding inaccuracies inherent in oversimplification. It fills an
important niche, making information delightfully available to non-
experts — and “experts” as well. Definitions, time lines, and salient
quotations in sidebars and boxes, along with copious endnotes and a
thorough index, are helpful, particularly for interested, but otherwise
uninitiated, readers. The “Afterword” is especially valuable, bringing
O’Leary’s argument and new direction of thinking into succinct focus.
It appears she has tried very hard to be fair and balanced, and from this
upright stance, in the end, she gives the nod to design. Readers may not
always agree in every way with what they read, but they cannot fault
her integrity.

O’Leary chronicles the modern design movement, logically be-


ingin with cosmology; clearly laying out evidence suggesting the

“Big Bang,” explaining the discovery of, and controversy over the

Anthropic Principle and the Rare Earth concept. Then comes over-

whelming biochemical complexity in cells — unanticipated by the early

Darwinists (this misunderstanding was at the heart of Huxley’s blunder

over deep-sea ooze) — leading to the recent revolutionary ID movement.
She notes that life is chemistry and physics, but most importantly in-

formation (p 53) — and, it seems, this information extends beyond
genesis. Most biologists are only beginning to grasp the implications of
this idea.

O’Leary tackles theological questions about ID in Chapter 15: “Is
ID Good Theology? Is It Theology At All?” ID is different from its
earlier counterpart – Paley’s more idealistic natural theology. She quotes
William Dembski when explaining that real design is a compromise
between competing objectives (p 216). It might be added that even if
the original creation was “perfect,” it is now degenerate. These details
are important when placing ID correctly within the spectrum of ideas
about origins. While things in nature do not need to be perfect from
our perspective to be intelligently designed, she quotes Stephen Meyer
to point out that intelligently designed systems “…possess features
that in any other realm of experience would trigger the recognition of
an intelligent cause” (p 210).

Darwinists and theistic evolutionists find ID repugnant for obvious
reasons. But others, among whom are some Young Earth Creationists
(YECs), have scarcely more regard for it. Nevertheless, individuals
from these, and other persuasions, are finding comfortable lodging under
the ID “big tent.” A major and seemingly wrong-headed concern among
some YECs is that ID does not specifically identify the designer. ID
proponents are cautious; they do not say the designer is God. O’Leary writes: “The design does not tell us who the designer is” (p 207). Empirical evidence is limited in what it says about the nature of the designer, and thus from that standpoint, cannot specifically be equated with the Judeo-Christian God without invoking revelation. Nevertheless, in Scripture God is by definition the Designer (i.e., Psalm 95:6; Isaiah 40:28). Rather than opposing ID, YECs should applaud it; for once science does not arbitrarily exclude the Creator! On the other hand, some Old Earth Creationists, fault ID for not distancing itself from YECs. When following empirical evidence, it may not be possible to please every philosophical position.

In evaluating various positions relative to origins, O’Leary is hardest on Darwinians and their followers, theistic evolutionists. In fact she thought Charles Darwin more honorable for losing faith over a cat playing with mice, than Ken Miller, a theistic evolutionist, who said it might not matter, after all (p 240). (Suffering in nature does matter!) On the other hand, while not necessarily accepting the YEC position, she is quite gentle with them. She writes: “…scientists working within this constraint will likely continue to come up with interesting information nonetheless. It is wrong for other scientists to ridicule or harass them.”

O’Leary’s respect was clearly won by ID: “The question is how to interpret the evidence. The most reasonable explanation is design” (p 243). This will undoubtedly make many Darwinists unhappy. Within the Darwinian camp the only valid question is: how did nature, in the absence of an Intelligent Designer, create what so obviously appears designed? For them, the question of whether or not nature was intelligently designed is forbidden. However, as O’Leary quotes Richard Halvorson: “The most important question for any society is the one that is forbidden.”
REUNITING FACTS AND VALUES

Total Truth: Liberating Christianity from Its Cultural Captivity.

Reviewed by Paul Giem

In Total Truth, Nancy Pearcey identifies an often felt but rarely clearly verbalized split into sacred and secular realms. Many identify the realm of facts with the secular, and the realm of values with the sacred. In this view, the realm of facts and science—the secular—belongs in the public sphere because it is objectively true. The subjective realm of religion and values belongs in the private sphere and should never intrude into the public sphere. Pearcey discusses Process Theology, Legal Pragmatism, Dewey’s philosophy of education, and Constructionism in education as examples where secularism has taken over entire areas of public life. As more and more subjects are claimed by the realm of “science” and “fact,” eventually nothing will be left for the world of “religion” and “values.”

Pearcey traces the history of this destructive dualism, starting with Plato and moving through Thomas Aquinas to Romanticism-Enlightenment dualisms such as the Cartesian dualism of Kant. Value-fact dualism has given rise to modernist science and post-modernist English departments in universities.

Although they have proven to be powerful cultural ideas, none of these dualisms completely solve the problems they were intended to address. Pearcey states, “This is the great intellectual lostness of our age: that many are forced to hang their entire hopes for dignity and meaning on an upper-story [faith] realm that they themselves regard as noncognitive and unverifiable” (p 109).

The major foundation of modern dualism is the modernist scientific image of nature as strictly mechanical and resulting from an amoral, Darwinian struggle for survival. Pearcey notes that the implications of Darwinism eventually destroy the authority of any ethical system, giving examples where Darwinists excuse not only abortion but also infanticide, rape, and bestiality. But, as Pearcey notes, citing Tom Bethell, the secular critics of these extreme views “were disarmed by their shared worldview” (p 214).
However, the “universal acid” (Daniel Dennett’s phrase) of Darwinism ultimately attacks itself philosophically. If evolutionary psychology explains all other thought as a product of evolution, and thus not necessarily true, it also explains itself in the same terms. Darwinism has no good defense against a postmodernist deconstruction of itself.

In addition, Darwinist philosophy has to explain away as illusions such phenomena as human consciousness, morality, altruism, religion and even the success of mathematics in science. Following Thomas Reid, Pearcey notes, “the purpose of philosophy is to explain what we know by direct experience, not to contradict or deny it” (p 312).

Darwinism’s grip on the realm of facts is not as tight as the majority of the scientific community would have one believe. Pearcey’s lucidly stated arguments will sound familiar to those who have followed the Intelligent Design movement closely. In the face of these difficulties with Darwinist theory, Pearcey quotes several Darwinists who have admitted that philosophical presuppositions drive their position. Thus Christianity is not automatically excluded from the realm of facts by any analysis of the facts themselves. On the contrary, it is more defensible than materialism, both philosophically and experimentally.

Pearcey argues that choosing a worldview is extremely important, and modernism or postmodernism should not win by default. She observes that many modern “secular” worldviews have a religious structure (as opposed to content) remarkably similar to that of Christianity. That is, they have a story that includes a Creation resulting in an ideal state, a Fall, and a Redemption. For example, for Marx, there was Darwinian evolution leading to the state of primitive communism. Mankind fell from this state of innocence through the creation of private property. Redemption comes from the proletarian revolt and destruction of all private property.

Giving a detailed and interesting history of the evangelical experience in America, Pearcey argues that because most explications of evangelicalism have been at least latently anti-intellectual, evangelicalism has tended to support the separation of life into the sacred and secular spheres. Even though evangelicals would be horrified to think that they are cooperating with the agenda of naturalism, she sees this as fitting in with that agenda.

*Total Truth* does contain some minor errors. There is at one point a stress on the word “cultivate” which the word itself will not sustain in
relation to “culture.” And there is the relegation of Islam to a status near Hinduism and neo-Platonism primarily because of its non-Trinitarian God (Appendix 2, especially p 387) without the realization that the same argument would apply to Judaism. These are more than offset by the author’s integrity, evident particularly when she calls on Christian leaders not to deprive ghostwriters of the rewards of their efforts, and then unobtrusively credits her husband for a phrase he had created (p 372).

I would like to sharpen Pearcey’s thesis slightly. In fact, there is a partial separation between religion and science. A comprehensive doctrine of the atonement or Christology from nature or even secular history seems improbable. When fixing my car, I do not get out my Bible to find out what to do. However, facts and values do not have a watertight separation. Religion (at least true religion) should permeate all of life, and all of thought. Any divisions should be natural in the sense of being unforced, and it should be expected that these divisions are not absolute. Rather than calling for the complete abolishment of dualism, I would argue for recognition of the porous boundary between the elements, which can thus become integrated.

Finally, I would like to call attention to the soul-body dualism which Pearcey apparently accepts (see her comment about the “immortal soul” of humans on p 320). This dualism is the basis of Cartesian dualism, which she rightly rejects, but without explicitly rejecting the body-soul dualism itself. Perhaps the division between body and soul is not as watertight as is commonly believed either.

*Total Truth* makes one of the best cases against the sacred-secular dualism prevalent in our society. It deserves to be read by anyone seeking to integrate his or her worldview.
Speculation about extraterrestrial aliens has gone on for a long time; at least 2,000 years. Titus Lucretius Carus was an early proponent of extraterrestrial life. Around 55 BC he wrote:

...it cannot by any means be thought likely that this is the only round earth and sky that has been made,...since this world was made by nature, and the seeds of things themselves of their own accord...could become in each case the beginnings of mighty things, of earth and sea and sky and the generation of living creatures. Therefore again and again I say, you must confess that there are other assemblages of matter in other places, such as this is which the ether holds in greedy embrace.\(^1\)

Lucretius is thought to be reflecting the earlier thoughts of Epicurus who also appears to have believed in extraterrestrial life.\(^2\)

The problem with speculation about extraterrestrial life is that if such life exists, it is extraterrestrial, making it hard to study from here on earth. The best that we can do from our terrestrial vantage point is to look for signs of life on other planets. These signs can fall into two categories: 1) evidence that conditions essential for life are present and 2) direct evidence of the activity of living things. Recently there has been much excitement over data collected by the Mars Odyssey spacecraft that seems to indicate hydrogen on the surface of Mars. This hydrogen is thought to be in water molecules and water is essential for life.\(^3\) If water is present on Mars, one condition for life is met, but it does not prove that all conditions necessary for life are present on Mars.

Finding direct evidence of extraterrestrial life may be more difficult than finding conditions conducive to life, but this has not stopped scientists from looking. A recent example might be discovery of carbonyl sulfide in the atmosphere of Venus.\(^4\) Inorganic production of carbonyl sulfide may be difficult while its production by organisms is known.\(^5\) Thus, presence of carbonyl sulfide may be viewed as possible evidence of the activity of organisms.
Signs of life are well understood and may be employed when searching for life on other planets. On the other hand, searching for intelligent life may be a more complex challenge. Signs of intelligence should be detectable in the same way that signs of life are detectable. Like signs of life, signs of intelligence can be divided into two categories: 1) Data not typical of natural processes and 2) data known to be the product of intelligence. In one sense, separation of these two categories of data is artificial, as many data known to be products of intelligence are also atypical of natural processes.

Before data can be categorized as atypical of natural processes, natural processes must be identified. In other words, the tools by which nature works must be known and understood before limits can be put on what nature can accomplish. The history of science is a record of humanity’s success in understanding how nature works. In general two tools are known to be used by nature: 1) A set of laws governing the interaction of matter and 2) chance, which determines where, when, and under what conditions matter interacts with other matter.

Gravity is an example of a law governing interactions between matter. In essence it is a simple law stating that bodies with mass are attracted to one another. But when combined with other simple laws gravity accounts for the apparently complex interaction of planets within our solar system and our solar system with the rest of the universe. Sometimes the products of simple laws of nature are elegant and ordered. For example, the structure of crystals is very ordered, but arises from the relatively simple interaction of positive and negative charges; like positively charged sodium (Na+) and negatively charged chloride (Cl-) to form table salt crystals.

Gravity is an impressive law of nature and, like other laws, it may be employed by intelligent beings for specific purposes. For example, farmers in some parts of England have removed rocks from their fields and stacked them into dry stone walls which now divide much of the British countryside into a checkerboard of cultivated fields. These walls serve important purposes including delineation of property lines and separation of livestock from fields in which crops are being grown. This purpose is facilitated by gravity, which prevents the rocks from floating away, but gravity is not responsible for the purpose. This is evident from the observation that gravity held the very same rocks in position in the fields before farmers came to work them. It took the intelligently directed efforts of farmers to move the rocks and arrange
them so that they now serve a purpose or function. If viewed from space, these rock walls immediately suggest the presence of intelligent design, as nature is not known to arrange rocks in long rows stacked as they are in dry stone walls. In addition, purpose is evident and thus intelligence is logically inferred from the presence of these walls. Dry stone walls in the northeastern United States or southeastern Australia also suggest intelligent causes; the location of the walls doesn’t matter. It is the presence of purpose and lack of known natural causes that suggests intelligent design.

Like dry stone walls, canals may also exhibit the characteristics of intelligently designed objects: structures not known to be naturally caused and exhibiting some kind of purpose. The network of canals that crisscrosses the United Kingdom exhibits these characteristics. Structurally they tend to be straight and to slope very gently if at all. Locks, clearly not a natural feature, control movement of water in the system. A map of the canal system reveals that they go between population centers suggesting their purpose as highways for transportation of materials. The great astronomer Percival Lowell, thinking he saw canals on Mars, immediately interpreted their presence as an indicator of intelligent life there. When better telescopes revealed only features known to be the products of nature, most people abandoned Lowell’s life-on-Mars theory.7

It was not because Lowell was a bad scientist that he concluded life existed on Mars; the error was in the poor data with which he had to work. What Lowell thought he saw were structures that functioned (moving or holding water) as part of a larger system. To function in the large system of interconnected canals, each individual canal conformed to specified criteria. For example, they had to connect with other canals and be large enough to hold or carry significant quantities of liquid. In other words, the structures Lowell thought he saw on Mars had an obvious purpose and were unlikely to be the product of chance couple with natural law; so he concluded they must have been designed by intelligent Martians. Inference from purpose to design is logical and within the realm of science. This is what forensic science and archaeology do routinely. Data are collected and examined. If they indicate the characteristics of intelligent design, then some intelligent agent is logically inferred. For example, when flint arrowheads are discovered, they are interpreted as the product of some intelligent being, not nature or some kind of magic. In searching for intelligence scientists routinely
look for patterns different from those produced by nature, and for purpose. Using this kind of logic, The Search for ExtraTerrestrial Intelligence (SETI) filters radio signals from space looking for patterns reflecting intelligence.8

So far we have established that there are principles for detection of intelligent design just as there are principles for detection of life. In addition, scientists routinely use these principles to detect the activity of intelligent beings in the past and present. However, a semantic trap may exist for those who seek to detect design in nature. The problem arises when we are attempting to delineate between the natural and the artificial. Defining nature as the product of natural causes while artificial things, like stone walls, are the product of intelligent causes appears to be logical. Taking nature, defined as a product of natural causes, and studying it to determine whether it is the product of intelligent design seems preposterous as it is by definition natural and not artificial. Clearly a different set of criteria needs to be created to allow for the delineation of products of natural laws and intelligent design.

This brings us back to the dry stone walls discussed earlier. The walls operate (remain functional) as a result of at least one natural law — gravity — but they came into existence as a result of intelligent design. Would living things still be part of nature if they operated in the same way, having been produced by a process involving intelligent design, but now operating according to natural laws? A way around questions of this sort is to simply define life as natural and demand that only natural explanations be employed when explaining it. An example of this would be: “Scientific knowledge is limited to natural explanations for natural phenomena based on evidence from our senses or technological extensions.”9 But this creates a kind of circular reasoning in which phenomena like life, if they are considered to be natural, may only be explained as the result of natural forces and chance and thus natural forces and chance must be sufficient to explain all natural phenomena whether this seems reasonable or not.

What if a scientist didn’t already know that dry stone walls are the result of intelligent action? They are pervasive in the British Isles and many other places; many lack a historical record of when they were made and by whom. What if the walls were mistakenly categorized as a natural part of the English landscape? Once they were categorized as natural, only natural explanations would be allowed to account for their origin and if natural explanations are by definition sufficient to account
for all of nature, then they must be sufficient to account for the origin of walls. Once they are categorized as “natural,” then there can be no way of ever showing that dry stone walls were the product of intelligently directed effort by generations of farmers. Restricting science to natural explanations creates a reasonable expectation that it will attribute properties to nature that nature may in reality lack and that phenomena mistakenly categorized as natural will continue to be mis-categorized, further skewing our understanding of how nature works.

The only way science can determine whether dry stone walls are the product of natural or intelligently driven processes is by allowing the possibility of intelligent beings who played a role in production of the walls. Once intelligent causes are allowed, science can evaluate the evidence, determine whether or not walls meet the criteria for intelligent design and draw logical conclusions. Without allowing the possibility of intelligence, the science of studying walls becomes dogmatic. The same is true when studying life or other phenomena.

If a determination is to be made about whether life is a product of intelligent or natural causes, the possibility of intelligent design cannot be forbidden before the investigation begins. But this raises again the problem of what is natural versus what is artificial. If nature is not natural it can hardly be nature. On the other hand, even artificial devices like machines operate according to natural laws and not magic. Once they are made, dry stone walls are as natural as any other pile of rocks; what makes them unnatural is the fact that something beyond the normal blind actions of nature was responsible for the arrangement of the rocks. One way around this problem is to allow something outside of nature to have acted on nature at some point. This avoids arbitrarily constraining the possible answers before addressing the question of intelligent design in nature. When applied to living systems, this would mean that they could have been acted on by an intelligence outside of nature: something supernatural.

Why should intelligent beings just as natural as humans be ruled out as the ultimate source of intelligent design in nature? The problem with this explanation is that the problem is pushed back without actually being addressed. Humans are the most intelligent beings known and they exhibit characteristics of intelligent design. If human intelligence is dependent on intelligent design, it hardly seems reasonable to suppose that other intelligent creatures are not dependent on an intelligent cause for their intelligence. Ultimately intelligence outside of nature is
necessary to account for intelligent design in nature. Just as something outside of the elements and laws governing their interaction is required to account for intelligent arrangement of rocks into a wall, intelligence in nature that is dependent on intelligent design requires an ultimate intelligent cause outside of nature. Who or what caused this supernatural intelligence? As long as we live in the natural world, we will probably have no basis for investigating this question, but this is not a logical reason to rule out the possibility of a supernatural intelligence.

To determine whether intelligent design can be inferred from data in nature we have established the need for allowing the possibility of an intelligence outside of nature and development of criteria for judging between natural and intelligent causes. Ultimately this is true whether intelligent design is evident in nature or not. The history of evolutionary thought illustrates this need. For example, Lucretius argued.

*The nature of the universe confirms it cannot have been created for us by divine power: it has so many faults.*

To argue against a supernatural origin of the universe Lucretius must first allow that the supernatural can be discussed and then show that criteria he has set — e.g., any imperfection precludes supernatural involvement — are logical, reasonable and have not been met. The argument from imperfection used by Lucretius has been recycled many times by more recent authors, for example, when arguing against a supernatural role in the creation of life Stephen J. Gould wrote:

*Imperfection carries the day [over divine creation] for evolution.*

The important point is not the questionable nature of the criteria used to rule out the supernatural, but that supernatural involvement in the origin of life may be logically discussed on the basis of natural phenomena. These examples show the necessity of including the supernatural or divine as one possibility if design — specifically intelligent design — or its absence, is to be investigated in nature. It seems unreasonable to restrict investigation of supernatural involvement in the origin of life to only one possible answer before the question is resolved. In addition, Lucretius and Gould show that discussion of intelligent design in nature has continued from ancient times to the present.

The philosopher and mathematician William Dembski has formalized the criteria listed earlier for determining whether intelligence was involved in production of specific phenomena. Dembski avoids the
term “purpose” as this may require the observer to get into the mind of the designer. Instead he uses the terms “specification” and “probability.” Specification refers to patterns that satisfy certain precise logico-mathematical conditions including phenomena that vary independently, but work together within fine tolerances. For example, the cylinders and pistons in an internal combustion engine exhibit specification because the iron from which they are formed may be molded into almost any conceivable shape, but they just happen to fit together in such a way that engines work. There is no natural law that causes iron to form cylinders or pistons or dictates that they should fit to a tolerance of several micrometers. Thus the probability of nature producing pistons and cylinders that fit correctly is very low. Pistons and cylinders fit together because they were designed to do so by intelligent engineers, they clearly are not a product of chance and natural laws.

As it turns out, much of nature exhibits the characteristics of intelligent design, whether informally stated as apparent purpose or more formally stated as specification and small probability. Many biologists have noted this appearance of purpose. For example, George Gaylord Simpson (one of the fathers of neodarwinism) wrote:

>This appearance of purposefulness is pervading in nature, in the general structure of animals and plants, in the mechanisms of their various organs, and in the give and take of their relationships with each other. Accounting for this apparent purposefulness is a basic problem for any system of philosophy or of science.14

This appearance of purpose is especially true of life at the molecular level and the language of design is frequently used when describing molecular machines and information. After publication of the human genome, Gene Mayers, who designed software used in the project, didn’t hesitate to use the language of design to describe what they had discovered in the project:

>What really astounds me is the architecture of life...The system is extremely complex. It’s like it was designed....There’s a huge intelligence there. I don’t see that as being unscientific. Others may, but not me.15

One criticism of those who claim to see design in nature is that they are not qualified to recognize design, but in the case of Gene Mayers, this argument cannot be made. As a designer of software he is
clearly in a position to recognize design. His involvement with the Human Genome Project qualifies him to discuss information in the genome. Biologists are, in general, less qualified to recognize design, and yet they may still intuitively suspect that what they study is designed. Nobel Prize winner Francis Crick, codiscoverer of the double-helical structure of DNA, warned:

_Biologists must constantly keep in mind that what they see was not designed, but rather evolved._\(^{16}\)

But why should biologists avoid the conclusion that the object of their study was designed? If something as simple as a dry stone wall can be accepted as a product of intelligent design, why should something as complex as the human genome, or a single cell, or even the molecular machines from which they are made not be viewed as designed?

Stephen Pinker, professor of psychology at the Massachusetts Institute of Technology, provides the answer to these questions when he writes:

_Queen conclusion is based on two facts that we would think would be entirely uncontroversial: language shows signs of complex design for the communication of propositional structures, and the only explanation for the origin of organs with complex design is the process of natural selection._\(^{17}\)

Pinker recognizes the signs of design in language, but allows only one explanation, the law he refers to as natural selection. Like other laws, natural selection is a phenomenon that can be studied in nature and thus its role in production and maintenance of natural phenomena can be elucidated. When discussing the law of gravity and dry stone walls, it was clear that gravity could not account for the production of the walls, but it did function in maintaining the wall by preventing stones from floating away into space. In a general sense it is possible for laws to be real and to function in the maintenance of structures while not accounting for their origin. Pinker attributes the origin of language, an activity of living things, to natural selection. Is it possible, in a general sense, for natural selection to account for the information and machines found at the molecular level in organisms?

Charles Darwin suggested that natural selection is sufficient if certain criteria are met:

_If it could be demonstrated that any complex organ existed, which could not possibly have been formed by numerous,
successive, slight modifications, my theory would absolutely break down.\textsuperscript{18}

Darwin limited the work of natural selection to very small steps. This is because to be selected, a trait has to increase fitness and large changes are unlikely to increase fitness. Michael Behe has discussed the implications of this limitation at length.\textsuperscript{19} The requirement that all vital components of living systems evolve in small steps and the need that every step be adaptive if it is to spread through populations places important limits on what natural selection can achieve. To determine whether systems found in living things are potentially the product of natural causes — the law of natural selection combined with chance events — requires that the molecules from which living things are composed be caused by natural laws.

This is a challenging determination to make. One difficulty is selection of molecules to examine that will inform the question. Most organisms are composed primarily of water and water is clearly a product of natural laws. Life is not required for production of water, oxygen reacts spontaneously with hydrogen to produce it. Proteins are clearly essential for life, but proteins are composed of amino acids. As long ago as 1953\textsuperscript{20} Stanley Miller and Harold Urey conducted experiments showing that some amino acids can be produced independently of any apparent direct intelligent input (although the machine they used to create amino acids in was clearly a cleverly constructed device). Natural laws and chance are sufficient for production of some amino acids. It may even be possible to join amino acids together under abiotic conditions and this has been demonstrated in a very limited way.\textsuperscript{21} None of the chemical bonds that holds the various atoms together in protein molecules is uniquely different from those found outside of living systems. What is unique to living systems is the specific ordering of amino acids in proteins. The order of amino acids, in combination with special protein folding molecular machines, ultimately determines the specific complex shape necessary for proteins to achieve their functional purpose. In other words all those natural laws that hold proteins together can be accounted for by nature. However, natural chemical laws do not account for the specific sequences in which amino acids are joined together. Again, the dry-stone-wall analogy applies. Natural laws account for the way the wall functions and hold it together, but they do not account for the origin of the wall in the first place.
Can natural selection account for the sequence of amino acids in a protein? This is the specific claim of those who believe intelligent design is not evident in living things. At best the laws of chemistry seem only capable of joining amino acids together, but not in any biologically meaningful order. To gain meaning in the first place requires either intelligent input or incredible chance. Once a protein has a functional purpose, and it is part of a reproducing system, it may be possible to hone that function by random mutation of the protein’s amino acid sequence coupled with natural selection of those changes that improve the fitness of the organism. The question is, does this require only “slight modifications” as Darwin suggested?

The simple answer to this question is no. This is because many proteins vital to life do not function on their own. Proteins commonly work in combination with other proteins. The protein Glyceraldehyde-3-Phosphate Dehydrogenase (G3P Dehydrogenase) illustrates this point. G3P Dehydrogenase is an enzyme that functions as part of the glycolytic biochemical pathway, a molecular assembly line breaking down sugar and releasing energy. All cells have this glycolytic pathway. The pathway has 10 steps and G3P Dehydrogenase functions at step 6. In the absence of the other steps, G3P Dehydrogenase would still be an impressively complex protein, but it would serve no purpose as it would have no substrate on which to work and the products of the chemical reaction it catalyzes would have no use. If it had no purpose, natural selection would not be able to act on slight modifications in G3P Dehydrogenase as the modifications would also have no purpose and thus they would not contribute in any way to the fitness of the organism. Once G3P Dehydrogenase has a functional role, modifications that diminish its function would decrease fitness while any modifications that improve function could increase fitness, but function must first be present for selection to operate.

Getting functional G3P Dehydrogenase using chance combinations of amino acids is a vanishingly small proposition. Producing all 10 enzymes that make up the glycolytic pathway of which G3P Dehydrogenase is part is not a slight modification, it is the sort of giant leap that nature is not known to do. In short G3P Dehydrogenase is one example of thousands that could be offered which demonstrate the inability of natural selection combined with chance to produce living things. Natural selection may be an important law of nature that maintains organisms over long periods of time, but just as gravity cannot make a dry stone
wall, natural selection cannot make functional proteins that are vital to the existence of living things.

Proteins at the core of living systems do not appear to be the product of known natural laws. This was one of the two criteria set up earlier for detecting products of intelligent design. The other criterion was that the data being examined fit the pattern of those things known to be the product of intelligence. In the case of G3P Dehydrogenase this property also is evident. Intelligence is known to produce purposefully ordered sequences in circumstances other than proteins. For example intelligent humans order letters in specific sequences for the purpose of conveying meaning. Meaning is the purpose of ordering letters into words just as function is the purpose of the ordering of amino acids in proteins. Nature is not known to produce meaningful ordering of letters, or chemicals, but intelligence is known to order things in meaningful ways. Thus the functional ordering of amino acids in G3P Dehydrogenase can be logically accounted for by some intelligent design taking advantage of the laws by which chemicals interact for the ultimate purpose of creating functional parts of the complex assemblages of machines that make up living systems. Physical laws allow proteins to function, but intelligent design accounts for their origin.

Many excellent examples of intelligent design exist at the molecular level, but it is not just at this level that life exhibits purpose. As Sir Julian Huxley, one of the fathers of modern Darwinism, put it:

> At first sight the biological sector seems full of purpose. Organisms are built as if purposefully designed, and work as if in purposeful pursuit of a conscious aim. But the truth lies in those two words ‘as if’. As the genius of Darwin showed, the purpose is only an apparent one.23

Purpose, a hallmark of intelligent design, is evident in nature at many levels. Huxley wrote when our understanding of the molecular makeup of cells was sketchy at best. Now that the molecular workings of cells are better understood, the inadequacy of Darwin’s naturalistic explanation has become obvious. This leaves us with no positive natural explanation for what we see in living things and a positive argument for design in nature. In short, as long as a supernatural Intelligent Designer is allowed as a potential cause for life, intelligent design can be studied in nature and in fact is evident.
ENDNOTES


2. Unfortunately most of the writings of Epicurus have been lost. The best available source is probably book 10 of *Philosophoi Biol* (Lives of Eminent Philosophers) by Diogenes Laertius written c. 230 AD. In this book Laertius reproduces several works by Epicurus including letters to Herodotus and Pythocles in which he seems to infer the presence of other worlds.


5. There does not seem to be general agreement about how difficult it is to produce carbonyl sulfide. For example, see: Leman L, Orgel L, Ghadiri MR. 2004. Carbonyl sulfide-mediated prebiotic formation of peptides. Science 306:282-286.


9. This definition comes from proposed Ohio State Science Standards 2001 entitled Scientific Ways of Knowing, Grade 10, Indicator 3. In the final voted standards, this standard was changed to take a neutral stance on explanations available to science.

10. This theory is sometimes called “directed panspermia.” An example of the arguments made for this theory can be found in: Crick F. 1981. Life itself. Riverside, NJ: Simon & Schuster. 192 pages.


22. Determination of the probability of producing a given protein under prebiotic conditions on earth using only chance and the laws of nature is currently impossible. This is because the variables – relative amino acid concentrations, conditions for production of bonds between amino acids and so on – necessary to insert in any calculation are unknown. A feel for the probability may be possible if certain assumptions are made. *Mycoplasma genitalium* is among the simplest known living things. In the case of its G3P Dehydrogenase, there are 337 precisely ordered amino acids. Assuming that conditions exist under which long chains of amino acids are formed and that amino acids are incorporated both randomly and with equal probability, the probability of generating *Mycoplasma G3P* would be $(1/20)^{337}$ which is $3.5 \times 10^{-439}$; essentially zero.