"CREATIONISM"

AN AUSTRALIAN PERSPECTIVE

Edited by
Dr. Martin Bridgstock
and
Dr. Ken Smith.

Australian Skeptics

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PREFACE

Martin Bridgstock and Ken Smith

Since the last edition of this book (July 1987) science has advanced in many areas. But creationism is still with us, and most of the errors exposed in this book are still doing the rounds of creationist circles.

Most articles contained on this CD edition are as valid now as they were when written in 1987 (or earlier in some cases). But, as with any writings on science more than a few years old, note should be taken about a few of the articles.

Firstly, the list of qualifications and affiliations of the authors was correct in 1987, but is now out of date. Some of them have gained additional qualifications, some have been promoted, some have changed jobs, and some have retired (and some may have done more than one of these things). They are all still committed to supporting science against pseudoscience.

Now for the actual articles in the book. If no comment is made here about one of the articles it may be assumed that the arguments in the book still hold. There may be additional evidence to support what is written here, but the overall picture shows no significant change.

`up-to-date'

This phrase occurs at several places in the book. It should be interpreted as meaning `the state of knowledge in the mid-1980s', and not taken to refer to any later time. Other phrases such as `thirty years ago' should also be interpreted as relative to the mid-1980s, not the first year of the twenty-first century.

Fundamentalism and bibliolatry

In 1987 only a relatively small number of theologians had written in opposition to creationism. The chapter on `Bibliolatry' could now supply much more evidence for this. Some of these writings are included in the reading list at the end.

Radioactive dating

Carbon dating has been extended much further into the past, mass spectrometry now enables the dating of milligram quantities of material, and the accuracy of dating is now only limited by the major problem of contamination with modern carbon. Other dating procedures using isotopes have been refined, and dating is now becoming a routine procedure.

Precambrian life

Precambrian fossils have continued to be found, and the development of life during the first 85% of the existence of the earth is becoming clarified.

Gaps in the fossil record

Gaps in the fossil record are regularly being filled in with new discoveries. Some of these, such as a range of fossils leading up to modern whales, regularly make their way into even daily newspapers. Creationists, of course, have an answer to these: instead of a fossil find filling a gap, it creates two new gaps, between it and the fossils on each side. Paleontoliogists just can't win!

Big-Bang

The `big-bang' is alive and well, and this, too, regularly makes the daily news. The earliest stages of the universe are still an active area of research, though it is too early yet to say whether the idea of `superstrings' is going to be successful in providing a useful step forward.

Can we observe evolution?

Anyone who asks `Can evolution be observed?' among a group of medical practitioners is likely to be greeted with incredulity. The medical and drug fraternity are fighting a continuing battle against bacteria, which keep evolving to become immune to the latest wonder drug. The occurrence of virulent new bacteria or viruses is also something which is regularly reported in the daily newspapers.

Human origins

The process of evolution leading to human beings is becoming clearer, both from further discoveries and from examination of DNA sequences in the primates. It is now agreed that chimpanzees are our nearest living relatives, with gorillas somewhat further away.

The speed of light

Arguments about possible changes in the speed of light have almost disappeared from creationist writings, though they are still found among some supporters of creationism. The change in the legal definition of the metre to one based on the speed of light has had a significant effect here.

What is the CSF?

The Creation Science Foundation has changed the name under which it operates to Answers in Genesis. This change at least reflects the idea that it is based on the Bible, and not on science. Since 1987 there have been a number of articles published in *the Skeptic* about the organisation, under one or other of these names, and further information can be found there on this CD.

Strange remarks

It is no exaggeration to say that this section could be expanded to fill a complete book. Some of the more outlandish of these remarks are reported from time to time in the pages of *the Skeptic*, so you can have some fun reading these on the CD.

The New Creationism

In recent years we have seen the rise of what has been called the `new creationism'. Some writers have even referred to the evolution of creationism. Creationist claims of bias, and arguments for design, were treated very briefly in 1987. The lawyer Phillip Johnson has been influential in conservative Christian circles, arguing that not only science, but even his own specialty law, and many other areas of scholarship, are hopelessly corrupt since they have been infected by an anti-supernatural bias. He has cited the old, tired creationist claims in support of this. Other aspects of the `new creationism' are claims that living organisms are too complex to have arisen from random mutations followed by selection. These go under the names of `irreducible complexity' or `intelligent design'. All three of these --- bias, irreducible complexity, intelligent design --- would warrant separate chapters, were the book being written today. However there are already available books by Miller (1999) and Pennock (1999) (see the reading list) which deal with these in some depth.

General

If the book were being written today, it would be possible to include a chapter on the way the basic ideas of evolution --- mutation followed by selection --- have led to advances in areas other than biology. As computers have increased in speed and memory storage, programs have been developed which mimic evolution to solve engineering problems. What are known as `genetic algorithms' operate by starting with an approximate solution to a problem, making a large number of copies of the solution, with various random changes in parts of the solution, and testing these to find which is the best. This one is taken as the start of the next round of reproduction with mutations, followed by selection. A number of significant improvements have been obtained in this way.

Recently IBM announced that it had gained inspiration from biological immune systems, which have evolved over millions of years, to develop computer systems which were capable of carrying out some measure of `self-healing' when the integrity of a computer network, say was under attack.

These two are perhaps just the start of scientists in other fields realising that biological systems, which have been around for many millions of years, and have evolved to fit with the environment, should be studied more closely, and the insights gained thereby used in other areas.

Continuing the fight

Despite all this, we should not be complacent that all is well with science in Australia, even ignoring political manoeuvering. Creationists may, at present, have little influence in setting official standards for syllabuses in schools. But with the pressure to let schools teach what students and parents want, rather than what is educationally sound, warnings need to be given. `The condition upon which God hath given liberty to man is eternal vigilance' was spoken over two hundred years ago. This is usually quoted as `The price of liberty is eternal vigilance', but in either form the sentiment is the same. Eternal vigilance is needed if we are to prevent science being taken over by people who have an ideological axe to grind, as happened in Germany with physics in the 1930s, and Russia with biology in the 1940s, and has been attempted with all of science in USA in recent years.

INTRODUCTION

Martin Bridgstock and Ken Smith

> 'We ardently support each person's right to hold any belief he or she wishes. Our nation is founded on freedom of belief, and it is a precious heritage. We are not concerned with beliefs per se, but we are concerned with inaccurate claims that science supports certain beliefs. And we are concerned when proponents of a belief-system attempt to force their beliefs on others and use fallacious scientific evidence or arguments to do so.'
>
> Kendrick Frazier, 1984.

Introduction

The aim of this book is to give the reader an understanding of some of the tactics of 'creation scientists'. In schools and in work places, arguments for creationism, as the movement is now known, are being advanced. Quite often these arguments are unexpectedly powerful; they seem to be backed with genuine scientific evidence and the average person finds it hard, or in some cases impossible, to evaluate them. Many of the creationist statements can only be checked by resources available in a large library, since quotations seem to be taken from a wide range of scientific periodicals.

This book begins with a brief overview of the nature of the controversy, and then gives an analysis of the isolated creationist view of the Bible. The bulk of the book consists of studies of creationists' alleged scientific claims. Many of these studies are short, designed to give the reader an understanding of the fallacious nature of these claims, and an outline of some genuine science, with references for possible further study. Others are longer, dealing with such crucial questions as the feasibility of Noah's flood, or whether humans actually evolved. These deserve deeper consideration, and they receive that. Finally we sum up, and give a list of further sources of information for anyone interested.

What is this thing called 'Creationism' ?

What exactly does 'creationism' mean? Most Australians have some sort of belief in a creator God, and so begin with a general predisposition to favour something associated with creation. However the complicated set of descriptions used by creationists might bewilder anyone. As well as 'creationism' there is 'creation science', 'progressive creationism', 'strict recent creationism', 'strict, young-earth, flood-geology creationism', and many more. What can one make of all this?

Henry M. Morris is usually credited with being the founder of modern creationism. He has defined 'Scientific Creationism' in nine 'tenets'. The first of these (Morris 1984b, p.362) reads

> 'The physical universe of space, time, matter, and energy has not always existed, but was supernaturally created by a transcendent personal Creator who alone has existed from eternity.'

The theological overtones of this are obvious, and appear in the other tenets too. We find reference to biological life being '..specially and supernaturally created..', and to '..an even more recent global hydraulic cataclysm.', that 'The universe and life have somehow been impaired since the completion of creation..', and that '..it is reasonable to assume that the creation presently awaits the consummation of the Creator's purpose.'. It is amazing that such clearly religious statements attempt to pass as science. They contrast with the *Everyman's Encyclopaedia* definition of science as follows:

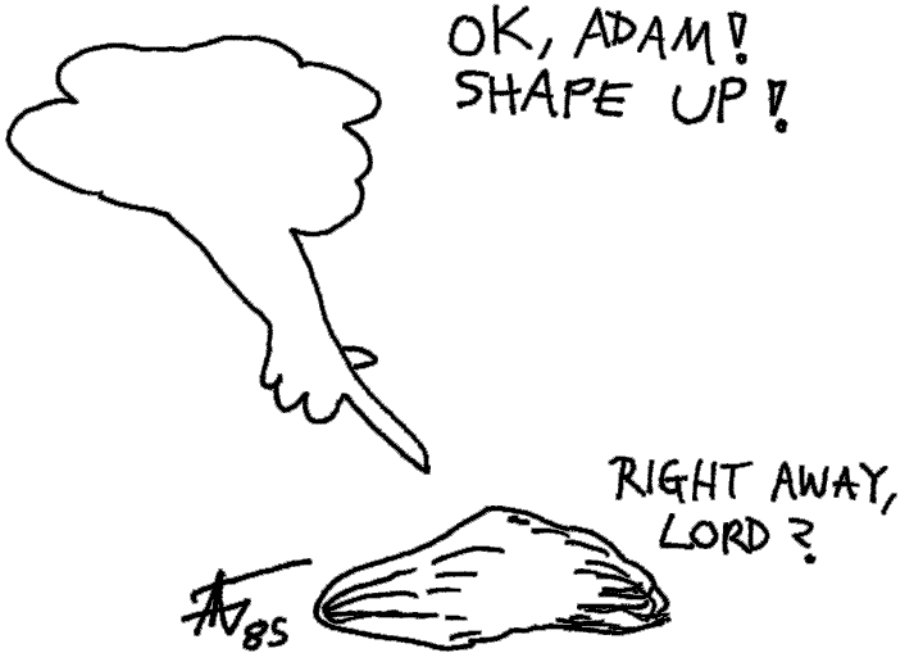
> 'Science is an attempt to provide systematic, justifiable explanations of natural phenomena. Science is a continuing process in which explanatory systems (called 'theories') are built up and improved over time by the work of numerous researchers . . .
> Three interrelated justifications can be offered for considering scientific statements to be particularly valuable descriptions of our universe: first, science attempts to be general and systematic; second, scientific statements are always capable of being tested; third, great effort is taken to ensure that science is objective.'

It is clear from this that science is a tentative quest to explain the material universe. Scientists accept or reject theories on the basis of their explanatory power. It is also clear that the religiously based ideas of the creationists are not even remotely scientific.

The creationist approach

Let us spell out precisely what creationism involves. Stripped of all qualifications, creationists believe that the universe is at most ten thousand years old, was created perfect in six days of twenty four hours each and has been deteriorating

ever since. They believe that all the different 'kinds' of life were created separately, though they cannot be pinned down on just what constitutes a 'kind'. They believe that Noah's flood was world-wide (in the modern sense of "world-wide") and laid down most rock strata and fossils, and that at the Tower of Babel humanity was dispersed into many different



tongues and races (see Morris 1984a for more information). It is plain that these ideas are based on a literalist interpretation of the Bible, and also that they conflict directly with virtually all of modern science.

Henry M. Morris states in many places that creationist theories are defensible upon purely scientific grounds. Perhaps the most definite can be found in No.85 of the Impact series of leaflets (July 1980) entitled 'The Tenets of Creationism'. This starts (with the emphasis as in the original)

> 'Creationism can be studied and taught in any of three basic forms, as follows:
> **Scientific creationism** (no reliance on Biblical revelation, utilizing *only scientific data* to support and expound the creation model).
> **Biblical creationism** (no reliance on scientific data, using *only the Bible* to expound . . .
> **Scientific Biblical creationism** (full reliance on *Biblical revelation* but *also* using *scientific* data to support . . .'
>
> (Morris and Rohrer 1982, p.59)

The Australian creationists seem to have a rather more complicated set of beliefs claiming, on the one hand, that creationism can find oil just as well as orthodox geology (*Ex Nihilo* July 1979: Editorial), but on the other hand (Mackay and Snelling 1985, p.31), that

> 'All scientists [sic] involved with the Creation Science Foundation have insisted from the start that science and religion have historically been interrelated, are currently interrelated and in fact cannot ultimately be separated.'

The reason for this difference is probably the American constitution. This rigorously prohibits the teaching of religion in public schools. In their drive to have creationism taught, therefore, American creationists have had to tone down or remove the overtly religious parts of their ideas. It is plain, however, that both in the USA and Australia creationism is primarily a fundamentalist religious movement.

Creationists' 'two-model' approach

Creationists are very fond of putting forward what they call the 'two-model' approach to the teaching of science. They

claim that there are only two ways to approach science, creation or evolution. To quote Henry M. Morris again

> ‘As a matter of fact, there are really just two basic world views, those of creation and evolution. The Biblical cosmogony is the only true creationist cosmogony, all others are evolutionary.’
>
> (Morris 1983, p.48)

There are many stories about the origin of the world other than the biblical one. One of the earliest is Enuma Elish from ancient Babylon. There is a battle between the god Marduk and the goddess Tiamat, in which Tiamat is killed. We then read (Heidel 1951, p.42)

> ‘He split her open like a mussel into two parts; half of her he set in place and formed the sky therewith as a roof.’

Barbara Sproul recently (1979) published a collection of stories from various parts of the world. One of the stories from Africa (Sproul 1979 p.44) begins

> ‘In the beginning, in the dark, there was nothing but water. And Bumba was alone.
> One day Bumba was in terrible pain. He retched and strained and vomited up the sun. After that light spread over everything. The heat of the sun dried up the water until the black edges of the world began to show . . .
> Bumba vomited up the moon and then the stars . . .’

It seems unlikely that creationists would want either of these taught in schools as ‘creation’. There is a wide spectrum of views ranging from an extreme literalist interpretation of the Bible through other religious ideas about the origin of things to scientific views which attempt to explain what we observe without any reference to supernatural beings (Marduk, Tiamat or Bumba) of any kind.

While the religious views of various groups of people are interesting, and should be included somewhere in the school curriculum, none of them have any place in science classes.

The roots of the controversy

Morris (1984b) and Nelkin (1982) have written of the history of creationism from opposing perspectives. There is a long history, among fundamentalists, of opposition to evolution. In the 1920s, this culminated in a series of laws in American states, designed to outlaw the teaching of evolution. Larson (1985) has surveyed the laws, from 1925 to 1981, which attempted either to ban the teaching of evolution or to enforce the teaching of creationism. Although all of these laws were eventually stricken down as unconstitutional, evolution was rather neglected in American science education.

The crucial event triggering the renewed controversy was, strangely, Sputnik. Its launch in 1957 forced the Americans to realise that their technological lead over the USSR was seriously threatened. In rather a panic they overhauled their science syllabuses and brought their science textbooks up to date, including those in biology. This caused great distress among millions of American fundamentalists. However, from experience, they knew that trying to ban the teaching of evolution was futile. So the new tactic began of dressing up their religious beliefs as ‘scientific’, and arguing for ‘equal time’ in the classroom. The ‘equal time’ argument makes a powerful appeal to democratic beliefs. The amount of ‘scientific evidence’ quoted by creationists is also impressive-looking, and many creationist speakers are powerfully persuasive. Alongside this ‘scientific’ movement went grass-roots attempts to affect teaching in schools. In some cases violence and destruction were part of the campaign (Nelkin 1982, pp.95,96), and it was quite common for teachers to be subject to pressure to omit parts of the prescribed syllabus.

At one stage no less than 23 American state assemblies were considering bills giving equal time to creationism. Two of these were actually passed, in Arkansas and Louisiana. Both were struck down by judges as unconstitutional. The Arkansas trial was a major confrontation between the two camps. It resulted in a resounding victory for those opposed to creationism, as Judge Overton clearly ruled that creationism was not science, but was aimed at advancing one particular religious view (La Follette 1984; Overton 1982). As a result of this, ten creationist bills died or were withdrawn. In the United States, although grass-roots agitation persists, creationism as a national issue seems dead. It is not the policy of a single American state to teach creationism alongside evolution. In fact in California, in September 1985, the Board of Education rejected a number of proposed textbooks because they did not give sufficient attention to evolution.

The Australian Scene

In Australia the constitution is less rigid in prohibiting religious education in state schools. The Creation Science Foundation (subsequently referred to as CSF), based in Queensland, has rapidly grown into an organisation with a half-million-dollar annual turnover, a well-produced magazine (*Ex Nihilo , now called Creation Ex Nihilo*), a newspaper (*Creation Science Prayer News*) and a full-time staff of fourteen.

CSF proselytises its views throughout Australia. There is no doubt that creationism is taught in many fundamentalist private schools. In only one state — Queensland — has much headway been made into the public system. The Minister for Education, Mr. Powell, has stated his expectations that creationism will be taught alongside evolution (*Ex Nihilo* vol.7, no.1, pp.26-31). His reply, in response to criticism (*Courier-Mail* May 30, 1984), that ‘there had not been a move by the State Government to introduce Bible lessons into science lessons’ seems to conflict with the statement quoted earlier by two of the CSF staff, Mackay and Snelling. Looking at the official science syllabus for Queensland secondary schools, as approved and published by the Board of Secondary School Studies, we find a rather different picture. In 1977 the science syllabus carried a section on evolution, and also included

‘Alternative theories
- spontaneous generation
- creation
- catastrophism’

By January 1981 the corresponding entry in the biology syllabus read

‘THEORY OF EVOLUTION
1. Origin of life: theories of spontaneous creation [sic], special creation, evolution;
2. evidence for theory of evolution;
3. principles of natural selection: Darwin;
4. raw materials for natural selection and evolution.’

It is almost certain that ‘spontaneous creation’ was a misprint for ‘spontaneous generation’. Note that creationism (under the name special creation) has now shrunk to an alternative theory of ‘origin of life’ only, but that no time is specified for the teaching of this section. Thus teachers could completely omit any mention of evolution. In the latest syllabus (September 1987) the heading of the section reads:

‘EVOLUTION
Minimum time: 10 hours
Major concept: On the basis of evidence drawn from the fossil record and other areas of scientific investigation, scientists infer that organisms on earth have been subjected to a process of evolution which has occurred over an extremely long time span. The most widely-accepted scientific theory which suggests mechanisms to explain evolutionary processes is the theory of natural selection.’

The syllabus then goes on to mention, as specific topics to be covered, the age of the earth, the fossil record, fields from which evidence supporting evolution is drawn, the nature of natural selection, and methods of speciation. Now creationism and other outmoded ideas have shrunk to nothing, at least 10 hours of class time must be spent on evolution, and the syllabus is broadly in line with that in developed countries and states. This reflects the view of scientists generally, as well as major bodies such as the United States National Science Foundation, and indeed informed opinion world-wide.

The Queensland Minister for Education does have the power to override the approved syllabus, at least in state schools. However in a letter to Nature (Powell 1986) he stipulated simply that ‘. . . teachers must acknowledge that alternative theories to evolution exist’. This is a far cry indeed from insisting that creationism be taught in state schools.

In general, therefore, it looks as if the growth of creationism in Queensland has followed the American pattern. It is a frightened reaction by a small minority to scientific advance, and to a complicated, uncertain world. The movement is not especially strong, except that in Queensland a fanatical minority has gained the ear of politicians. There is no objection to religion being presented as religion. But if religion attempts to masquerade as science, then scientists can be expected to object, and to do so loudly and at length. A vigorous counter-attack is under way.

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CREATIONISM, FUNDAMENTALISM AND BIBLIOLATRY

John Knight

> 'The whole aim of "scientific creationism" is to give the story of Genesis a veneer of scientific respectability. "Scientific creationism" is a mockery of the objectivity of science and it debases conventional religion as well. Prominent theologians have been offended by the intrusion of religious beliefs into politics and the public schools, and by the contention that acts of faith such as divine creation can be construed as scientific.'
>
> E. Peter Volpe (1981): *Evolution*, vol.35, p.1249.

Creationists typically present their particular interpretation of Genesis as if it were the only possible reading of the text, and indeed as if its acceptance were a *sine qua non* for being a genuine Christian. Thus a recent Creation Science Foundation publication (Snelling et al., 1983, p.14) asserts:

> 'The controversy over Creation and Evolution then is really a battle between two religions. You must choose the chance, randomness, no God evolutionary philosophy which provides the bases for the religion of humanism in which 'anything goes': homosexuality, nudity, abortion, incest, etc. cannot be regarded as evil for evil does not exist. Or you must choose the absolutes of the Creator God who made everything and therefore has the authority to dictate what is right or wrong for His creation.
>
> The choice then is between the religion of Christianity with the basis of its Gospel in a literal creation, or the religion of humanism with its basis in evolution.'

In such a position there is no middle ground. 'Truth' is clearly defined. The earth is only about 6,000 years old, or at the most some 10,000 years old; all 'major life forms' were specially created, and have 'only a limited ability to vary'; Fossils and the strata were produced by Noah's Flood. The Tower of Babel thereafter accounts for the diversity of human races and languages now found. Further, there is clear evidence to support all of this (Snelling *et al*., 1983). It follows that true science will agree with the Bible (or rather with a particular reading of the Bible). Such a position is characteristic of a particular form of Christianity, Fundamentalism.

Fundamentalism and bibliolatry

In its late nineteenth century origins, Fundamentalism was a Protestant reaction against Darwinism, radical Biblical criticism ('Modernism'), liberalism and agnosticism. Against these emergent 'heresies', it asserted certain religious basics or fundamentals whose giving up would represent the rejection of the Christian faith. A typical list of such fundamentals would include the literal truth and verbal inspiration of the Bible, the creation of the earth and its inhabitants in six literal days; a universal Flood; the Virgin Birth, substitutionary atonement and literal resurrection of Christ and his imminent Second Coming and the end of the present age; the Trinity; and the literal nature of the Biblical miracles (See

Rudolph, 1958; Knight, 1985a). More generally, Fundamentalism has a particular attitude to the Bible to which it ascribes absolute authority in the same way as it accuses Catholicism of doing with the authority of the Pope or the Church. In this sense, it seems appropriate to characterise it as a form of Bibliolatry. It is a worship of the Bible rather than a worship of God. Yet as the great biblical scholar, Barr, points out,

> 'Fundamentalism is the imposition upon the Bible of a particular tradition of human religion, and the use of the Bible as an instrument of power to secure the success and influence of that form of religion.'
>
> (Barr 1982, p.27)

However, as Barr also notes, fundamentalist interpretation 'is literal only where and when it is convenient to it to be literal' (p.26). Thus, though it asserts the literal reading of Genesis 1, Fundamentalism will almost certainly provide a figurative reading of something like Mark 10:21, in which Christ commands the rich young ruler, who claims to have kept all the commandments, to sell all his possessions and give the proceeds to the poor. Again, though it treats the Bible as in some way an arbiter or authority over science, it does not follow the Biblical version of the ratio of the circumference of a circle to its diameter, which 1 Kings 7:23 clearly states as three to one: for the great laver for Solomon's temple is described as having a diameter of ten cubits and a circumference of thirty cubits. Nor (to my knowledge) do fundamentalists reject Mendelian genetics on account of Jacob's use of sympathetic magic (and that of a quite phallic form) in Genesis 30:31-43 where Laban's cattle conceive spotted rather than pure coloured offspring. Nor do most of them accept the Semitic cosmology in which the creation narratives are construed. Indeed they seem unaware that, as *The Interpreter's Dictionary of the Bible* (1962) notes,

> 'The Bible takes for granted a three-storied structure of the universe: heaven, earth, and underworld (Exodus 20:4). According to this Weltbild, the earth is a flat surface, corrugated by mountains and divided by rivers and lakes. Above the earth — like a huge dome — is spread the firmament, which holds back the heavenly ocean and supports the dwelling place of the gods (Gen. 1:8; Ps. 148:4). The earth itself is founded upon pillars which are sunk into the subterranean waters (Ps. 24:2; 104:5), in the depths of which is located Sheol. In this view, the habitable world is surrounded by the waters of chaos, which, unless held back, would engulf the world in chaos (Gen. 7:11; cf. 1:6).'
>
> (Vol. 1, pp. 725, 726)

Similar issues ignored by fundamentalists include the apparent existence of two creation narratives (Gen. 1:1-2:4a; Genesis 2:4b-25). But a 'literal' reading of both narratives indicates major inconsistencies. In the former account, 'man' is the final creation; in the latter account, man is created first, then the birds and animals, and (finally), woman. In the same way, two accounts of the Flood appear to be merged. Thus Genesis 7 and 8 state variously that the Flood lasted for either 40 or 150 days, and that either seven of every 'clean' and two of every 'unclean' animal went into the Ark, or that only two of every kind went in. Hence modern biblical scholarship typically accepts the existence of several different sources or traditions (e.g. 'Yahwist', 'Elohist', 'Deuteronomic' and 'Priestly') existing in the Pentateuch or Books of Moses (Genesis to Deuteronomy). (For example, see *The Jerusalem Bible* (1974, pp.3,4); *The Moffatt Translation of the Bible* (1935, pp. xi-xvi).)

I am also puzzled as to how supporters of 'creation-science' can assert that the biblical flood, as a universal cataclysm, destroyed the antediluvian world and created all or the greater part of the strata and the present land forms, while ignoring Genesis 2:4-14. For this passage, part of the second creation narrative, mentions rivers (e.g. the Tigris and Euphrates) and countries (e.g. Ethiopia and Assyria) as if they continued from antediluvian to post-diluvian times.

Mainstream Christianity

I do not think it is necessary to labour the point. The mainstream Christian positions avoid such problems. While accepting the inspiration of Scripture, they do not elevate it to a position it cannot maintain, as though it were not set in particular times and cultures, and expressed in particular (and human) languages. And, as Barr (1982, p.27) again points out, that text (2 Timothy 3:16) upon which fundamentalists most rely in their assertion of inerrancy for the Bible, does not address the historical (or scientific) inspiration of the Bible, or specify which are the inspired books constituting scripture or the sacred canon — a task which cost the early Christian Church much debate and long years to decide. What seems to be a more mature attitude towards the Bible has sometimes been called the 'historical-critical' method of interpretation (Herr, 1982). This approach recognises that the biblical writers addressed events and issues which were important or familiar to their original audiences and that they used terms and concepts which those audiences understood. It follows that to understand the text more fully, it is important to be aware of the culture, the history, and the literary context of the period being studied. Such a hermeneutic provides a basis from which modern Christians from a very different age and culture can seek to understand their faith and traditions.

In this alternative view, the creation narratives are seen as asserting the absolute sovereignty of God, his status as author and upholder of the universe, and a denial of worship (idolatry) to any created thing, whether sun, moon or stars (which are not even accorded the dignity of titles in the narrative), or living creature. The narratives have nothing to say either for or against evolution, nor could they be expected to.

And so it is possible for a Christian botanist (Rogers 1984, p.8) to assert in the Uniting Church journal *Life and Times*:

> 'A belief in God as creator, and an acceptance of evolution are in no way alternatives. I do not believe in evolution, nor in gravity. They are facts of life. I believe in God the Father Almighty, maker of heaven and earth. That is worth believing!'

Similarly, the leading Catholic paper, *The Leader*, (Gleeson 1984, p.9) stresses that the Bible, according to the Second Vatican Council, teaches 'saving truth' but 'not scientific truth, not historical truth in every detail'. Gleeson is clear that 'in searching the Genesis stories for truth we do not have to ditch any convictions we may have about evolution'. Rather,

> 'Religion and science, far from contradicting one another, must be seen as partners, the one complementing the other, to give us a fuller picture of our world and of ourselves.'

This approach compares with what I call the 'proof text method' of interpretation used by fundamentalists. Given the assumption that every part of Scripture is equally sacred and equally part of some seamless web of Truth which can be apprehended directly across time and cultural barriers, fundamentalists are justified in detaching texts from their context and reconstructing them so as to create a new 'text' or 'reading' of the Bible. This, incidentally, I consider explains their faulty use of science, where they too often take statements by famous scientists or evolutionists quite out of context (for examples see Ruse, 1982; Bridgstock, 1985).

Thus far I have presented creationism as an expression of the fundamentalist mind-set, and shown that the range of Christian traditions extends beyond such positions. I now suggest that a more scholarly interpretation of Scripture avoids repeating the old and unnecessary debate between religion and science. Nor should science be forced to conform to some particular (and distorted) reading of the Bible as providing absolute Truth for all times and all places. For science is a human activity; it changes, grows and develops. Hence if the Bible contains statements of ultimate Truth while science is an on-going process, there is no other point for science than to repeat or underline the text. But, as the scriptural examples I have provided surely suggest, that is an absurd activity.

Finally, as I have argued elsewhere (Knight, 1985a, 1985b, 1985c) fundamentalism should more properly be construed as a social phenomenon than a theological position. As the initial quotation from the Creation Science Foundation literature indicates, the real concerns of fundamentalism, and hence of 'creation-science', are more properly social and political, as their recent incursions into political activism in the U.S. (Moral Majority, Reaganism, anti-socialism and anti-welfarism) and Australia (Festival of Light, Society to Outlaw Pornography and Committee Against Regressive Education, the Bjelke-Petersen phenomenon in Queensland) indicate. In short, fundamentalist fears of pluralism, atheism, humanism, socialism, and relativism are justified by their perception as mortal threats to the moral fabric of society. That is, the assertion of creationism is a particular example of a more general concern for stability and cohesion in the community during a period of change and crisis (e.g. the nuclear threat, the transition to post-industrial society, the current economic crisis, the East-West tensions, and so on). And what is constructed is a rhetoric around 'Christianity', 'the family', 'morality', 'law and order', and 'free enterprise' which merges with the wider development of the New Right in Australia, the U.S., and Britain. But whether marching into the future, backwards, is the safest way to go is a question I leave to my readers to decide.

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'But lots of creationists are scientists, and with so many brilliant people on both sides shouldn't both be taught?'

Martin Bridgstock

This type of argument is frequently encountered. The first point to make is that the speaker is abandoning his or her own judgement, substituting a vague statement about 'brilliant people'. A second, equally simple point is that much of the 'scientific opinion' quoted by creationists is downright false. In a recent paper, I checked eight quotes from famous scientists apparently expressing doubts about evolution. The quotes had appeared in an advertisement in *The Australian*; four were misquotes and all eight were grievously misleading (Bridgstock, 1985).

Qualifications of creationists

Having said that, a sizeable number of people with impressive-sounding qualifications in science do appear to support creationism. The Creation Research Society claims to have over 500 voting members (see Morris 1984, p.194), who must have a postgraduate degree in science and believe literally in the Bible. Is this not impressive?

Well, not really. The Creation Research Society does not make its membership public (Morris 1984, p.187), which means that its members' qualifications cannot be checked. However, among publicly self-declared creationists, a disturbing number have rather odd qualifications.

In the United States, almost any institution can call itself a 'university' and issue 'degrees'. In consequence, there are a sizeable number of 'degree mills', which issue degrees in return for little more than payment. In defence, the major universities 'accredit' acceptable institutions; lack of accreditation throws a black cloud upon any 'university qualification'.

A number of prominent creationists do not appear to have accredited qualifications. For example, Dr. Harold Slusher is the Dean of Postgraduate Studies at the Institute for Creation Research, and the author of many creationist works. However, it turns out that Slusher's DSc degree is an honorary one from Indiana Christian University, awarded for his work on creationism! Since then, Slusher has also received a PhD from Columbia Pacific. Neither Columbia Pacific nor Indiana Christian University are accredited.

Dr Richard Bliss presents an even stranger case. He is author of the creationist Two Models teaching kit, and has been described as a 'recognised expert in the field of science education.'. However, it turns out that Dr Bliss

> 'received his degree (EdD) from the University of Sarasota which the Philadelphia Inquirer characterised as a diploma mill in a Florida Motel and the Atlanta Journal noted was not accredited, had no campus, and specialised in graduate degrees with the only time students spend at the school being during vacations from their regular jobs.'
>
> *Creation/Evolution Newsletter* (May-June 1984, p.9)

It seems that one should regard the claim that hundreds of qualified scientists believe in creationism with rather a large pinch of salt. However, qualifications are not all. One can be a perfectly good scientist with no qualifications. Recently, the creationists had the chance to parade the full weight of their scientific expertise at the Arkansas court case.

In 1981, the Arkansas state legislature passed a bill forcing public schools to give equal time to teaching creation and evolution. The American Civil Liberties Union challenged the constitutionality of the Legislation in court. Before Judge William Overton, the ACLU produced an awesome display of brilliant scientists. They included the world's leading geneticist (F.J. Ayala), the world's best-known palaeontologist (Stephen Jay Gould), an internationally-known philosopher of science (Michael Ruse) and several more. All testified that creationism was not scientific.

If ever the creationists needed to deploy their full scientific firepower, this was the time. A few top-rank scientists indicating why they believed creationism to be scientific might well have counteracted the ACLU's case. Instead, as one observer put it, the best the creationists could produce was:

> '. . . this collection of sad sacks, flub-a-dubs and third-rate hobbyists [who] had been gleaned mostly from the kinds of schools where the faculty must sign pledges certifying their literal belief in the factual inerrancy of the Bible and were not, in the post-Enlightenment sense, really academic institutions at all.'
>
> Lyons (1982, p.77)

When it came to the crunch, the creationists could not produce a single major scientist who supported their position. Where were the many distinguished scientists when they were most needed? Could it be that they do not exist?

In Australia, the situation seems similar. The Creation Science Foundation Ltd., in 1984, had seven members. None of these listed his occupation as scientist; two described their occupation as missionary, one was a teacher, one a solicitor, two were listed as medical practitioners and the remaining one was an accountant. And these people are out to change Australian science!

Scientific publications by creationists

One last check should be mentioned. When a scientist produces any kind of discovery, his first priority is to publish his findings in a scientific journal; the best known of these are *Science* and *Nature*, but there are thousands of others. If there are creationist scientists, working away somewhere, a search of these journals should reveal the presence of their work.

Cole and Scott (1982) did just such a check. Using a computer, they found that no scientific work supporting creationism was being published. A few creationists were publishing scientific work, but it was all in their own field of specialisation, unrelated to creationism.

Cole and Scott went further, though. Had creationists even tried to publish papers supporting their views? The authors contacted the editors of 68 major scientific journals, and asked if they had received any submissions from creationists. Out of 135,000 papers sent in to these editors over a four year period, only eighteen were creationist. Of these eighteen, twelve went to a single science education journal. None had been accepted, and the reasons for rejection include: 'ramblings . . . no coherent arguments . . . high-school theme quality . . . tendentious essay not suitable for publication anywhere . . . more like a long letter than a referenced article.' (Scott and Cole 1985, p.26). Rather charitably, the authors conclude that these poor papers were submitted by amateurs.

Some creationists claim that there is a 'conspiracy', and that no creationist papers would ever be accepted. Scott and Cole found that a number of editors spontaneously said that they would accept such papers if they were of high enough standard (Scott and Cole 1985, p.28). Further, some journals have a very open policy. For example, the *American Zoologist*; any member of the American Zoological Society can present a fifteen minute paper at the annual meeting, and an abstract will be published in the journal. If the creationists had a single Society member, their results would be guaranteed publication, yet this has not happened.

Summary and conclusion

Creationists claim that a large number of scientists support their position. However, there is no evidence that any major scientist uses creationist theories, or does creationist research, or has published such research. Some major creationists have such dubious qualifications that grave doubt is thrown upon the 'hundreds of scientists' that the Creation Research Society claims.

Perhaps one last point is worth making. Many 'creation scientists' clearly hold their views for religious, not scientific reasons. They have every right to hold the religious views of their choice, but to pretend that these are scientific is a misrepresentation.

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EVOLUTION IS 'ONLY A THEORY'

Mark Hodes

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The administrative committee of the California State Board of Education recently voted to require junior high school science texts to improve their presentation of evolution. Jean Sumrall, chair of the Creation Science Research Centre, reacted by saying, 'My concern is with evolution, not if it will be taught but how it will be taught. It is a theory to be presented as a theory'. My subject is the use of the word theory by critics to imply inadequacy.

Theory has three primary senses, all of which are employed by scientists. These are theory as a formal system, theory as hypothesis, and theory as extended explanatory structure.

Theory as a Formal System

To mathematicians theory is a technical term meaning a set of sentences (e.g. equations) closed under the operation of deduction. To understand the meaning of closed, consider the set of all whole numbers. If you select any two whole numbers and add them, the result is a whole number and therefore is already in the set of whole numbers. So you cannot escape from the set of whole numbers by adding. The set of whole numbers is said to be closed under the operation of addition.

In similar fashion, form an initial set of sentences called axioms or postulates. Specify rules for deducing new sentences from old; these are called rules of inference. Insert into the initial set of axioms all sentences (theorems) which follow logically by the rules of inference from the axioms or from theorems already inserted. The new set thus formed generally has infinitely many members and by definition is closed under the rules of inference. This set of axioms and theorems, together with the rules of inference, is called a theory. Mathematicians amuse themselves by asking such questions as whether all structures which the theory could potentially describe (called models) are isomorphic to each other. If so, the theory is said to be categoric.

Theory as Hypothesis

In colloquial language, theory is often used to mean hypothesis, conjecture, guess, expert opinion, and ill-informed godawful blind shot-in-the-dark.

'And now we will sing theory number 392'

Unfortunately the colloquial meanings leap most readily to the lay mind when confronted with the phrase ‘theory of evolution’. In ‘theory of evolution’ theory is in fact used in the third sense, described below.

Theory as Explanatory Structure

All science, being empirical at root, is provisional in its conclusions. Every belief is subject to revision, refinement, or relegation to ‘the ash-heap of history’. For this reason all science is hypothetical, and therefore theoretic in the first sense of theory. But theory in ‘theory of evolution’ is not there to pay homage to the fallibility of science. Rather it indicates the high degree of explanatory power provided by the elaborated idea of evolution, one of the two or three greatest ideas of post-Renaissance science. This explanatory power derives from (here is the crucial point) our ability to organize the content of biology along the lines of a formal system, the first sense of theory, using the postulates of evolution as the organizing principles, as the axioms, the seed sentences, of a deductive structure.

A theory as explanatory structure is secure knowledge, resistant to revision, to exactly the extent that its theorems vary widely in their content and in their generality, and are supported by experiment and observation. In point of fact, the implications of evolution theory range across the entire phylogenetic spectrum and are corroborated by a plethora of both experimental and observational evidence. The modern synthesis of molecular biology, population genetics, and evolution by natural selection derives its great strength from the interrelatedness of its independently confirmed components.

In summary, critics who disparage the theory of evolution as only a theory exploit a poor pun by substituting theory as hypothesis for theory as explanatory structure, the sense in which scientists refer to the Theory of Evolution.

CREATIONISM IS NOT THE END!

The people who brought you creationism have not run out of ideas. Robert Schadewald (1984,1985) has attended the 1984 and 1985 Bible-science conferences in the USA and reports that geocentrism — the idea that the earth stands immovable at the centre of the universe — is gaining ground.

In 1984, five out of eighteen speakers at the conference favoured geocentrism. In 1985, there were not only geocentrist speakers but also a full-blown debate between geocentrists and those who favour heliocentrism (the idea that the earth goes round the sun).

Schadewald reports the words of geocentrist Richard G. Elmendorf, who argued that:

> ‘Geocentricity threatens the very foundation of evolutionary science.’

According to Elmendorf, geocentricity was in the same position as creationism ten years ago.

It must have been a strange debate, as references to science and the Bible flew thick and fast. The first speaker on the HELIOCENTRIC side told the audience:

> ‘I can’t tell you how much I’d like to believe in geocentricity.’

Apparently the geocentrists clearly won the Biblical side, the heliocentrists the scientific side. So beyond creationism stretches the magnificent vista of geocentrism. And beyond that? Well, if all science is to be subordinated to a literal reading of the Bible, then it is easy to make a good case for a flat earth!

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THE MEANING OF 'RANDOM' AND 'CHANCE'

Ken Smith

Throughout creationist writings one regularly comes across statements criticizing evolution because of the apparent 'random' nature of the process. A good example can be found in an anonymous article in the *Creation Science Prayer News* for February, 1984. This article was highly critical of the Lego World Show Number 4, which dealt with the development of life on the earth. The author wrote

> 'To emphasize the evolutionary concepts, we have added in brackets the phrase "by chance random processes" to remind you of what they are saying.'

He quoted some of the publicity for the show, and modified it to read (where the emphasis is as in the Prayer News article):

> '. . . Over the next 3 million years, this rather special animal **slowly became** (by chance random processes) adapted to life on the plains. The feet **became** (by chance random processes) more suited to running, losing their ape-like ability to grasp, and **gaining** (by chance random processes) an arch. The hip joints **moved** (by chance random processes) towards the centre of the pelvis . . .'

It is quite clear that the writer is trying to persuade his readers that the word 'random', in science, has the meaning of 'blind chance', as it is widely understood by the non-scientific public, or as *The Concise Oxford Dictionary* definition of 'random' reads:

> 'haphazard, without aim or purpose or principle, heedlessly.'

But in science many words are used in senses which differ from their everyday usage. 'Theory' is one, and Mark Hodes' article in this book explains the errors creationists make about this. 'Random' is another one, and it has several meanings in science, which differ from everyday usage.

1. 'Random' — no known determining cause

This is one of the rarer meanings of 'random' in science. There are very few phenomena where it is believed that there is no determining cause in the background. One of these is radioactive decay of atoms. Any particular atom which is unstable may decay within the next minute, or it may not decay for a million years, and there is no way of knowing when it will decay. If we have a very large number of these atoms it is possible to calculate what proportion of them will decay in the next ten minutes, say, but it is quite impossible to say which of the atoms will so decay. Any individual atom decays 'at random', but there are laws governing the decay which enable us to calculate how likely it is to happen. Because we can only calculate 'likelihood' and not 'certainty', the decay is referred to as taking place 'randomly'.

2. 'Random' — no apparent order or pattern

Consider the sequence of digits

5, 2, 3, 9, 4, 8, 5, 3, 2, 8, 0, 1, 7, 5, 9.

What are the next five (say) digits in this sequence? The answer and source of the sequence is provided at the end of this article. About one reader in ten should get the next digit right, about one in a hundred should get the next two digits right, and only about one out of every 100,000 should get all five digits right. Because there is no apparent pattern or order in the digits, the next digit is just as likely to be 1 as it is to be 3 or 8. The sequence is called 'random'.

3. 'Random' — unpredictable in principle

There are a number of phenomena in science where the outcome of a particular experiment or measurement cannot be predicted, even in principle. Most of these relate to events at the atomic level, where we can only calculate the probability

of a particular event occurring. But there have been, in the history of science, many cases where the cause of an event was unknown (see sense 1 above), and so it could not be predicted. One example of this is the occurrence of earthquakes. Before the discovery of continental drift the cause of earthquakes was unknown, and hence there was no possibility of predicting them. They appeared to occur at ‘random’ intervals.

4. ‘Random’ — unpredictable in practice

This is by far the most common usage of the word ‘random’ in science. There are a vast number of situations where all the phenomena involved are known in great detail, but it is quite impossible to predict the outcome of a particular event. Familiar everyday examples of these are common gambling devices such as coins, dice and roulette wheels.

The behaviour of the ball in a roulette wheel is governed by Newton’s laws of motion, which are about as well established as any in science. The impact of the ball on various parts of the wheel is also well-understood in terms of the properties of the materials involved. But in spite of this it is impossible, in practice, to predict the outcome of any particular throw. This is because the final outcome depends critically on the precise details of how the ball and wheel are started off. An extremely small change in the initial spin of the wheel, or the direction in which the ball is thrown, can lead to a very great change in the final position of the ball. In principle this could be predicted — in practice it cannot.

The same is true for tossing coins and throwing dice — if the initial positions and speeds of these are known exactly the final outcome can be predicted. A very small change in the initial spin of a coin can lead to a great change in the number of times it rotates, and hence it is impossible, in practice, to calculate whether it will land heads or tails.

Earthquakes arise because of the build-up of stresses in rocks, due to motion of the plates which make up the crust of the earth. But not enough is yet known about the motion of these plates and the resulting stresses for any accurate calculation to be made about the future occurrence of earthquakes. Thus, at least for the immediate future, earthquakes can be described as occurring ‘at random’.

‘Random’ — its meaning in biology

Which, if any, of the above meanings of ‘random’ is that meant when a biologist refers to ‘random mutations’? It is certainly not meaning 1 (no known cause), since mutations arise from errors in copying the genetic material in strands of DNA. In many of the earlier writings about evolution, ‘random’ was used in sense 3, since the manner in which the genetic information was carried on the chromosomes was unknown. But since almost all of the process is now understood (see the articles in Scientific American for October, 1985, entitled ‘The Molecules of Life’, for an up-to-date survey of knowledge) this is no longer so. This leaves meanings 2 (no apparent pattern) and 4 (unpredictable in practice), and both of these are involved. The process of duplication of genetic material is so complicated that, at least at present, it is impossible to predict what form any mutation will take, or even if there will be a mutation. Also, such mutations as do occur do not appear to show any pattern.

But neither of these meanings come under the heading of ‘blind chance’, as the creationists would have us believe. Here again, as in the use of the word ‘theory’, creationists have set up a straw man, believing that if he can be demolished then evolution will also fall.

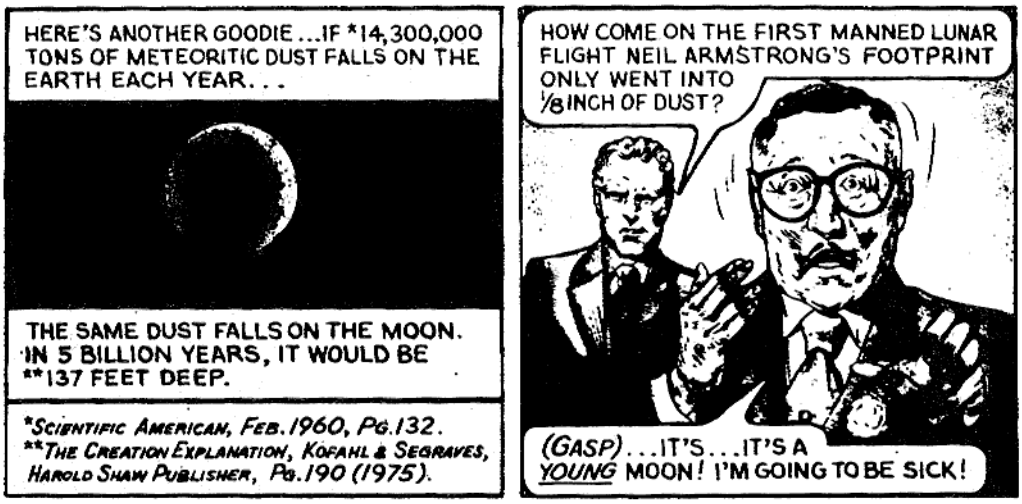
Answer to the problem in ‘random’: sense 2.

The next few digits in the sequence are 3, 7, 6, 6, 3, 3, 7, 9, 2, 7, 4, . . . They are the final digits of the phone numbers listed on p.512 of the 1984 Brisbane White Pages telephone directory. They are certainly NOT random in the sense of ‘blind chance’, since they occur in a perfectly definite order and even a single change cannot be tolerated, but there is also no evidence of pattern in them.

DUSTY ARGUMENTS

Martin Bridgstock

One much-used creationist argument is easy to understand, powerfully persuasive and based on scientific evidence. In Jack Chick's comic book *Primal Man?* it appears like this:



Chick (1976, p.30)

The same argument has also been used by Morris (1974), Wilson (1985), Slusher (1981) and many other creationists. Indeed, if the moon is billions of years old, why do not deep drifts of dust appear there?

Clearly, the key question is how much dust hits a planet or moon in a year. The *Scientific American* reference is to work by a geophysicist, Hans Pettersson. In 1957 he set up dust collecting units on high mountains in Hawaii. Pettersson was very aware that atmospheric dust might swamp the space dust he collected. He finally estimated that about 14 million tons of dust landed on the earth annually. However, he was prepared to 'find five million tons per year plausible' (Pettersson 1960, p.132).

Pettersson's results were tentative. The dogmatism with which the creationists have used this result is unjustified. This is doubly so, because we now have access to dust collection techniques using aircraft, high-altitude balloons and spacecraft. These enable researchers to avoid the problems of atmospheric dust which plagued Pettersson.

The results of these studies show that Pettersson's estimate was grossly in excess of the true figure. For example Dixon, McDonnell and Carey (1985) give a figure of 10,000 tons, using high-altitude aircraft; Millman (1975) uses a mathematical summary to arrive at a figure of 30 tons per day (10,950 tons per year), and other researchers have also arrived at this figure (e.g. Bradley, Brownlee and Veblen, 1983). This figure, less than one-thousandth of Pettersson's figure, completely disposes of the creationist notion that there should be deep drifts of dust on the moon.

Recently, creationist Andrew Snelling (1985) has attempted to defend the 14 million ton figure. One argument is that Isaac Asimov, writing in 1959 (!) found the figure credible. Of course he did: the more advanced collection methods were not available to check. Snelling's second argument seems to be that the more recent methods of dust collection do not account for all possible particles. This is not valid, in that Miller (1984), for example has shown that NASA's figures on space dust agree very well with the actual amounts of cosmic dust found on the moon. Snelling's arguments appear worthless.

Perhaps more revealing than the numbers is the contrast between the scientists' actions and the creationists'. Pettersson, a reputable scientist, made a tentative estimate of the amount of cosmic dust hitting the earth. Other scientists have checked his methods and carried out a whole series of experiments. Gradually, a better estimate of the amount of space dust has emerged. The creationists, by comparison, seized on one figure which suited them and have used it in argument ever since. They have done no research, attempted to discover nothing further. It is this contrast which reveals that creationism has no claim to be science.

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TRUST NOT THE SECULAR MEDIA!

Martin Bridgstock and Ken Smith

Readers of the *Creation Science Prayer News* will have noted some rather amusing convolutions in a recent issue.

The February 1986 issue enjoined its readers, in a headline on page 3, “DON’T PUT YOUR TRUST IN SECULAR MEDIA”. A cartoon shows a couple of dastardly characters (presumably from the media) cutting up a film and gloating “Won’t Creation Science be surprised at what they said!!!”.

The trouble is that the accompanying article has nothing to do with altering what the creationists have said! Instead there is a rather vague account of the loss of over $90,000 from the Creation Science Foundation’s funds. Exactly where the money went is not spelled out; we think it should be.

More surprises come when one looks at page 2, immediately opposite. There is no denunciation of the media there. Instead, under a sub-heading “Public Vote for Creation”, a media poll (Channel 7) is reported as follows:

> ‘The results of this phone-in vote were quite staggering. (And no doubt upsetting to the evolutionists.) *19,670 voted for creation to be taught in schools and 10,610 voted against.’*

The turnabout in attitude to the media here is quite remarkable. However the creationists, as usual, have misinterpreted all the results. The poll asked whether six-day creation should be taught in schools. Both of us would have voted “Yes”. Six-day creation is a religious doctrine, and so is perfectly entitled to be represented in religious studies, alongside other religious views. It is when this one religious perspective claims special treatment for itself — and only for itself — in science lessons that we and other scientists oppose it.

A QUOTABLE QUOTE

`Are there creationists who are religiously motivated but are not at the same time social and political conservatives? There must be, but in twenty years I have yet to encounter a single such person. Are there creationists, politically conservative or not, whose main concern does lie in the apparent moral implications of evolution and what it means especially to their own personal lives --- whose main goal is not to influence what other people's kids are taught in school? Again, probably so. But the vast majority of active creationists do not restrict their activities to preaching to the converted, though they do plenty of that as well. They are motivated primarily to see that evolution is not taught in the public schools of the United States.'

Niles Eldredge (2000): *The Triumph of Evolution and the Failure of Creationism* Page 11.

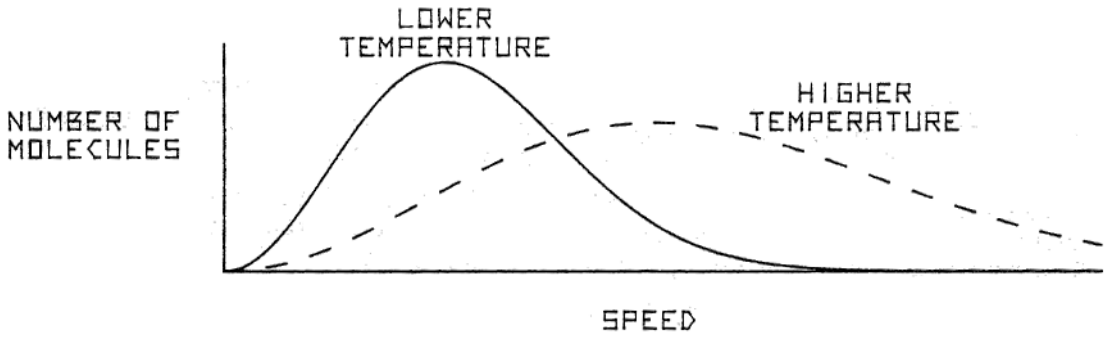
WHERE IS THE EARTH'S RADIOGENIC HELIUM ?

Ken Smith

In January 1957 there was a letter published in Nature with this title, written by creationist M.A. Cook. It is generally agreed that the helium in the atmosphere of the earth comes from radioactive decay of uranium and thorium in the crust. Cook attempted to show that there was not nearly enough helium in the atmosphere if the earth was about 4.5 billion years old, as is generally accepted. Cook's claim is still being repeated throughout the creationist world, and occurs in the second of the 'Origins' series of films, produced in the early 1980s. In the booklet accompanying the films (Taylor 1983, p.13) Cook is quoted as saying

> 'There is no chance whatsoever that helium could be leaving the atmosphere. Where is the earth's radiogenic helium? The answer seems to be that the earth is just not that old.'

A small amount of physics is needed to explain the creationists' error. Molecules of gases travel with different speeds, and the relative numbers moving with these various speeds can be calculated from the Maxwell-Boltzmann law, named after the 19th century scientists who originally derived it. The adjoining figure shows the proportion of molecules with different speeds for two different temperatures.



It is clear that only an extremely small proportion of the molecules are moving faster than about three times the most common speed. The average speed of the molecules depends on the temperature and increases as the temperature rises. It also depends on the mass of the molecules, and is higher for light gases such as hydrogen and helium than for heavier gases such as oxygen and nitrogen. If a molecule is to escape from the atmosphere it must be moving faster than about 11 kilometres per second. The Maxwell-Boltzmann law enables us to calculate what proportion of molecules have this speed at any given temperature, or, alternatively, how fast the gas is leaking out of the atmosphere. At sea level temperatures a negligible proportion of molecules are moving faster than the escape speed. Cook quoted some results from the chapter by Spitzer in the book edited by Kuiper. However he did not quote Spitzer's concluding words. They read, in part (Spitzer 1952, p.247)

> 'When this correction is taken into account, a temperature of 1500^{O} is required to dissipate helium from the earth about as fast as it is being liberated by the denudation of rocks.'

The temperature here is given in ^{O}Kelvin, which is 273^{O} higher than ^{O}Celsius. This work was written in 1947, when knowledge of the upper atmosphere was based on very indirect measurements, and the temperature of the upper atmosphere was believed to be about 500^{O}K. It is important to remember that Cook's original work, which had some validity at the time, was also done BEFORE the International Geophysical Year of 1957-1958. During this time more was discovered about the upper atmosphere than had been known earlier. The early artificial satellites did not stay up nearly as long as had been expected. This was because the atmosphere extended much further out into space than had been previously thought, which in turn was because the upper regions of the atmosphere were much hotter than previously thought. One of these regions has, in fact, been given a name expressive of its temperature — it is now called the 'thermosphere'. In Allen (1983, p.63) there is the sentence

> ‘In the thermosphere, by contrast, solar energy boosts the air temperature to a maximum of 3,600^{O}F, at an altitude of about 180 miles.’

3,600^{O}F is about 2,000^{O}C, which is, from Spitzer’s work in 1947 quoted earlier, quite high enough for helium to escape relatively freely.

We can thus answer Cook’s question — the earth’s radiogenic helium has escaped into space from the hot upper regions of the atmosphere. The argument by creationists is invalid, simply because they are apparently unaware that experimental data obtained nearly thirty years ago contradicts their assumptions.

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A QUOTABLE QUOTE

‘The efforts of the tens of thousands of scientists who have produced data relevant to the age of the earth or the universe have been motivated by a search for truth. If the age of the earth were 10,000 years or less, that result would have been proclaimed by many and accepted by all.

In contrast, those who propound creationism have started with a literal interpretation of the Bible. They have no substantial body of experimental data to back their prejudices. Truth is not on their side. In the end their activities must bring only harm to their cause.’

Philip H. Abelson (1982): *Science*, vol.215, page 119.

A QUOTABLE QUOTE

‘Disagreements and clashes of opinion are rife among biologists, as they should be in a living and growing science. Antievolutionists mistake, or pretend to mistake, these disagreements as indications of dubiousness of the entire doctrine of evolution. Their favorite sport is stringing together quotations, carefully and sometimes expertly taken out of context, to show that nothing is really established or agreed upon among evolutionists. Some of my colleagues and myself have been amused and amazed to read ourselves quoted in a way showing that we are really antievolutionists under the skin.’

Theodosius Dobzhansky (1973): *The American Biology Teacher*, vol.35, p.129.

A QUOTABLE QUOTE

`To believe such a view of creation in the absence of good evidence is a matter not of science, but of faith. At some point, bad science is the same as pseudoscience, and continuing to believe in it is to make it a religion. Whether the supposed ``intelligent designer'' is alien or divine, the conclusion is the same.

Were the new creationists to hold their views explicitly as matters of faith, though we might still consider such religious views false, there would be no worry of their importing their views into science classrooms. But as we have seen, intelligent-design theory is disingenuous or at least extremely misguided in its claim of religious independence. In this regard it is nothing more than the old creationism now dressed up in designer clothes.'

Robert Pennock, *Tower of Babel: The Evidence against the New Creationism*. Page 275.

IS THE SUN SHRINKING ?

Ken Smith

In the booklet accompanying the 'Origins' series of creationist films, which were produced in the early 1980s, there is a segment which claims that the sun is shrinking (Taylor 1983, p.11). It is stated that measurements since 1836 have shown that the diameter of the sun is decreasing by about 5 feet per hour. It is further claimed that observations of eclipses indicate that this rate of shrinkage extends back at least 400 years. The booklet then goes on to state

> 'Using the most conservative data, it would seem that the sun would have had twice its present radius only 100,000 years ago. Twenty million years ago the surface of the sun would have been touching the surface of the earth.'

In extrapolating any rate of shrinkage back over this time interval creationists are, of course, guilty of exactly the same 'uniformitarianism' for which they criticize scientists in general.

But is the sun really shrinking this fast? The data used by the creationists appears to come from a paper presented by J.A. Eddy and A.A. Boornazian at the 154th meeting of the American Astronomical Society held in June, 1979 (see Eddy and Boornazian 1979). Any paper presented at a scientific meeting (apart from special invited addresses and survey papers) is likely to be very much a preliminary version, and subject to a greater or lesser degree of revision before publication. There are a number of ways of measuring the apparent diameter of the sun, and Eddy and Boornazian only considered one of them. Other writers (see references in Gilliland 1981) have produced evidence which conflicts with this relatively rapid shrinkage. Gilliland (1981) has examined much of the data available from the early 18th century up to now. He concluded that the major change in size has been a periodic oscillation, with the sun shrinking and expanding over a 76 year cycle, with the last maximum occurring around 1911. However the experimental scatter in the observations (see Gilliland 1981, fig.3 on p.1149) is such that fairly sophisticated mathematical techniques were required to extract this information.

Gilliland stated that there was also the possibility of a steady shrinkage of about a tenth the rate proposed by Eddy and Boornazian, but that the experimental errors were such that zero shrinkage was also possible.

More recently Stephenson (1982) has examined information which can be obtained by using solar and lunar eclipses. The earliest recorded solar eclipse for which the date is certain took place on June 15, 763 BC, though Stephenson (1970) suggests that a clay tablet (of a religious nature) from Ugarit refers to an eclipse on May 3, 1375 BC. In any attempt to use these early records additional complications arise due to the gradual slowing down of the earth's speed of rotation, due to friction from the tides. This would lead to an accumulated time error of 8 or 9 hours by July 17, 709 BC, the date of the earliest recorded total eclipse. At this time the sun cannot have been much, if any, larger than at present, or the eclipse would not have been a total one. Stephenson (1982, p.161) concludes that observation supports a rate of shrinkage of about 0.16 seconds of arc per century (equivalent to about 13 cm per hour), but that the error in this figure is about 0.14 (or 12 cm per hour), so that there is no solid evidence of shrinkage. This agrees with Gilliland's conclusion.

To answer the question posed in the title of this section — the sun appears to oscillate up and down in size, but there is very little evidence of steady shrinkage. Any creationist arguments based on such shrinkage should be treated with very great caution indeed. In fact, as Van Till (1986) aptly says, the idea that the sun has been steadily shrinking appears to be yet another creationist legend.

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THERMODYNAMICS AND EVOLUTION

Ken Smith

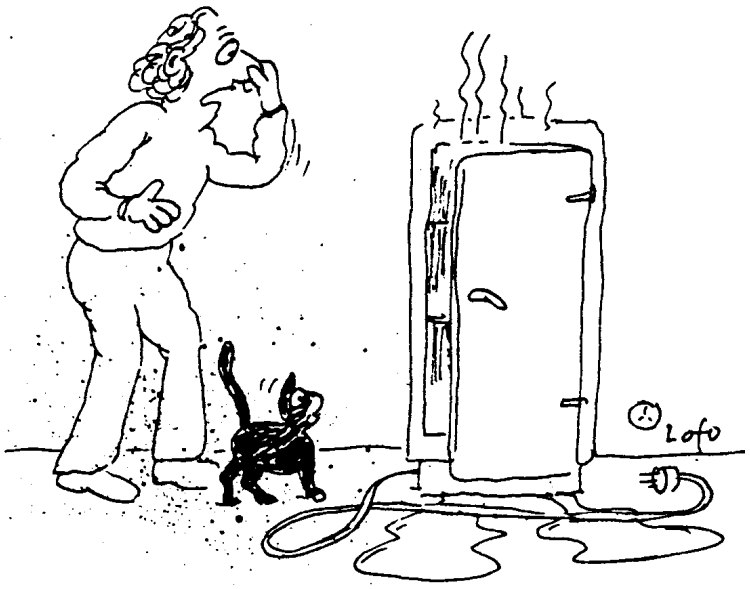
Thermodynamics is the area of physics about which creationists make more noise than any other, and is also the one in which they show the greatest lack of knowledge. The same argument keeps appearing over and over again; evolution is impossible since it contradicts the second law of thermodynamics. Thermodynamics is not easy, but a relatively simple introduction, relating the concept of entropy to the disorder in a system, and quoting the second law correctly, can be found in Angrist and Hepler (1973). According to creationists (see, for example, Morris, 1970, chap. VIII entitled 'Thermodynamics and Theology') the second law states that disorder must always increase. Since evolution requires increasing order it must be false. But things are rarely that simple in science.

Thermodynamics and closed systems

At a kindergarten level, it appears that things always tend towards a state of disorder — wood rots, weeds grow in the garden, and so on. But this is at the kindergarten level. To raise the level of discussion one step, in physics classes at secondary level the law is stated in a rather more precise way — in a closed (or isolated) system the entropy can never spontaneously decrease. The emphasis here is on the fact that the system must be isolated. Most of the diagrams in Angrist and Hepler (1973, chap.7) emphasise this isolation of the system. Since the surface of the Earth is continually receiving energy from the sun it is not isolated, and so simple statements about increase of disorder are irrelevant. This error has been pointed out, among others, by Mackay (1978, p.37), who is an evangelical Christian. He states

> 'The earth is not an isolated system. It receives a continual flood of highly ordered energy from the sun; and if one estimates the resulting increase in entropy (energy disorder) for the sun, this vastly outweighs any local reduction in energy disorder brought about on earth by biological processes, whether evolutionary or otherwise.'

This does not satisfy the creationists, however. They claim that no system is ever truly isolated (true), and that therefore the second law must apply to open systems (false). They fail to distinguish between an ideal situation and the real world. The second law only applies to the ideal situation, but some systems come sufficiently close to being isolated that the second law applies very closely indeed.



According to the Second Law of Thermodynamics any system, left to itself, runs down.

Things rot and mildew . . .

Thermodynamics and equilibrium

To raise the discussion yet another step, in tertiary level courses on thermodynamics the law is stated even more precisely: in an isolated system which is almost in equilibrium with its surroundings (that is, the temperature throughout the system is almost the same as that of the surroundings) the entropy will tend to increase. Near the end of their book Angrist and Hepler (1973, p.193) state

> 'Thermodynamics as we have described it in the preceding chapters can only be applied to systems that are in well-defined states — states where the properties are uniform throughout the system.'

It is in the area of nonequilibrium thermodynamics that creationists appear to be completely at sea, but this is precisely the area which must be treated in evolution. Healthy human beings, for example, maintain an almost uniform internal temperatures of 37.1^{O}C, irrespective of the outside temperature, and are clearly not in equilibrium with the surroundings. Nonequilibrium thermodynamics is a relatively new field of research, and is still growing rapidly. Ilya Prigogine is the acknowledged world expert in the area, for which he received the 1977 Nobel Prize for Chemistry. Prigogine and Stengers (1984) give a fairly gentle discussion of the topic, with many illustrations of how order can arise in systems which are not close to equilibrium. Coster (1981) gives a more detailed introduction, and provides further examples. Far from evolution being in conflict with thermodynamics, chapter 17 of Nicolis and Prigogine (1977) is entitled 'Thermodynamics of Evolution'.

Entropy, disorder and energy

Creationists in a very simple-minded manner equate increase of entropy with increase of disorder. The error involved here is rather subtle, and needs some advanced mathematics to clear up, for which this is not the appropriate place. But in many cases all that is needed to reduce the entropy of part of a system (with a corresponding increase in the entropy of the rest of the system) is a sufficiently large supply of energy. Consider some simple everyday examples. In the Southern Hemisphere winds blow clockwise around a low pressure area in the atmosphere, and anticlockwise around a high pressure area. If the energy supply from the sun was cut off everything would settle down to a uniform state. As long as energy is being supplied we have orderly patterns of the flow of air in the atmosphere. This order arises because the input of energy is high enough.

As another example, food in a refrigerator stays fresh while the power is on, but turns into a disorderly mess if there is no energy being supplied from the mains.

As yet another example consider the production of metals from ores. To produce aluminium all that is needed are supplies of chryolite and alumina, and ample power. Apply enough heat to the chryolite to melt it, dissolve the alumina in this, and pass an electric current through the molten mixture. Aluminium is obtained. The process requires vast amounts of power, most of which eventually goes into heating the environment, and thus producing a large increase in the entropy of the surroundings, but some of which goes into producing the (relatively) low entropy metal.

Creationists also regularly claim (see Morris 1984, p.43; Wieland 1980, p.9) that order can only increase if some 'program' or 'coded information' is available to convert disorder into order. The flow of air in the atmosphere happens simply because air expands when heated and then rises. If creationists wish to claim that the air is 'programmed' or 'coded' to expand when heated that is their privilege, but it is not what most people understand by a program or code.

This misuse of thermodynamics is yet another example of creationists' ignorance of the true nature of the scientific topic about which they talk.

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ARE RADIOACTIVE DECAY DATING METHODS RELIABLE ?

Ken Smith

Creationists repeatedly claim that the various dating methods used by scientists and archaeologists which rely on radioactive decay are either inaccurate or unreliable (or both). A good exposition of the procedures used in radioactive dating can be found in Faul (1966) or York and Farquhar (1972). This section will be restricted to some of the errors to be found in the creationists' chief resource book, Slusher (1981).

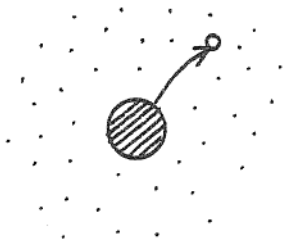
Creationist errors

Slusher (1981) contains at least two major blunders, thus casting considerable doubt on the rest of his exposition. On p.22 we read 'The disintegration rates of ^{133}Cs clocks have been shown to vary on circumnavigation of the earth . . .'. It would appear that Slusher is referring to tests of relativity which were made by transporting caesium clocks around the earth in opposite directions. The predictions of relativity were verified within the limits of experimental error (see Hefele and Keating 1972), but there was no radioactive decay or disintegration of any sort involved. Then on p.49 he states 'The decay rate of Fe^{57} has been changed . . .'. No reference is given, and this isotope of iron is STABLE! If Slusher has difficulty distinguishing between relativistic effects and radioactive decay, and believes that a stable isotope is radioactive, there is something seriously astray in the creationist world.

Have the decay rates changed ?

One major claim (Slusher 1981 pp.21,49, etc.) is that the decay rates may have changed with time. Matthews (1982) mentions changes up to only 4% (though these were caused by external effects and were not changes with time — see Emery 1972), and correctly states that these would not significantly affect the dates obtained. A small amount of physics is needed here.

Atoms consist of a small dense nucleus surrounded by a cloud of electrons. The forces between the particles in the nucleus are called nuclear forces, and the electrons are held around the nucleus by electromagnetic forces. Radioactive decay happens because of interactions between these forces, and the decay rates are determined by the relative strengths of the forces. Two of the common radioactive decays used in dating of rocks are rubidium-strontium and potassium-argon decays. In rubidium-strontium decay the nucleus of a rubidium atom emits an electron, thus changing into strontium, while in potassium-argon decay the nucleus of a potassium atom absorbs an electron, and changes into argon.



Rubidium-Strontium decay

Potassium-Argon decay

These processes are opposites of one another, and if the relative strengths of the forces were to change the decay rates would change in opposite directions. Thus if the attraction between an electron and the nucleus increased, it would be less easy for an electron to leave the nucleus of a rubidium atom, decreasing the decay rate, but potassium nuclei would absorb electrons more easily, thus increasing the decay rate. Since dates obtained by the two methods generally agree we can be confident that there has been no significant change in the decay rates. Slusher (1981 p.25) refers to an article by the creationist R.V. Gentry (in Creation Research Quarterly 1966) as evidence that decay rates involving alpha particles have changed. But Gentry (1973 p.353) in a respectable scientific publication stated that the evidence did not necessarily support a change in these decay rates.

Radiocarbon dating

Radiocarbon dating is a happy hunting ground for creationists. Slusher (1981) and Wieland (1981) produce a number of invalid arguments, including the creationists' proposed vapour canopy before Noah's flood. A more reasonable argument is that the rate of production of carbon-14 by cosmic rays may have been different in the past. This has been tested by analysis of growth rings in trees (see Zeuner 1958 chap.1). By matching the variations in growth ring patterns a calendar extending back to before 6,500 BC has been established (see Ferguson and Graybill 1983). Most creationists, such as Wieland (1981), skip over this point. Specimens have also been analysed by carbon-14 dating, and it is found that the amount of radiocarbon in the atmosphere was indeed different in the past. Unfortunately for the creationists the calibration curve produced by Clark (1975), which agrees closely with other calibration curves, goes in the wrong direction. For example, a radiocarbon date of 3,000 BC , when corrected in the appropriate way, turns out to give a calendar date of 3,700 BC, so that things are actually older than the first estimate.

At this point the creationists raise another argument — how do we know that trees produced only one growth ring each year? Some trees, they claim, can give two growth rings a year. Provided the word 'can' is emphasised, this is correct. The light part of each ring comes from rapid growth during spring and summer, while the dark part comes from slower growth during autumn and winter. There are occasionally (very occasionally) years in which the peculiar weather may lead to a fast-slow-fast growth pattern, giving two rings. But a far more serious source of error should be apparent to most Australians — the effects of drought. During a long drought growth virtually stops, and rings are not produced. It is thus far more likely that there are missing rings than extra rings. Again, unfortunately for the creationists, ages are likely to be underestimated.

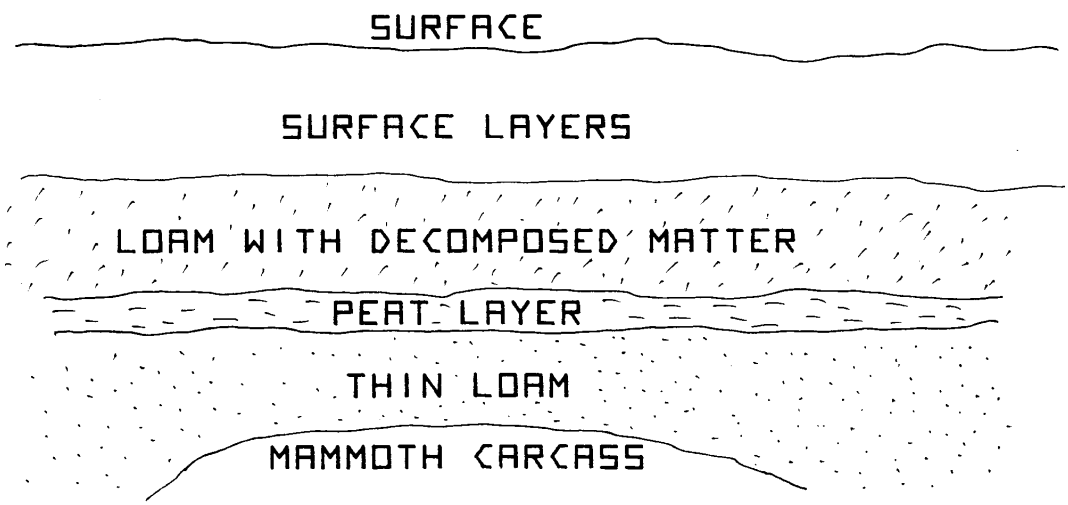
Creationists scour the scientific literature to find statements which, to the uninitiated, seem to cast doubt on the validity of radioactive dating. A selection of these can be found in Mackay et al. (1984). 'Quotations' 97 to 99, which claim to be taken from respectable scientific periodicals, seem to raise doubts about the usefulness and validity of radiocarbon dating. If the original articles are consulted a very different picture appears. To give just one example, 'quotation' 97 reads, together with the reference:

> **'97**. 'The hair on the Chekurovka mammoth was found to have a carbon-14 age of 26,000 years but the peaty soil in which it was preserved was found to have a carbon-14 date of only 5,600 years.'
> *Radiocarbon Journal, vol. 8, 1966, pp.320-321.*'

This is quite different to the original, which comprises two items in the journal whose title is simply *Radiocarbon*. The first of these, Mo-215, gives an age of 26,000 ± 1600 years (before AD 1950, the standard origin for radiocarbon dates) for hair from the mammoth, which was buried at a depth of about 1.5 metres near Chekurovka in the Bulunsk region of Siberia. The second item, Mo-215a, refers to peat, for which the age was measured as 5,610 ± 200 years. The first two sentences of this item reads:

> 'Peat from the same section as the mammoth carcass Mo-215, but from a depth of ca. 1 m (i.e., 0.5 m above the mammoth carcass). Peat layer, 15 cm thick, is overlain by loam, 45 cm thick, with intercalations of decomposed matter; a thin loam 30 cm thick, underlies the peat.'

From this it is easy to reconstruct the appearance of the site. It would be something like the following:



Obviously the mammoth would be much older than the peat. Whoever produced the 'quotation' has a rather strange idea of what 'peaty soil' means. Even worse is the use of quotation marks when the alleged 'quotation' bears so little resemblance to the original.

Conclusion

Are radioactive dating methods reliable? When undertaken by competent laboratories, and provided the results are analysed correctly, the answer is an unequivocal 'YES!'.

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A QUOTABLE QUOTE

'And, as standing on the lip of a canyon and looking downward may arouse that species of space-related fear called acrophobia, so pondering the conceptual abyss of geological time may bring on a bad case of chronophobia.

To my knowledge, there are no formal organizations of acrophobiacs. But the chronophobiacs are well organized, and vocal. Their organizations go by different names, of which the Creation Research Society is one.'

Claude C. Albritton (1980): *The Abyss of Time*, page 10.

A QUOTABLE QUOTE

'I think it will be evident, however, that our discussion of creationism is not exactly what creationists have in mind when asking for equal time. In effect, we are following the suggestion that creationism *might* usefully be included in science courses — as an example of bad science. Understanding what something is *not* can often help in understanding what it is. Modern science is not creationism.'

David B. Wilson (ed.) (1983): *Did the Devil Make Darwin Do It?* page xxii.

HOW OLD IS COAL ?

Edgar L. Deacon

Coal seams, according to orthodox geological views, are the consolidated and modified plant material resulting from the growth over long periods in the distant past of vegetation in luxuriant swamp-forests near sea level. Later subsidence of the land produced a coverage by sediments such as mud and sand. This deposition, perhaps aided by subsequent uplift of the sea floor, and/or by changes in sea level, led eventually to another period of swamp conditions. Many repetitions of this cycle of events sometimes occurred, resulting in the formation of various layers of vegetable matter separated by layers of sediments. In the course of time, the heat and pressure from the overlying deposits converted the layers of vegetable matter into seams of coal. These conditions were particularly prevalent during the Carboniferous era which is estimated to have prevailed between about 350 and 270 million years ago.

Now some creationists in defence of their contention, on biblical grounds, that the Earth was created a mere 6000 or so years ago, have propounded an alternative scenario. This they base on the fate of some 500 square kilometres of coniferous forest when Mount St. Helens in northwest USA erupted explosively in May 1980. Following the eruption a gigantic raft of broken logs and stumps floated on nearby Spirit Lake. These eventually sank and could form a stratum which the creationists believe would soon form coal following coverage by further deposits of volcanic ash and sediments. The conversion, they think, would be speeded by heat and the catalytic action of admixed clay. So they conclude 'it is entirely feasible that all today's coal seams were formed by the volcanism, flooding, erosion, tectonism and hydrothermal activity during the global year-long Noah's Flood catastrophe and its aftermath.' (Snelling and Mackay, 1984).

These authors claim some support for their theory from the fact that some coal seams in Queensland and New South Wales lie sandwiched between layers of tuff (volcanic debris). However this is by no means generally the case. For example, under a large areas of Pennsylvania, West Virginia and Ohio there are numerous coal seams interleaved between strata of sandstone, limestone, shale (consolidated clay) and conglomerate; but no layers of volcanic origin are present in the depth range of some 1200 metres (Moore, 1958). The limestone strata formed from the deposition of the shells of microscopic marine organisms, along with some precipitated calcium carbonate, represent very long quiet periods inconsistent with the creationist picture of catastrophic coal formation.

Where bituminous coal seams of fairly even thickness extend over large areas there is good reason to believe that they mark the site of the swamp in which the parental vegetation lived and died, and that there has been no appreciable influx of plant material from the surrounding areas. As pointed out by Holmes (1965) this conclusion is supported by the fact that the clay below such seams is riddled with innumerable rootlets of the plants which first colonized the swamp. Further evidence is that such shiny coals 'contain no fish remains or other fossils of aquatic animals, and (except in certain bands of durain) are uncontaminated with muddy sediment. Such ash as remains when the coal is burnt is derived either from the vegetation itself or from carbonate minerals and pyrite that have been deposited in cracks by percolating ground-waters.' For example, coals ranked as 'medium-volatile bituminous' in the Book of Standards of the American Society for Testing and Materials contain typically only 1.5 to 2% of ash.

Such bituminous coals could not have originated from the sinking of rafts of broken logs and stumps after the Mount St. Helens model — this type of material would pack so loosely that much volcanic ash and mud would inevitably be incorporated on consolidation. Furthermore, according to Genesis, to which the creationists adhere, the world was well stocked with animals and birds at the onset of Noah's flood. So according to the creationists' theory the coal seams should contain, not only fish remains, but also occasional fossils of a considerable range of animals and birds. Such have never been discovered either in the coal or in any of the sedimentary strata between the seams deposited in the Carboniferous period. So much attention has been given to coal that they could not possibly have been missed had they existed.

Further evidence of the great age of the Carboniferous seams is that they contain no traces of modern types of vegetation, but plentiful fossils of extinct species of ferns, giant horsetails and clubmosses. These spore-bearing plants are primitive in comparison with the abundant flowering plants and trees of the present day.

There are, of course, some coal seams which were laid down in geological periods following the Carboniferous, notably those of the latter part of the Cretaceous Period which is reckoned to be some 150 million years later than the era of the main Carboniferous deposits. The Cretaceous seams are distinguished from those of the Carboniferous Period by being associated with different plant species, including some true flowering plants. Cretaceous strata also contain fossils of reptiles, dinosaurs, some birds and small mammals.

Some realistic idea of the vast extent of geological time can be gained if the catastrophic coal theory is rejected in favour of the swamp-forest origin. An estimate can then be made of the time represented by the thickness of a coal seam from the amount of vegetation which can be produced annually under favourable conditions by a complete plant cover in a moist tropical climate. This is of the order of 50 tonnes per hectare (20 tons per acre) of dry plant material. This consolidated into a uniform layer would have a thickness of 5 mm. However, much material is lost during decay as carbon dioxide and methane (marsh gas). It has been estimated that at least one foot of peat was needed to produce one inch of coal (Holmes, 1965). So it should be fairly conservative to take each millimetre in thickness of a coal seam to be the product of one year's growth of the original swamp-forest.

A well-explored example is the Pittsburg seam of bituminous coal which has an average thickness of three metres under some 15000 square kilometres around West Virginia (Moore, 1958). This thickness corresponds to a lifetime of the swamp-forest of the order of 3000 years — about half the age of the Earth by creationist reckoning. Furthermore, in the 1000 m or so below this seam there are a dozen others and these all belong to a part only of the latter half of the Carboniferous period. How such an orderly layer-cake arrangement could have been produced by the raging waters of the Flood has yet to be explained by 'Creation Science'.

The crowning absurdity of the creationists' position is their insistence on taking literally the Genesis statement that during Noah's Flood all the mountains on the entire Earth's surface were covered with water. They choose to ignore the remarkable parallels between the Genesis version and the earlier Babylonian legend according to which the flood was also a punishment for sin with only certain favoured individuals being saved by building an ark. That a remarkable flood had occurred during a prehistoric period of settlement beside the Euphrates was shown by excavations at Ur conducted by Sir Leonard Woolley earlier this century. (Ur was the birthplace of Abraham according to Genesis). Pottery and objects of the prehistoric period were found interrupted by an 8-foot deposit of clean water-laid clay (Woolley, 1954). This is evidence of a mighty flood, but there is no reason whatever to suppose it extended beyond the lowlands of Mesopotamia. Memories of such a flood, embroidered with myth, would undoubtedly have persisted into the historic period.

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THE EARTH'S MAGNETIC FIELD: EXPERIMENT AND THEORY

Ken Smith

The series of 1:50,000 scale maps of Australia, and many other similarly detailed maps, have a note indicating that the direction between true north and magnetic north is changing slowly. The strength of the earth's magnetic field is also changing slowly. Reasonably accurate measurements of it have been made since the early 1800s, and less accurate information is available back to the 16th century.

In 1973 the creationist T.G. Barnes produced a 'technical monograph' (updated in 1983) which claimed that the earth's magnetic field was decaying with time, and that even as recently as 20,000 years ago it would have had an impossibly high value. Barnes' work has serious flaws, both in his treatment of the experimental data and in his attempt to provide a theoretical explanation. The present article gives a brief analysis of some of Barnes' errors. Dalrymple (1983) gives a more lengthy treatment.

The experimental data

Barnes refers throughout to what is known as the dipole component of the field. This has indeed decreased since the early 19th century, but data in McDonald and Gunst (1968), which was available when Barnes wrote, shows that many of the other components of the field have increased over this time interval. Barnes gives no indication of having consulted the *Journal of Geomagnetism and Geoelectricity*, which is essential reading for anyone interested in the earth's magnetic field. In it Yukutake (1971) indicated that the dipole component in fact reached a maximum around AD 1800, and in 1600 was about the same as in the early 20th century. Figure 1 shows the data for the period 1835-1965, as given in Barnes (1983, p.45).

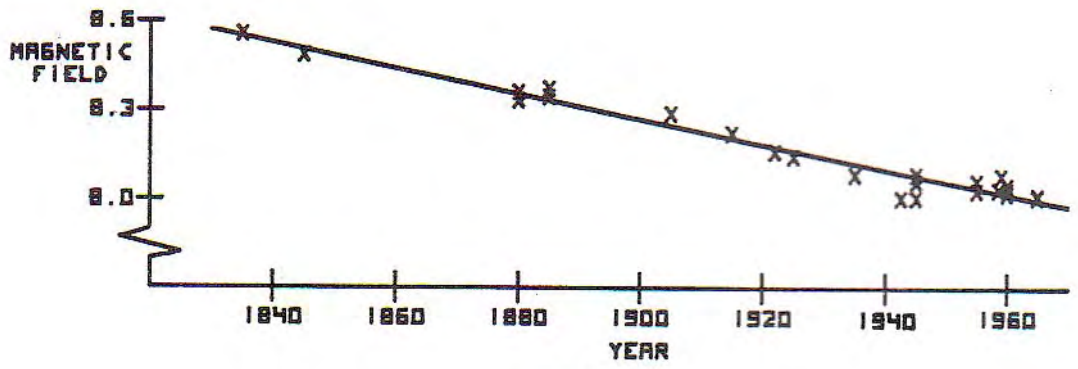

Figure 1

For earlier times the intensity of the earth's magnetic field can be estimated from magnetism of pottery kilns and rocks. Figure 2 shows data from 7,500 BC to AD 1,500, reported by Barton et al. (1979), together with the values for AD 1835 and 1965, from Barnes (1983).

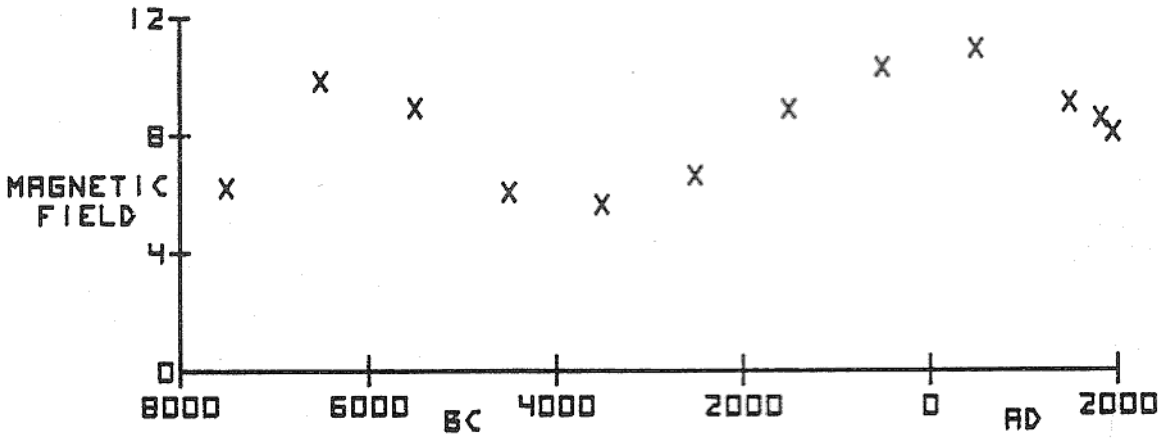

Figure 2

The agreement between the values obtained by two quite different methods is very good. For even earlier times less accurate information is available, but it is known that the earth's magnetic field has reversed itself many times. A summary of the evidence is quoted in Moffatt (1978, chap.4). Can this sort of behaviour, that is, oscillation up and down in magnitude, and reversal, be explained? In other words, is there any theory which enables us to predict this behaviour, using the known laws about electric currents and magnetic fields?

Interpretation of the data

Despite the evidence produced by Yukatake (1971), Barton et al. (1979) and many other workers (see Moffatt 1978), Barnes proceeds to fit an exponential curve to the data from 1835 to 1965. This curve is shown in Figure 1. Before continuing the reader may care to place a ruler against the curve.

It is easily seen that the difference between the curve and a straight line is very much less than the scatter in the experimental data. In such a case, unless there is a strong reason for preferring one particular form of curve, the simplest one should be accepted, in this case the straight line.

Even worse is Barnes' prediction for the strength of the field for earlier times. For AD 1500 Barnes' work would predict a value of 10.3, which is not too far off the measured 9.1. But for AD 500 he would predict 16.9, which is well above the measured 10.9, and for 7,500 BC he would predict 924.7, which is clearly grossly in error.

This brings us to Barnes' alleged theoretical derivation of the form of the 'decay'. Barnes makes many appeals to some work by Horace Lamb published in 1883 and 1884, dealing with electrical currents in spherical conductors. But Lamb's work is simply irrelevant; he specifically stated that the conductors were at rest (see Lamb 1883, p.520). The core of the earth is a liquid, as Barnes (1983, pp.8,14, etc.) accepts. If a current flows in a magnetic field there is a force on whatever carries the current. This is the principle on which electric motors work. If a force is exerted on a liquid it moves, and so the electrical currents in the earth's core must lead to motion in the core. The statement (Barnes 1983, p.68) that 'there is no physical evidence' of motion in the core can only be accepted by people unaware of how electric motors work. Once the liquid starts moving, Maxwell's equations, which both Lamb and Barnes used, are no longer adequate, and the full magnetohydrodynamic equations (see Jacobs 1963, pp.126-133) must be used. Lamb can be excused, since he wrote long before the appropriate equations had been obtained. There is no such excuse for Barnes.

Dynamo theory

The theory which explains the generation of magnetic fields in rotating, conducting liquids (or gases) is known as 'dynamo theory', since it bears some resemblances to the generation of currents by ordinary dynamos. It is applied not only to the magnetic field of the earth, but also to other planets and stars. An elementary introduction to dynamo theory may be found in Carrigan and Gubbins (1979), a somewhat more detailed exposition in Jacobs (1963), and a highly mathematical treatment of some parts of the theory in Moffatt (1978). In spite of the vast amount of literature available on this topic (the 9-year-old [now over 20-year-old] bibliography in Moffatt (1978) includes over 200 items), Barnes makes many scathing remarks about the impossibility of any dynamo action. On page 77 he writes

> 'No acceptable dynamo theory to sustain or oscillate the earth's magnetic field has ever been conceived nor is one very likely.'

This statement is simply wrong. Rikitake (1958), 15 years BEFORE the first edition of Barnes' work appeared, proposed a very simple dynamo model which did just that. Figure 3 presents a typical solution of Rikitake's equations.

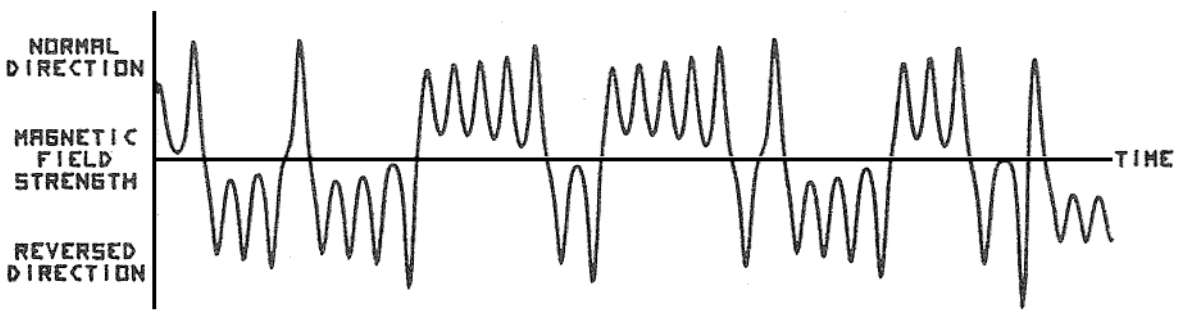

Figure 3

This shows the same sort of oscillations as are seen in figure 2, and also shows reversals at irregular intervals. If this comes from a simple dynamo model then it is perfectly reasonable to assume that more realistic models will give results closer to those measured. There is no reason to doubt that current theoretical explanations of the available experimental data, on the basis of dynamo theory, are essentially correct, although refinement is undoubtedly needed.

Conclusion

Why is the earth's magnetic field changing? It arises from electric currents in the earth's molten core, as Barnes says. But these currents flow in a magnetic field, and hence motions are set up in the core. This changes the direction of current flow, and so the magnetic field changes, which gives new motions in the core, and so on. Creationists appear to be completely unaware of this interaction between magnetic fields and currents. Maybe they have their own explanation of how and why electric motors work.

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PRECAMBRIAN FOSSILS

Tony Thulborn

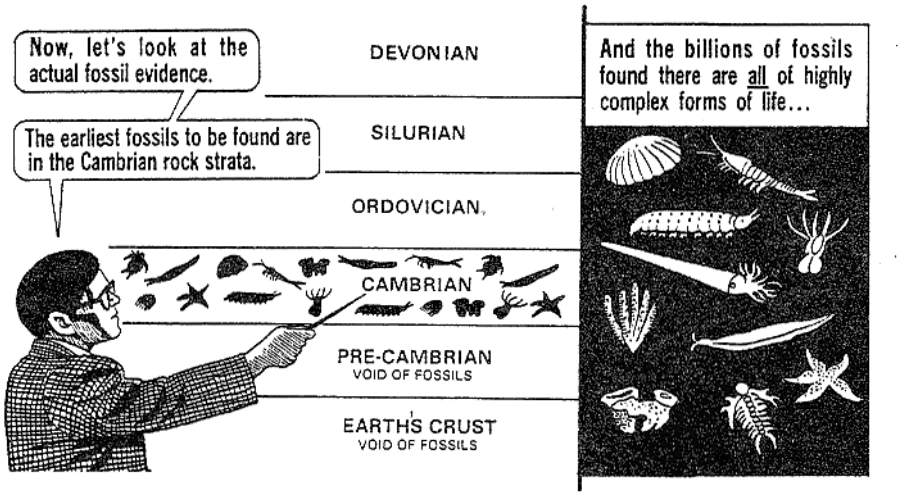
About 600 million years ago, at the start of the Cambrian period, there was an important breakthrough in the evolution of life: animals began to develop hard shells for the very first time. This breakthrough had dramatic consequences. Animals became bigger and more mobile, and they began to explore life-styles that were impossible for soft-bodied creatures. Previously, during the Precambrian, animals had been entirely soft-bodied, so that they were preserved as fossils only in unusual circumstances. By contrast the hard-shelled animals of the Cambrian were frequently preserved as fossils.

Creationist claims

Creation scientists often claim that the seemingly 'sudden' appearance of fossils at the start of the Cambrian is evidence of divine creation. If this were true there would be no fossils at all in the Precambrian rocks — for the simple reason that those rocks would have been formed before the creation of animals and plants. The fact that fossils do occur in the Precambrian flatly contradicts the so-called 'creation model' of earth history.

Precambrian fossils are a major headache to creation scientists, who usually try to conceal their embarrassment by pretending that the fossils really don't exist at all or that they aren't worth bothering about. Here are some typical examples of the way in which creation scientists try to gloss over the evidence of Precambrian fossils:

> 'These rocks, classified together under the term Precambrian, contain no fossils other than some single-celled types such as bacteria and algae.' (Kofahl 1980, p.60);
>
> 'The rocks older than the Cambrian show practically no signs of life, nothing except a few traces of what may be single cells and algae . . . Except for them, the pre-Cambrian rocks are barren and lifeless.' (Johnson 1981, p.22);
>
> 'Below this level, in rocks known as 'pre-Cambrian', virtually no fossils are found at all.' (Baker 1983, p.8).



This is perhaps the most widely known presentation of the creationist argument about the 'lack' of Precambrian fossils. The booklet, by D.T. Gish, is called *Have you been brainwashed?*, and was still being sold in 1987.

An even more revealing example comes from a biology text-book promoted by the Creation Research Society (Moore and Slusher 1974). On successive pages the evidence is quoted as:

page 421: Precambrian fossils are summarized as 'Some algae, fungi, and modern invertebrates; fossil record questionable'.
page 422: Precambrian fossils are '. . . only a few, none of which are undisputed'.
page 423: '. . . no fossils are recorded from Precambrian times'.

In the space of three pages this text-book manages to transform those embarrassing Precambrian fossils from 'questionable' to non-existent!

The facts

Despite such misleading claims indisputable fossils have been found in Precambrian rocks throughout the world — in Afghanistan, Australia, Britain, Canada, China, Mauritania, South Africa, Sweden, the Soviet Union, the United States and Zimbabwe. Among those fossils are the abundant remains of simple life-forms including algae and bacteria, some of which have been dated by reliable methods at ages up to 3.5 billion years. Other Precambrian fossils represent bigger and more complex organisms. From South Australia alone there has come an entire fauna of such animals — at least 40 species, including primitive-looking creatures resembling sponges, jellyfish, flatworms, segmented worms and sea-pens (allied to soft corals). The scientific periodical *Precambrian Research* frequently carries articles about Precambrian fossils: one recent issue (volume 29, nos.1-3, 1985) mentions no fewer than 80 species from China. There is even an entire book on the subject of Precambrian fossils (Glaessner 1984).

It is now a solidly established fact that Precambrian fossils are found world-wide and that those fossils are, in some places, remarkably abundant and diversified. Moreover those fossils are the remains of archaic and soft-bodied organisms that tie in very neatly with earlier predictions about the course of organic evolution (Barghoorn 1971; Fox 1984, p.226). When creation scientists claim that Precambrian rocks are practically devoid of fossils they are indulging in wishful thinking . . . or outright deception.

In the face of this overwhelming scientific evidence one creation scientist was recently forced to admit that Precambrian fossils really do exist after all. In a startling turnabout from the standard creationist arguments Snelling (1983) confessed:

> 'They [certain Precambrian rocks] are either rich in fossils or they commonly contain abundant organic matter which is the remains of fossils' (page 42);

and

> 'It is thus no longer feasible or possible for creationists to argue that Precambrian rocks are non-fossiliferous' (page 44).

It is worth repeating that the existence of any Precambrian fossils — even algae and bacteria — will completely demolish the standard arguments of the 'creation model'. Animals and plants cannot have been created at the start of the Cambrian if they were already in existence during the Precambrian. The existence of Precambrian fossils is substantiated by a massive amount of factual evidence, and some creation scientists (such as Snelling) now find themselves forced to admit that fact.

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A QUOTABLE QUOTE

'Thus the revival of fundamentalism fills a social void. The creationists are part of this revival, reflecting a quest for order and authority in a society increasingly influenced by censors of the right. Using representations that are well adapted to the twentieth century and claiming scientific respectability, they offer intellectual plausibility as well as salvation and the authority of science as well as the certainty of Scripture.'

Dorothy Nelkin (1982): *The Creation Controversy*, page 195.

'GAPS' IN THE FOSSIL RECORD

Tony Thulborn

Creationists often complain that evolutionary trees contain more gaps than solid evidence. They suggest that 'missing links' remain entirely unknown and that evolutionary tree-diagrams are therefore based on imagination rather than fact. The following generalizations are typical of their complaints:

> 'The fossil record has many embarrassing gaps, even reversals. It has been said that the record is 'composed mainly of gaps' and that it does not provide intermediate forms between species.' (Kofahl 1980, p.57)

> 'The fossil record reveals the absence of transitional forms of life (which should be in abundance according to Evolutionary theory).' (Taylor 1983, p.35)

There are indeed some gaps in the fossil record — as orthodox scientists have always openly admitted. But there are also many and convincing examples of transitional forms — though this fact is never mentioned by creationists. Most interesting of all is the fact that the so-called 'creation model' of life-origins contains far more gaps than a conventional evolutionary tree!

'Gaps' and the 'Creation Model'

A favourite ploy of creationists is to compare an 'Evolution Model' of earth history to a 'Creation Model' of earth history (while conveniently overlooking the fact that these two 'models' are not logically equivalent). Such a comparison reveals that the so-called 'Creation Model' actually contains more gaps than the 'Evolution Model'.

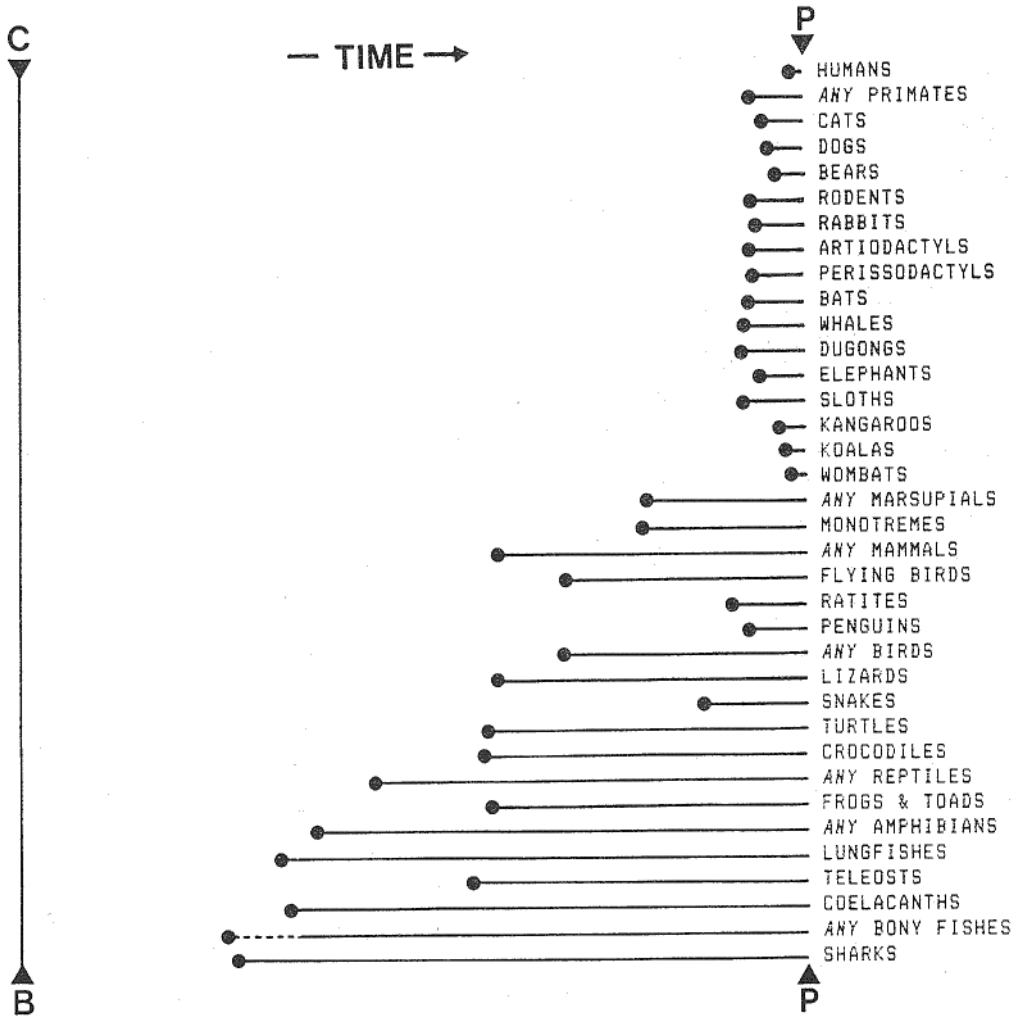

Figure 1 is a rough diagram of the 'Creation Model' and its implications. The line C/B represents the base of the Cambrian rocks — often taken by creationists to represent the geological time-level of the Creation event. On the right-hand side the line P/P indicates the present day, with a list of some common 'kinds' of animals. (Creationists inevitably refer to 'kinds' of organisms — though 'kind' is not a recognized scientific term). If the creation model were true, all of these 'kinds' (and others) should have a fossil record extending back to the creation event (the line C/B). None of these 'kinds' extends that far back. Something like 70 percent of this diagram is composed of gaps; in fact, it contains far more gaps than a conventional evolutionary tree!

Figure 1 also shows that the various groups of animals do not make their first appearance at random. Instead they appear in the definite order that is predicted and explained by theories of evolution. Primitive organisms such as sharks appear earliest, followed by amphibians and reptiles, and then by mammals and birds.

Reasons for the 'Gaps' in the Fossil Record

Standard text-books of palaeontology (the scientific study of fossils) usually begin by pointing out that the fossil record contains only a tiny fraction of all the animals and plants that have ever existed. Consequently it is not surprising that there should be a number of gaps when scientists attempt to reconstruct the genealogy of those animals and plants. Archaeologists encounter similar gaps when they attempt to trace the course of human history, as do historians when they investigate the biographies of historical figures. Those gaps do not mean that we cannot unravel the outlines of human history or that biographies are pure imagination; nor do the gaps in the fossil record prevent scientists from discerning the evolutionary history of life on earth (see Patterson, 1977, for a clear summary of all the evidence).

Some theories of organic evolution predict that there will be gaps in the fossil record. For example, the concept of allopatric (geographic) speciation maintains that a new ('daughter') species originates as a small population of animals or plants that become geographically isolated from the bulk of the population in the ancestral ('parent') species. In other words, allopatric speciation predicts that 'parent' and 'daughter' species will be found in different places; it will be unusual to find fossils of both species preserved in a sequence of rocks at any one place. Good discussions of allopatric speciation are given by White (1968) and Eldredge (1971).

Then there is the concept of punctuated equilibria, which involves the idea that a new species originates rapidly from an ancestral species — perhaps in the course of a few generations. The rapidly-evolving transitional forms would be so few in number, and so ephemeral, that they would stand little chance of being successfully preserved as fossils. The implications of punctuated equilibria are well explained by Eldredge and Gould (1972) and by Gould and Eldredge (1977).

Finally there is the very real possibility of 'clandestine' evolution. Adult organisms have very limited capacity for structural change (aside from the ability to heal injuries or to regenerate lost parts). New structures and evolutionary advances are most likely to be incorporated during embryonic development, when organisms are in the very business of building their body structures. The development of an embryo can be likened to a definite building 'schedule' or 'programme' that is controlled by genes. Some genetic controls resemble on/off switches: they instruct the embryo when to begin building a particular body structure and when to cease building it. Other genetic controls may be compared to the accelerator and brake pedals in a car: they control the speed at which the embryo builds its various body structures. Even the smallest changes in these controlling genes can have profound effects: the embryo may speed up or slow down the growth of individual structures within its body, with the result that it may add extra developmental stages or delete existing ones. It is obvious that embryos have tremendous potential for evolutionary change — and it is equally obvious that embryos are very unlikely to be preserved in the fossil record. Many evolutionary changes may remain hidden (or clandestine) because they took place in embryos which were rarely preserved as fossils. The evolutionary potential of embryos is discussed in detail by Gould (1977).

In summary, gaps do exist; but those gaps may not necessarily betray the inadequacy of the fossil record. The gaps may be an indication that new species emerged rapidly in geographic isolation, and that evolutionary changes occurred in embryos rather than in adult animals. Despite those gaps there are still many good examples of 'missing links'.

'Missing Links' Discovered

Creationists often state that there are no examples at all of transitional forms in the fossil record. In making that statement they overlook (or choose to ignore) a vast amount of evidence to the contrary. The fossil record contains literally thousands of transitional forms.

A very brief search through the literature on fossils enabled Cuffey (1984) to find no fewer than 350 examples of transitional forms, among organisms as diverse as protozoans, corals, molluscs, arthropods, echinoderms, fishes,

amphibians, reptiles, birds and mammals. Some of those fossils were transitional between species while others were transitional between genera or higher taxa (such as orders or classes).

The fact that many such fossils are transitional forms is not always stressed by palaeontologists, for at least two reasons. The first reason is one of motivation. Well before the end of the 19th century evidence from the fossil record had fully substantiated the reality of evolution. Subsequently palaeontologists spent less and less time confirming what was already a well-known fact. Today's physicists do not devote their lives to proving that Newton was basically right about gravity; and astronomers do not waste their time by repeatedly demonstrating what has been known since the days of Galileo. Nor do palaeontologists find it necessary to repeatedly confirm the well-established outlines of evolution. Nowadays palaeontologists have different and more pressing tasks — such as the refinement of the geological time scale and the search for mineral resources.

The second reason why transitional fossils are not always labelled as such is a matter of practical convenience. Palaeontologists frequently discover fossils that are intermediate between two species. Usually they try to 'squeeze' those transitional forms into one or other of the previously-defined species. Transitional fossils are simply 'lumped' into the most similar species as a matter of convenience; if they were not, each transitional fossil would have to be placed in its own separate species and scientists would soon be overwhelmed by a vast number of species names! As a result of this standard 'lumping' procedure a continuum of evolutionary change (a fossil lineage) becomes divided up into a series of arbitrarily defined species (segments of the lineage). In other words, an evolutionary lineage of fossils will appear in the literature as a string of species names. That string of names does not necessarily imply that each species is quite separate and distinct from the next: in many cases those species actually overlap but they have been separated arbitrarily as a matter of convenience.

Archaeopteryx and feathers

One of the most famous transitional fossils is *Archaeopteryx*, from the Late Jurassic limestones of Solnhofen, in Bavaria. From those limestones, which accumulated as soft calcareous muds some 150 million years ago, have come five skeletons of *Archaeopteryx* — all of which show the imprints of feathers. Most people consider that *Archaeopteryx* is a bird, because it has feathers. Yet every other feature of *Archaeopteryx* is matched in reptiles — more specifically in the predatory theropod dinosaurs (some of which were no bigger than chickens). To put this another way, the only feature that distinguishes birds (including *Archaeopteryx*) from reptiles is the presence of feathers (see Thulborn, 1984, for a full discussion of the evidence). Birds have feathers whereas reptiles have scales.

Is it really impossible for scales to have evolved into feathers? Many birds, from chickens to ostriches, show a continuous gradation from scales on some parts of their bodies to feathers elsewhere (Lucas and Stettenheim 1972; Dyck 1985). Moreover scales and feathers are identical in chemistry, molecular structure and mode of development (Spearman 1966). Most significant of all is the fact that scales and feathers are interchangeable. Recent laboratory studies demonstrate that chicken embryos can be induced to transform their developing scales into feathers, and their feathers into scales (e.g. Dhouailly, Hardy and Sengel 1980). In their structure and appearance such artificially induced feathers are indistinguishable from natural ones. Indeed, it now seems possible for scientists to transform scales to feathers, and vice versa, almost at will! Similar interchanges between scales and feathers are known to occur spontaneously in wild populations of birds. Does the transformation of scales into feathers require massive genetic engineering? The answer is no. The transformation is triggered by a single chemical — retinoic acid, which is probably better known as vitamin A.

Archaeopteryx is a splendid example of a transitional fossil, showing an undeniable mixture of reptile and bird characteristics. In every feature except its feathers *Archaeopteryx* is similar to theropod dinosaurs. That one distinguishing feature — feathers — represents the crucial dividing-line between reptiles and birds. And today, in the laboratory, it is possible to breach that dividing-line by using simple chemical treatment to transform scales into feathers.

Archaeopteryx is not the only example of a creature that is transitional between major groups of organisms. Equivalent intermediates are known, for example, between amphibians and reptiles and between reptiles and mammals. The case of the reptile-mammal transition is particularly well-documented: there are well over 200 genera of fossil mammal-like reptiles (also known as therapsids or 'quasi-mammals') that demonstrate a step-by-step transition from undoubted reptiles to undoubted mammals (Kemp 1982). That transitional series of mammal-like reptiles is so complete that it is difficult to decide where reptiles finish and mammals begin! In fact, palaeontologists must now rely on trifling differences of anatomy in order to separate fossil reptiles from fossil mammals (see, for example, Crompton and Sun, 1985, p.100). There are similar examples of transitional forms that sit right on the dividing-line between dinosaurs and their ancestors (see, for example, Thulborn 1980, p.252) and on the dividing-line between amphibians and reptiles (see, for example, the seymouriamorphs discussed by Romer, 1968). And these transitional forms are not exceptional cases.

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A QUOTABLE QUOTE

'In more recent times, Germany hounded out the Jewish scientists of Europe. These, arriving in the United States, added immeasurably to scientific advance here, while Germany lost so heavily that there is no telling how long it will take to regain its former scientific eminence. The Soviet Union, in its fascination with Lysenko, destroyed its geneticists, and set back its biological sciences for decades. China, during the Cultural Revolution, turned against Western science and is still laboring to overcome the devastation that resulted.

Are we, with all these examples before us, to ride to destruction under the same tattered banner of orthodoxy? With creationism in the saddle, American science will wither, and we will raise a generation of ignoramuses who will not be equipped to run the industry of tomorrow, much less to generate the new advances of the days after tomorrow.

We will inevitably recede into the backwater of civilization, and those nations that retain open scientific thought will take over the leadership and the cutting edge of human advance.

I don't suppose that the creationists really plan the decline of the United States, but their loudly expressed patriotism is as simple-minded as their "science" and, if they win out, they will, in their folly, achieve the opposite of what they say they wish.'

Isaac Asimov (1981): *New York Times Magazine*, June 14, p.101.

A QUOTABLE QUOTE

'Incidentally, I'm working on a theory that the attempt to persuade Americans that the world is 6,000 or so years old is actually a diabolical Russian plot, because some KGB genius realizes that 'creationism' will ultimately destroy the US oil and mining interests. The next move is to get Congress to pass a law making pi = 3, as is clearly stated in I Kings 7:23 and II Chronicles 4:2. Then Detroit will be forced to manufacture cars with elliptical wheel, etc. You can take it from there . . .'

Arthur C. Clarke (1984): *1984: Spring*. page 265.

THE REEFS OF ABRAHAM

Ralph Molnar

Peter Isdale (1984) described a method of determining the volume of flow of the Burdekin River during prehistoric times. The coral of Pandora Reef, which lies in the path of water flowing out from the Burdekin (the river plume as it is called) deposits fluorescent material into its skeleton. This material fluoresces under ultraviolet light, and the intensity of the fluorescence is proportional to the amount of water flowing from the Burdekin. By matching the amounts of fluorescence over the historical period with the recorded monthly flow of the river, Isdale demonstrated this match, and, by using the fluorescence, he was able to determine the amount of outflow during prehistoric times. Having the fluorescent bands as a marker for the yearly wet seasons, the rate of growth for Pandora Reef may be easily determined by dividing the vertical depth of coral over which fluorescent bands had accumulated by the number of those bands.

I am sure Isdale never suspected that his method would be used as the basis of a claim that the entire Great Barrier Reef has formed since the time of Abraham, about 3700 years ago. Nonetheless, this has been done by Read and Snelling (1985). They suggest that if Pandora Reef grows at an average of 15.7 mm per year (which is approximately the 15 mm per year given by Isdale) this means that the entire reef, which is 55 metres high, grew in less than 3700 years, and was not present during the time of Abraham.

This argument occupies only one-half page of the two and one-half page article. The remainder is occupied by a more-or-less accurate account of Isdale's paper.

Now let us examine this conclusion logically. Read and Snelling point out that a growth rate of about 15 mm per year agrees with previously measured rates of 5 to 25 mm per year, but do not mention that the first rate is of growth upwards (vertically) and the second range of rates applies to growth outwards (Isdale 1984, p.578). They then extrapolate this rate, which has been measured only for corals growing within 20 km of the present shoreline (Isdale 1984, p.578) to all corals. This is a reasonable procedure, but it is poor form not to point out that extrapolation was involved.

However there is a fundamental problem with Read and Snelling's conclusions. If we wish to determine the age of a tree that is still growing we determine how rapidly it grows, and if the rate of growth is constant or varies. We then divide the height of the tree by the growth rate and so obtain an estimate of the age of the tree. This is the procedure Read and Snelling have adopted. But there is a difference between trees and coral. Corals stops growing when they reach the surface of the water, whilst trees do not reach any such surface which prevents further growth. Read and Snelling (1985 p.9) have measured the height of the Great Barrier Reef (although which reef is not stated) from the surface of the water to the edge of the continental shelf. This means that the reef is not still growing. What they have estimated is not the age of the reef, but the time it took to grow, which was approximately 3700 years. Unless it has just encountered the surface of the water, and Captain Cook can testify that it did not, then it is more than 3700 years old.

So after all Abraham could have had a Barrier Reef holiday. The travel arrangements, however, might just have been a bit tricky.

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A QUOTABLE QUOTE

'It is wrong to hold creation and evolution as mutually exclusive alternatives. I am a creationist and an evolutionist. Evolution is God's, or Nature's, method of Creation. Creation is not an event that happened in 4004 B.C.; it is a process that began some 10 billion years ago and is still under way.'

Theodosius Dobzhansky (1973): *The American Biology Teacher*, vol.35, p.127.

THE MYTH OF 'CREATED KINDS'

Tony Thulborn

In reading about creationism and evolution you may have noticed one curious fact: creationists and orthodox scientists use quite different words to identify groups of animals and plants. Scientists use words like species, genus, family, order and so on (e.g. the domestic cat, species *Felis catus*, in the genus *Felis*, in the family Felidae, in the order Carnivora). By contrast creationists use the word 'kind' (e.g. the cat 'kind'). What, exactly, do creationists mean by the word 'kind'? And why do they persist in using such non-scientific language?

What is a 'Kind'?

The word 'kind' does not appear in any modern dictionary of science. It is only used by creationists. Yet no one, not even a creationist, has ever been able to provide a satisfactory definition of a 'kind'. A satisfactory definition means an *operational* or *workable* definition — one that allows you to identify a 'kind' with absolute certainty.

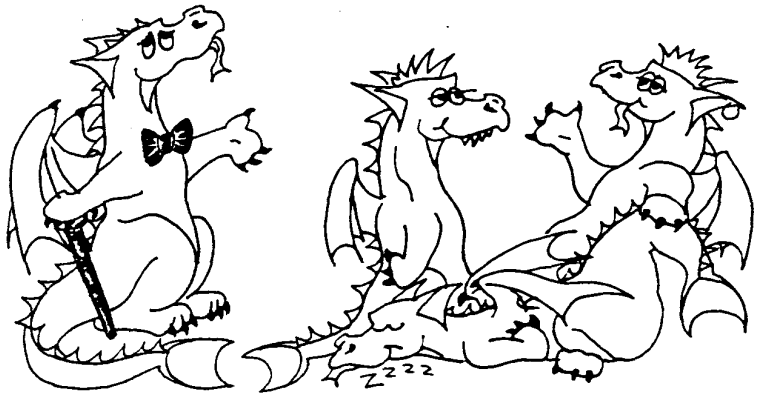
Creationists have often tried to define a 'kind'. But most of their definitions have been failures: they simply don't work. Occasionally creationists have concocted definitions that do work, but these convey nothing that wasn't said earlier (and often more clearly) by orthodox scientists. In trying to explain what they mean by 'kinds' creationists commonly take three approaches: etymology, example and negative statements.

1. Etymology. Here creationists try to convey the meaning of the word 'kind' by referring to its historical derivation. Taylor (1983, p.23) gives a good example.

> 'In Genesis 1 and 2 we read that God created the basic kinds of plants and animals. These basic units among living things are referred to by Creationists as "Genesis kinds" or "baramin". [Baramin: a coined word formed by writing the Hebrew roots bara (created) and min (kind) . . .].'

However, 'the Bible does not precisely define the boundaries of the created kinds . . .' (Kofahl 1980, p.54). Consequently an etymological definition is of no practical use: it tells us where the word 'kind' came from, but it doesn't actually tell us what a 'kind' is.

2. Example. Creationists frequently try to explain the meaning of 'kind' by giving one or more examples. Often they will cite cats, dogs, horses and humans as examples of 'kinds'. Such a list of examples does not constitute an operational definition. The knowledge that cats and dogs and horses are 'kinds' does not allow you to decide about turtles, ostriches, bumble-bees or anything else.



'How unkind to think that my kind is like their kind! Whatever a kind is . . .'

3. Negative statements. Creationists commonly state what a 'kind' is *not*, leaving you to guess, by implication, what a 'kind' might actually be. So, for instance, it is often stressed that a 'kind' is not necessarily the same as a species:

> 'Creationists do not consider created kinds as species as we know them today'
>
> Moore and Slusher (1974, p.439)

Such negative statements will never produce an operational definition. It would be exactly the same if a child asked 'What is a butterfly?' The child's parent might answer with a string of negative statements (It's not a worm, not a beetle, not a spider, . . . and so on) without ever explaining what a butterfly is.

In some cases creationists have been asked outright to define a 'kind' or have tried to construct operational definitions. On every occasion those creationists have argued themselves into a corner or have produced definitions so trivial that they say nothing worthwhile. Three examples should suffice.

1. In the Arkansas 'Balanced Treatment' court-case of 1981 the following exchange took place between lawyer Bruce Ennis and creationist Wayne Frair (misspelt as Friar in Gallant 1984, p.296):

   Ennis: You have been studying turtles for many years, haven't you?
   Frair: Yes.
   Ennis: Is a turtle an originally created kind?
   Frair: I'm working on that.
   Ennis: Are all turtles within the same created kind?
   Frair: That's what I'm working on.

   Frair, like every other creationist cross-examined in the Arkansas case, was unable to define what he meant by a 'kind'.

2. In the handbook accompanying the 'Origins' series of creationist films, Taylor (1983) gives two definitions of 'kind'. One definition (p.19) is 131 words long; the other (p.23) is even longer — 227 words. Both definitions are non-operational, consisting of little more than etymology, examples and negative statements. The final part of the second definition is worth repeating: Taylor emphasizes that a 'kind' is not necessarily the same as a species (a negative statement!) and then says that 'New *species* can arise, but new *kinds* cannot.' (emphasis is in the original).

   Really? New species can arise? Isn't that what Darwin said? Wasn't the title of his book *The Origin of Species*? Taylor evidently didn't realise that if a new species can arise then evolution must be true. If a new species can arise then so can a new genus — because a genus is simply a collection of related species. And if new genera can arise then so can new families — because a family is simply a collection of related genera . . . and so on. In trying to explain what is meant by a 'kind' Taylor became so confused that he inadvertently affirmed the reality of evolution!

3. In a brief summary of the supposed evidence for creation Gish and Bliss (1982, pp.132-133) provided an operational definition of a 'kind'. It reads as follows:

   > 'A kind may be defined as a generally interfertile group of organisms . . . that does not interbreed with other groups under normal circumstances.'

   Compare that with a scientific definition of a species (from Abercrombie, Hickman and Johnson 1980, p.279):

   > '. . . a species is roughly a group of individuals able to breed among themselves . . . but not to breed with organisms of other groups.'

   These two definitions amount to exactly the same thing.

By now it should be clear that creationists have never managed to explain what they mean by a 'kind'. Most of their attempted definitions are outright failures: they simply don't work. Some creationists, such as Frair, admit openly that they don't know what a 'kind' is. Others, such as Taylor, only succeed in contradicting themselves when they try to define a 'kind'. The few definitions that do work (such as the Gish/Bliss example) boil down to nothing more than the definition of a species — even though creationists are adamant that a 'kind' is not the same as a species.

Why creationists use the word 'kind'

By stripping away all the verbal camouflage it is possible to figure out what creationists really mean when they talk about 'kinds'. To put it bluntly, a 'kind' is any group of organisms that a creationist cares to select. The only criterion in selecting such a group is that it should *never* provide support for evolution. This is a splendidly elastic definition! And that is exactly why creationists persist in using the word 'kind'. An example will make this clear. Imagine that scientists demonstrate the evolution of one species into another (as they often do). Creationists respond by saying that both these

species are actually the same 'kind' . . . so that it's not really a case of evolution, but merely 'variation within a kind'. If scientists demonstrate the evolution of one genus from another . . . creationists can say that both genera are the same 'kind'. And so it will go on. Whenever scientists provide an example of evolutionary change creationists will simply expand their elastic concept of a 'kind' and call that change 'variation within a kind'. Small wonder that creationists are content to leave the meaning of the word 'kind' as vague as possible. By doing so they can always refuse to acknowledge the reality of evolution: they can always call it 'variation within a kind'.

Evolution of 'kinds'

Creationists assert that 'kinds' cannot arise by evolution and that no single 'kind' could ever evolve into another 'kind'. They argue that the 'gaps' in the fossil record are clear proof of all this. Their flawed arguments about these 'gaps' are discussed elsewhere in this book. And there is clear evidence that creationist 'kinds' can arise by evolution. Let's look at two examples.

1. Humans and Chimps. Gish and Bliss (1982, p.133) assure us that any evolutionary change between 'kinds' would require 'enormous expansion of the gene pool'. In other words they maintain that one 'kind' couldn't possibly evolve into another 'kind' without tremendous genetic upheavals. Gish and Bliss have no factual evidence whatsoever to support that statement. Indeed, a look at the scientific evidence shows that Gish and Bliss are absolutely wrong.

   Creationists insist that humans are a 'kind' that is separate from all other 'kinds'. It follows, therefore, that humans and chimps must belong to different 'kinds'. Elsewhere in this book Colin Groves explains that chimps are among the closest evolutionary relatives of humans. Are chimps and humans really so different, in terms of genetics, that they couldn't have evolved from the same ancestor?

   In his book *The Intelligent Universe* Fred Hoyle, one of the most outspoken scientific critics of evolutionary biology, shows the chromosomes of a chimp alongside those of a human (1983, p.227). Even Hoyle has to concede that '. . . the similarities are striking . . .' and that the chromosomal differences are '. . . insignificant compared to the different roles that the two species play on Earth . . .'. He agrees (p.226) that '. . . the chimpanzee possesses genes that are little different from those of a man — it needs refined techniques to tell them apart . . .'. Other scientists have found '. . . an astoundingly small difference in structural genes between the two species . . .' (Gould 1977, p.405, summarising the findings of King and Wilson 1975). In short, the genetic differences between chimps and humans are trivial; these two 'kinds' could easily have evolved from a common ancestor.

2. Dogs and Bears. Dogs are probably the creationists' favourite example of a 'kind'. Yet it is not clear where creationists would agree to draw the limit of the 'dog kind'. Does this 'kind' include wolves, foxes, jackals, hyaenas? Does it extend even further, to weasels, raccoons, pandas and bears? Even among these living animals there is no very obvious boundary to what could be called the 'dog kind'. Nevertheless, for the sake of argument, let us assume that creationists would not normally include bears in the'dog kind'. Now dogs and bears both have an extremely good fossil record; there are more than 50 genera of dogs and dog-like creatures known from the Tertiary rocks alone (dated from about 70 million to 2 million years before the present). Some of those fossil forms reveal the descent of modern dogs from primitive dogs. By comparison the ancestry of bears is more surprising: as we trace back the fossil ancestors of bears we encounter creatures that become progressively more and more dog-like (Romer 1966). Ultimately the most ancient and primitive bears merge into extinct creatures that are sometimes called 'bear-dogs'. As their name implies, these animals are neither bears nor dogs, but they show features ancestral to both. Creationists maintain that bears and dogs are different 'kinds' — yet the fossil record clearly demonstrates that both these 'kinds' evolved from a common ancestral stock. It is obvious that different 'kinds' can and do arise by evolution.

These examples (humans and chimps, bears and dogs) are not exceptional. Most, and probably all, of the 'kinds' mentioned by creationists do not have sharply defined limits. And modern scientific evidence, from biochemistry, genetics, anatomy and fossils, clearly reveals that so-called 'kinds' actually merge into each other.

'Kinds' and classification

If 'kinds' were objective and definable units creationists should have been able to draw up a list of all the known 'kinds'. They have never done so. No modern creationist has ever produced a classification based on 'kinds'. Indeed, a creationist text-book of biology (Moore and Slusher 1974) plainly exposes the redundancy of 'kinds': the book has a glossary to define the technical words used in the text — but it doesn't explain what a 'kind' is. This book also includes a classification of plants and animals (pp.527-547): it is a standard classification that makes no mention of 'kinds'!

So, if 'kinds' are definable realities why don't creationists define them? If 'kinds' are objective realities why don't creationists show us an appropriate classification of plant and animal 'kinds'? The answer is obvious: 'kinds' are *not* objective and definable realities. They don't exist. They are myths.

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Courtesy of the Queensland Teachers' Journal

ILLOGICAL CREATIONISM

Ralph Molnar

'How sad that we're being taught what to think . . . and not how to think.'

attributed to John Mackay, January 1986.

This article is concerned with the logic of creationist arguments. Logic is a prerequisite for science, so that which is illogical cannot be science. Reading an interesting book on logic — such as those by Flew (1975) or Thouless (1953) or Stebbing (1939) — and then looking at creationist writings can be illuminating.

Let us look first at a two-page contribution by John Mackay (1979a). He implies that those who support evolution regard creationism as without scientific content '. . . since, in their opinion, it is a totally religious concept which involves why and not how.' (Mackay 1979a, p.12). The implication of the final phrase is that science deals only with 'how' (i.e. processes) and not 'why' (reasons). Meyer (1982) in his history of biology discusses how evolutionary biology in particular deals with questions of 'why'. Other sciences also deal with questions of 'why': such as 'Why does Mars appear red?' (because of the chemical composition of its surface). Mackay's claim thus provides a plausible but misleading idea that science is incapable of dealing with questions of 'why'. This distracts from an answer to the question of why creationism is not scientific, by providing a false definition of science in which creationism appears able to handle a question that science cannot. This diverts attention from the critical point: why scientists consider creationism unscientific. This is done by introducing a false statement as if it were true. This is the 'fallacy of many questions' (Flew 1975,p.99), but here used in a statement.

Mackay gives five claims of 'The Modern Evolutionary Theory'. He then says that by accepting these five claims as 'reasonably scientific', we accept 'any similarly constructed definition of creation as reasonably scientific' (Mackay 1979a, p.12). He does not state that this is a reasonably scientific definition, only that if it is then we must accept a similar definition of creationism as scientific. Here one may fall into a major error: confusion of the validity of an argument with its truth (Flew 1975, chapter 1). 'Valid' means 'logically sound', but need not imply truth. Consider this example:

'All tigers adore Confucius.'
'Miss J is a tiger.'

Hence

'Miss J adores Confucius.'

The logic is absolutely correct, but the conclusion is not true, because neither of the two initial statements are true. A logical argument is true if it is valid and if the assumptions are true.

Perhaps these errors, entertaining as they are, do not characterise creationist writings. Creationists have claimed that a human skeleton from Guadeloupe (in the West Indies) was catastrophically buried, probably in Noah's flood. Bowden (1984 p.45) comments on suggestions that the skeleton be dated by carbon-14 method, and the surrounding rock by other radiometric techniques (since the carbon-14 method is inapplicable). He states that the carbon-14 method 'will almost certainly give a recent date' while other radiometric methods 'will almost certainly give a very LONG age'. No reasons are given. His conclusion is 'thus proving that neither method is reliable.' (Bowden 1984, p.45). So he says if two objects dated by two different methods give different results, then both techniques are invalid. Here there is an unstated premise, namely that the two objects under debate are the same age. This is exactly the point under discussion! Bowden has assumed what he wishes to demonstrate, a logical fallacy known as 'begging the question' (Flew 1975, p.65).
Further on, he writes (Bowden 1984, p.49);

'. . . the formation of beach rocks has been known since the turn of the century, yet it still seems that the precise mechanism is still unknown for Wise says 'It is currently thought . . .'

Perhaps one can think something that is unknown, but equally one can think something that is known. What argument implies that it is unknown? Presumably the argument would be

'Things that are unknown can be thought.'
'The mechanisms of formation of beach rock can be thought.'

hence

'The mechanism of formation of beach rock is unknown.'

This is the fallacy known as affirming the consequent (Flew 1975, p.34). Incidentally it is also enlightening to read the paper by Wise (1984) and see what it is that he said ‘. . . is currently thought’.

Finally Bowden quotes a letter; ‘The skeletons are frequently in a foetal position . . . sometimes surmounted by a conical dish, giving the appearance of a Chinese head-dress.’ Later on (same page) he writes:

> ‘. . . if they ARE American Indians, then we have a simple means of dating the skeletons. We have only to ask the socio-anthropologists at what period in their culture the wearing of Chinese hats was all the rage in fashions!’

The original quotation mentions dishes that resemble Chinese hats, which somehow are transformed into Chinese hats by Bowden. This is confusing a metaphor for reality.

The reader may wonder whether all creationist writings are equally illogical. Don’t take my word for any of this — look for yourself. Read any of the creationist cult writings and see for yourself how many logical errors there are.

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A QUOTABLE QUOTE

‘Does it really advance the Christian cause by forcing the facts of nature to fit into a preconceived theory of the Earth as is done by the creationist movement? No, it harms our cause. Christ has called us to truth and honesty. We are to tell the truth in love, but we are not telling the truth if we insist that the facts of nature indicate that the Earth is very young and that the Earth was totally covered and renovated in one year by the Flood as described by Flood geologists. I am not accusing creationists of lying or deliberate distortion. No doubt they have honorable intentions, but if they continue to espouse their theories when other Christian brethren have repeatedly called attention to the falsity of their theories, they must be challenged to stop.’

Davis A. Young (1982): *Christianity and the Age of the Earth*, page 152.

A QUOTABLE QUOTE

‘In fact, scientific creationism, geocentrism and flat-earthism are respectively the liberal, moderate, and conservative branches of the Bible-Science tree. The intense hostility expressed by the scientific creationists towards the flat-earthers does not extend to modern geocentrists, who hover on the edge of respectability among creationists. Indeed, though the Bible is, from Genesis to Revelation, a flat-earth book, the geocentrists have combined forces with liberal creationists to cast the flat-earthers into outer darkness.’

Robert J. Schadewald (1983): “The Evolution of Bible-science”, in Laurie R. Godfrey (ed.): *Scientists confront Creationism*, page 293.

CLAIMS OF CENSORSHIP

Tony Wheeler

Creation science authors are disadvantaged! There is a 'black list' of creation scientists maintained by the editors of science journals so as to deny them publication. This is the claim of Dr. Andrew Snelling, B.Sc.(Hons.), Ph.D., of the Creation Science Foundation, made on Friday 22nd February, 1985, during a presentation of films at the University of Queensland.

I am a scientist. I believe that every submission to any journal should be judged on its own merits, not on any beliefs the author may (or may not) hold. I may disapprove of what they say, but I shall defend their right to say it! I was prepared to fight for justice on Snelling's behalf. 'Give me the evidence' I asked, 'and I shall pursue enquiries.'.

The response from Snelling has been a deafening silence. He received my letter; he said so on Thursday 21st March, 1985. He was writing a reply he said. It never came. Oh, Andrew! I was so prepared to do battle for your rights.

Since then I have learned that these claims of persecution are quite common (see Morris 1982; Setterfield 1984). But a recent thorough investigation by Scott and Cole (1985) has found that the absence of creationists articles from mainline scientific journals is because virtually none have been submitted.

Snelling has made other serious attacks on the integrity of the scientific community. One specific grievance was made at the meeting on 21st March. He was conducting research in the Department of Geology and Geophysics in preparation for submitting a dissertation for a Ph.D. In the course of this work he found evidence that various Northern Territory ores had an age of zero years, not the hundreds or thousands of millions of years that others had estimated (see Hills and Richards 1976). Naturally he published his remarkable findings in a creationist journal (Snelling 1981). Now, according to Snelling, because of these contrary findings, other geologists were a little upset, and, again according to Snelling, they put pressure on his head of department not to grant him the degree. But it seems that this head of department was moved by other considerations; according to Snelling the head was afraid to 'create another Galileo'. And so that is why Andrew Snelling was awarded the Ph.D. that he so obviously deserved, despite his courageous and outspoken honesty.

But it seems that Snelling's thesis did not contain any contentious ages of Alligator River ores. And it seems that his other writings were 'outside the scope of his thesis and could not possibly have had any bearing on the award of his Ph.D. degree'; so says his head of department, Professor G.M. Phillip (1985). And further, Snelling's writings on creationism were only brought to the department's attention after the Ph.D. had been conferred. And it also seems that at this time, while preaching about creationism, he was still publishing figures of hundreds of millions of years in geological journals.

So much for Andrew Snelling's claims of academic persecution. In the meantime he has risen from being a project geologist with Denison Australia Pty Ltd to a full-time employee of the Creation Science Foundation. His aim is to develop 'a completely consistent Creationist Model of Australian geology' (see *Ex Nihilo*, vol.6, no.2, p.3). Good luck!

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BIG-BANG CREATION

Ken Smith

One of the very peculiar things about those who call themselves 'creation scientists' is that they are vehemently opposed to the scientific evidence for the creation of the universe. Evidence shows that the universe came into being about 15 billion years ago, and many scientists refer to this as the "moment of creation". Two of the recent books which use "creation" in their titles are those by Trefil (1983) and Barrow and Silk (1985).

Modern understanding of the universe is based on Einstein's general theory of relativity. This has passed, with flying colours, all tests which have been made on it (see Kovalevsky and Brumberg 1986), and we can safely use it to explain physical phenomena. Gamow (1948), with some minor corrections by Alpher and Herman (1948), predicted, on the basis of general relativity, that there would be low temperature radiation filling the universe. This prediction was shown to be valid by the discovery by Penzias and Wilson (1965) of what is now called the "microwave background radiation". Penzias and Wilson shared the 1978 Nobel prize for their discovery. Such experimental confirmation of a theoretical prediction is part and parcel of the scientific enterprise.

This radiation is a relic of the time, about 500,000 years after the moment of creation, when hydrogen atoms (as opposed to ions) were first formed. Since 1965 scientists have gradually been pushing back the frontiers of knowledge closer and closer to the origin of the universe. Some fairly readable books, which indicate the many lines of evidence for estimates of the age of the universe, are those by Calder (1982), Weinberg (1983), Trefil (1983) and Barrow and Silk (1985). What happened in the very early moments of the universe is a flourishing area of research.

For some reason best known to themselves our creationist friends reject this evidence that the universe had an origin. It is probably because the microwave background radiation, together with much other scientific evidence, all points to a universe between 10 and 20 billion years old, not the few thousand years which they insist on for purely religious reasons. A creationist discussion of the origin of the universe can be found in Slusher (1978). Why anyone writing in 1978 should regard the steady-state theory, popularised by Hoyle (1950), as still viable after the discovery of the background radiation must remain a mystery. He makes the following remark about the background radiation:

> 'However, it should be noted that this background radiation can be explained on a different basis than an explosion or big bang.'

Apart from an earlier reference to a paper which itself was based on an assumption which is not taken seriously by other scientists, he gave no justification for his statement. Much of the book is taken up with standard creationist arguments against the accepted age of the universe, and does not relate specifically to cosmology or cosmogony. His bias is shown in two sentences near the end of the book.

> 'Truly we have suffered too long and too disastrously under serfdom to barren naturalistic nature-myths regarding the cosmology and cosmogony of this actual universe. The evolutionist lives in a dream world in which any resemblance to the real world is lacking.'

In fact, with the vast and ever-increasing knowledge of the universe which is being obtained, it is the creationist who lives in a dream world of his own making. Most religious people are quite happy to accept scientific evidence that the universe had an origin, however long ago it was.

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CAN EVOLUTION BE OBSERVED?

Martin Bridgstock

Most of this book is concerned with the creationists' attempts to produce evidence for their viewpoint, or against normal science. They have, however, occasionally attempted a much bolder strategy. They have tried to define the scientific evidence for evolution out of existence! The originator of this awesome manoeuvre seems to have been Henry Morris. He begins his argument by pronouncing:

> '. . . it is impossible to *prove* scientifically any particular concept of origins to be true. This is obvious from the fact that the essence of the scientific method is experimental observation and repeatability. A scientific observer, be he ever so resourceful and brilliant, can neither observe nor repeat *origins*!'
>
> Morris (1974, p.4) (Italics in the original)

Having eliminated archaeology, geology and palaeontology — to say nothing of astronomy, astrophysics and cosmology, for none of these are experimental sciences — Morris proceeds to argue that not only can evolution not be studied as a past event, it cannot be studied in the present either!

> 'If evolution is taking place today, it operates too slowly to be measurable, and, therefore, is outside the realm of empirical science.'
>
> Morris (1974, p.5)

With a couple of dazzling strokes, Morris seems to have disposed of all possible evidence for evolution. If evidence from the past cannot be studied scientifically, and evidence from the present is unobservable then — hey presto — no evidence for evolution can exist!

Morris' claims have been echoed elsewhere, for example by Snelling et al (1983, p.6) and by Doolan (1984, p.29). Once the claim is made, it is usually followed by a statement that one needs some form of preconception to study the past, and the creationist preconception is as good as any other.

Let us quickly examine the claim that science cannot investigate the past. It is clear from Morris' statement that it rests upon a false definition of science. Not all science is experimental. As we saw in the introduction, the essential characteristic of science is that it is a tentative, falsifiable attempt to use theory to explain observations. The key requirement is that theories be testable, not that they be experimental. Good examples appear in this volume. Tony Thulborn's account of Pre-Cambrian fossils is one: scientific theory indicated that certains sorts of fossils should be found, and eventually the theory was vindicated by finding them. Colin Groves' paper is replete with examples of theories being assessed, and in some cases modified with regard to observation. It seems clear, therefore, that science can study the past, and has done so successfully.

But can we observe evolution?

The question still remains, however: can we see evolutionary processes occurring today? After all, if evolution is presented as something which happened in the past, why should be believe that it happened at all? Many people do not believe what they cannot see. Can evolution be seen to occur?

The short answer is yes. For scientists, the crucial question revolves round the concept of 'speciation', that is, the process of devlopment of new species. Darwin's book was, after all, called *The Origin of Species*!

What is a species? Definitions vary slightly, but Mayr's is among the clearest. He defines a species as:

> '. . . species are groups of actually or potentially interbreeding natural populations which are reproductively isolated from other such groups.'
>
> Mayr (1940,1963)

Other definitions are on similar lines (e.g. Dobzhansky, 1970). As Archer stresses, the key concept is 'reproductive isolation' (Archer, 1987, p.33). If two groups of organisms interbreed with each other in natural conditions, then they may be termed members of one species.

One the face of it, we might not expect to find observable examples of speciation. After all, life has been on this planet for over three billion years (see Tony Thulborn's paper in this volume on Pre-Cambrian fossils), and we have been

looking for speciation for less than a century. Might not observed evolution be rare, simply because of the timescale involved?

In fact, the answer to this is no. Both in the laboratory and in the wild, speciation has been observed. What is more, the view that speciation goes on all the time is a view which leads to testable predictions. More about that later.

Laboratory-induced cases of speciation

A number of laboratory experiments have demonstrated that selective breeding can lead to speciation. Some experiments have shown the way that barriers to interbreeding arise. Kessler (1966) took two species of vinegar fly, which normally mate in about 4-5% of cases. He then bred the flies for both high and low tendencies to interbreed, and ended up with groups with quite different tendencies to cross-species mating. The tendencies varied from 0-2% for the low groups to as much as 21% for the high group. This shows that barriers to interbreeding can increase or decrease through the selection process. Of course, if interbreeding falls to zero, then the species are completely separate.

In other cases, populations of the same species of insect (*Drosophila melanogaster*) were bred separately in differing environments. After five years, the two populations were significantly less likely to interbreed.

The most striking cases of artificial speciation, though, are to be found in plants. Literally hundreds of new plant species have been manufactured. Probably the best known is the (flowerpot) primrose, *Primula kewensis.* This is a brand new species, produced artificially.. First, two species were hybridised — *Primula verticillata* and *Primula floribunda*. The offspring from this hybridisation is sterile. However, it is possible, using chemicals, to double the number of chromosomes of the hybrid. This results in a new species of plant, fertile only within itself. Many examples of this process exist, including the crocus, the tulip and the iris (Ridley, 1981, p.831).

But what about speciation in nature?

Such examples are impressive to many people, but anti-evolutionists would not accept them. After all, why should they believe that an experimental production of species could also occur in the wild? In the case of natural plants, there is a way of looking. If this process happens naturally, then we would expect to find plants with chromosomal multiplication. And indeed, sizeable numbers of plants have two, three or four times the normal number of chromosomes. About 47% of all flowering plants come from speciation events of this type.

However, we still have not looked at the case of speciation observed in nature. Have species been observed appearing in the wild state? The answer is yes. One clear-cut case is cited by Archer (1987). The apple maggot fly first became noticed in 1865, when it began to infest apple trees. Previously, this insect had used the native North American Hawthorn as its home. However, Bush (1969, 1975a,b) found that some insects had transferred to the apple. Because of the different ripening times of apples, these insects had different maturation times, different relative body sizes, oviposter size, and other characteristics. Because of the different maturation times, there is no interbreeding and the apply maggot fly is now two species.

The study by Prakash (1972) of the vinegar fly yielded similar results. The fly was transported from Guatemala to Colombia, and a few years later was exhibiting different reproduction characteristics from other populations of vinegar flies.

Further points on speciation

From this sort of evidence, it is pretty clear that the process of speciation is going on all the time. A comprehensive study of the various processes of speciation is that of White (1978). It is astonishing that creationists are unaware of the depth of research that has gone into this topic.

The processes of speciation are central to the whole theory of evolution. One can go further, however, and look at the situation we find in nature. If speciation is an ongoing process, then as we look at creatures in nature, we should find a mass of more or less overlapping populations, varying from ones which are completely interfertile, through all gradations, to those which are reproductively distinct. This, indeed, is exactly what we do find. A good example is that of ring species. Ridley describes a striking case like this:

> 'The herring gull and the black-backed gull co-exist in Britain, but do not interbreed. They are connected, however, by a more or less continuous series of interbreeding populations distributed around the North Pole. If you move west from Britain, across North America, the gulls look more like herring gulls. They continue to vary as you make your way round the North Pole until by the time you reach Siberia they are starting to look more like black-backed gulls. When the extremes meet, as they do in Britain and Northern Europe, they do not interbreed. There is a kind of unilateral speciation.'
>
> Ridley (1981, p.832)

As Ridley points out, this is very difficult for creationists, since they have to explain this remarkable gradation, and why so many subtly different gulls were created. By contrast, the normal scientist can point to this as an example of the barriers between species not being immutable.

Perhaps one other example will suffice. It comes from Dobzhansky, and concerns the drosophilid flies in Hawaii. As Dobzhansky points out, there are about 2,000 species of drosophilid flies in the world, and about a quarter of them occur in Hawaii. Of these, all but 17 are unique to Hawaii. What is more, these species exhibit diversity not seen elsewhere: the largest and smallest drosophilids are in Hawaii, as well as strange species, such as the one which lives as a parasite in spiders' egg cocoons.

This can be explained, suggests Dobzhansky, in terms of evolution. The drosophilids arrived early in Hawaii, and diversified to fill the many available niches. What might creationists have as an explanation?

> 'Antievolutionists might perhaps suggest an alternative hypothesis: in a fit of absentmindedness, the Creator went on manufacturing more and more drosophilid species for Hawaii, until there was an extravagant surplus of them in this archipelago. I leave it to you to decide which hypothesis makes sense.'
>
> Dobzhansky (1983, p.26)

Implications

What does all this mean? The first point, obviously, is that creationist claims that new species have not been observed emerging are just plain wrong. They have been observed, both in the laboratory and in the natural state.

It is also worth noting that evolution — a genuine scientific theory — offers predictions in many directions. Creation, on the other hand, gives no understanding of what we actually find in nature. For example, we have seen that creation gives no clue to the ring distribution of the black-backed and herring gulls. Again, if all plants were created, why do do many show the phenomenon of multiple chromosomes? And, as Dobzhansky has pointed out, the creationist explanation makes no sense when confronted with the diversity of drosophila in Hawaii.

However, creationists do not seem totally unaware of this evidence. Andrew Snelling was confronted with an example of speciation when I cited the case of the apple maggot fly. His reply was to the effect that these were not large changes. This is not a substantive criticism, as Richard Dawkins (1986, chapters 3 and 4) has demonstrated that small changes, cumulating steadily, can produce the enormous range of diversity we see in living things.

Some creationists do not exclude the possibility of speciation. They are, in general, bound to their concept of invariant 'kinds', and believe that living creatures cannot vary beyond the boundaries of their 'kind'. The problem with this, as Tony Thulborn points out elsewhere in this volume, is that the concept of kind has no meaning. Creationists will have to specify the meaning of 'kind' before their claims can be examined.

Creationists are therefore in a cleft stick, and show no signs of solving the problem. If they deny the possibility of new species emerging, then they are contradicted by a mass of empirical data. If they restrict their statements to their chosen idea of 'kind', then their commments have no meaning. For the rest of us, the evidence for speciation is a powerful argument in favour of the theories of biological science.

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BITS AND PIECES: OTHER CREATIONIST ARGUMENTS

Martin Bridgstock and Ken Smith

Creationists have produced a range of other arguments. We will look at some of the most common here.

1. Ocean sediment

Perhaps the most magnificent example of a creationist inserting both feet in his mouth is Henry Morris, when he writes that,

> '. . . the present rate of sedimentary erosion would have reduced the continents to sea level in six million years and would have accumulated the entire mass of ocean-bottom sediments in 25 million years. Present rates of volcanic emissions would have produced all the water of the oceans in 340 million years and the entire crust of the earth in 45 million years.'
>
> Morris (1972, p.92)

Other creationists seem to have different ideas. Chick (1976, p.30), for instance, thinks that the continents would have washed away in fourteen million years, not six. More striking is that Morris has indicated perfectly clearly that he is aware of forces building up the land, as well as ones eroding it. Yet instead of arriving at a net figure, he takes them separately and pretends that they both point to a young earth!

In fact, there are more factors than volcanic emissions building up the land. The movements of continents, through plate tectonics, have been directly measured with laser satellites (Abell 1983, p.36), and these movements, in some circumstances, produce the rising of land from the sea, and these too have been measured (Bandy and Marincovich, 1973). In other circumstances, one geological plate slides beneath another, disposing of ocean-bottom sediment.

In fact, sediments provide excellent verification of the idea of an ancient earth. Hudson (1964) plotted the thickness of strata against their age, as measured by radioactive dating. He found an excellent, and very strong, correlation between them. If EITHER radioactive dating were unreliable, OR strata were deposited quickly, during Noah's flood, then this result is inexplicable.

2. The argument from design

('A watch implies a watchmaker, and living things are so much more complicated than any watch')

We have heard this argument described as 'unanswerable', but cannot see why. There are several perfectly good responses. A religious believer might point out that accepting a creator does not mean that the creator did the work in six days, nor that nearly all of it was wiped out in a flood. Indeed, science is precisely the discipline which can tell us HOW creation was accomplished ('After all, a watchmaker has tools.'). The means used for creation appear to include a beautifully simple set of basic laws, and great amounts of time. The simplistic creationist cuts himself off from these questions, and so bars himself from grasping the true majesty of the creation. It can also be pointed out that the person who argues from design must talk about the WHOLE of creation, not just selected parts.

For example, why was the poliomyelitis virus created, or the smallpox germ? Why was a terrible disease like elephantiasis created? Even if this is attributed to Original Sin, the questions can be pushed further. What about the ichneumon fly and other solitary wasps? These lay their eggs in the bodies of other creatures. When the young hatch, they eat their way out through the living flesh of the host. How does the simplistic creationist account for this marvel?

3. It's all bias!

Australian creationists are fond of equating their views and those of science, by arguing that both reflect an underlying bias. In the case of creationism, of course, that bias is toward God, in the case of normal science, it is alleged to be atheistic or perhaps Satanic. And since science, they say, is as bigoted and dogmatic as creationism, the creationists can continue making their dogmatic statements. It's not a question of being dogmatic, merely of which dogma.

This torrent of sophistry conceals a vicious misinterpretation of the way science actually works. If science is motivated purely by bias, how do creationists explain that science changes? Consider for example, the theory of continental drift.

It was rejected by scientists when it was first put forward, because no forces could be found strong enough to move continents about. Later, when it became clear that such forces did exist, the theory was accepted. This sounds a perfectly reasonable account, but how would creationists explain what happened; did the bias change?

The same point applies to any scientific advance. If science is all bias, how does it make new discoveries? What about all the new drugs and medicines which appear? What about the discovery of the structure of DNA, the overthrow of the principle of the conservation of parity or the discovery of the silicon chip? All of these can easily be explained in terms of intelligent people trying to understand the material world; if the creationists are right, and science is simply bias, then how were the discoveries made at all?

By contrast, creationism fits closely the idea that it is completely bias. Its ideas are fixed, and seem to depend not at all upon observation and evidence. Some clear examples of this can be found in the quotes section of this book. Again, if creationism and science are equally biassed, then we might expect them to be about equally successful in making discoveries. We are still waiting for the first creationist antibiotic, or oil strike, or breakthrough in biochemistry, or prediction of a new particle in physics.

In sum, creationism certainly appears based on bias and dogma. Their attempt to pin the same label upon science appears to reflect both an ignorance of what science is actually about, and an attempt to muddy the waters of debate.

4. The improbability of life arising naturally

Regularly throughout creationist literature one reads calculations which purport to show that the probability of life arising by natural causes is so low that to all intents and purposes it cannot have happened. It has been likened to the probability that a tornado in a junk yard would produce a modern airliner. Are these estimates correct? And if they are correct, what do they mean?

In fact, events which, on the face of it, are extremely improbable have occurred. Let us consider Queensland's Five Dollar Casket. There are 100,000 tickets sold at $5 each; the first prize is $200,000, second prize $30,000, and so on down to 1,000 prizes of $20 each. What is the chance that ticket number 85705 wins first prize? It has 1 chance of winning, and 99,999 chances of not winning, so the odds are 99,999 to 1, or about 100,000 to 1. What is the chance that, in the same casket, ticket number 23089 wins 2nd prize? This is also 100,000 (about) to 1. The chance that both these events happen is then $100{,}000 \times 100{,}000$ to 1, or 10,000,000,000 to 1. If we now add the chance that ticket number 87943 wins 3rd prize, the odds become $100{,}000 \times 100{,}000 \times 100{,}000$ to 1, or 1,000,000,000,000,000 to 1. We can keep specifying numbers for prizes in this way. Suppose we conclude by saying that we want tickets 00129, 00312, 00379, . . . , 99954, 99985 each to win a $20 prize. Since each of these has 1,000 chances of winning and 99,000 chances of losing the odds against 00129, 00312, etc., each winning $20 are only about 100 to 1. If we put all these together the odds against this specified set of tickets winning the stated prizes turns out to be about 10^{2350}, that is, 1 followed by 2350 zeros, to 1. These odds are astronomical. There is no way in the world, one would think, that such an event could possibly happen. But it did! These are the numbers which won the specified prizes in Casket 119, drawn on November 13, 1985.

What has all this to do with the probability of life arising spontaneously? It is the distinction between predictions made before and after an event, and the misleading assumptions built into creationists' arguments. The odds against a specific set of numbers winning casket prizes is that given, but SOME set of numbers MUST win the prizes. In the same way creationists assume that the specific proteins which go to make up various parts of living organisms are the only possible proteins which would work, whereas it is known that many variations of these work equally well. One has only to think of the various blood groups or hair colours to realise that plenty of variation exists in nature.

But the fundamental error made by creationists is the implicit assumption that proteins are formed in a single step, like the Casket draw. The truth is that the proteins we now have are the result of a long process in which favoured ones are preserved. These are used as the basis for the next step, and so things are gradually built up to the complexity we now see in living things. Taken together with the point mentioned earlier that many different protein molecules may equally well serve the same purpose, creationists' arguments about the improbability of life arising by natural causes are misleading, to say the least.

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DID HUMAN BEINGS EVOLVE ?

Colin P. Groves

> ' . . . but man, proud man,
> Drest in a little brief authority,
> Most ignorant of what he's most assur'd,
> His glassy essence, like an angry ape,
> Plays such fantastic tricks before high heaven
> As make the angels weep . . . '
>
> William Shakespeare, *Measure for Measure*, II.ii.114-122

The Macquarie Dictionary defines Ape as follows:

> '1. a tailless monkey or a monkey with a very short tail. 2. an anthropoid ape. 3. an imitator; a mimic. 4. any monkey. 5. (formerly) £500.'

— while an Anthropoid Ape is:

> 'any ape of the family Pongida, comprising the gorilla, chimpanzee, orang-utan, and gibbon, without cheek pouches or developed tail.'

— which is a serviceable, if old-fashioned, definition, apart from the (perhaps inadvertent) misspelling of Pongidae as Pongida.

In the Classical World of Greece and Rome, no Anthropoid Apes were known. Occasional monkeys reached them: there is, for example, a beautifully stylised fresco found on Thera of a pair of long-tailed monkeys, which look to me like mona monkeys from West Africa. The Greeks knew of baboons and other large monkeys which the Egyptians obtained from Sudan and Ethiopia and kept alive, fed them inadequately, and mummified them after their untimely deaths: these they called sphinxes and cercopitheci. But the monkey best known to both Greeks and Romans was the virtually tailless species which, then as now, roamed the oak forests of the Atlas Mountains: the Barbary Ape (*Macaca sylvanus*), which the Greeks called Pithecus and the Romans Simia. Galen, the famous physician, dissected one and was struck by how very human-like it was in its anatomy.

St. Augustine, a North African himself, disagreed implicitly with Galen's assessment, and laid down that living creatures were clearly divided into those with reason (human beings) and those without (animals: including monkeys). The 13th-century theologian Albertus Magnus, on the contrary, insisted that there was a third, intermediate category, into which monkeys fitted: these were creatures which, while lacking the facility to reason, have some control over their animal natures (memory, imitative ability). The other member of this intermediate category, incidently, was 'pigmies': what he meant by this we do not know, but it is possible that even then some Anthropoid Ape had been brought alive to Europe. As we shall see, the 'pygmies' of Greek legend were for some centuries identified with Anthropoid Apes, especially chimpanzees.

With the establishment of the Dutch East India Company in what is now Indonesia, stories began to reach Europe of the great Orang Utan (literally Wild Man) of Borneo. Jacob Bontius described one in the mid-17th century. In 1641 Nicholaas Tulp, a physician, saw a live chimpanzee in Holland and published a description of it, calling it an 'Orang-outang', and noted its very human demeanour and features. In 1698 an English anatomist, Edward Tyson, dissected a young chimpanzee that had died in England, and his meticulous description of its anatomy was published in the following year, revealingly entitled: *Orang-outang sive Homo sylvestris: or, the Anatomy of a Pygmie compared with that of a Monkey, an Ape, and a Man*. Still more revealing were the lists of anatomical characters he drew up, comparing the chimpanzee with the 'ape' (the Barbary Ape, of course) and with humans: in 47 such characters it resembled the human condition, while in 34 it resembled the monkey.

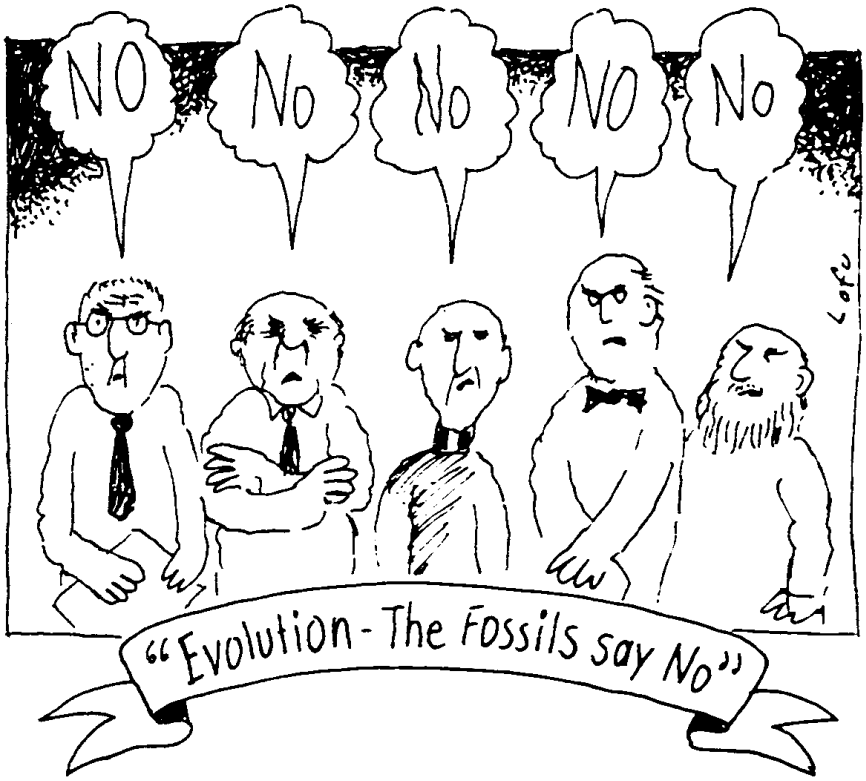
The primates

Today, we recognise that humans, apes (this term being generally now restricted to Anthropoid Apes only, and this is the sense in which I will use it from now on), monkeys, and lesser-known animals such as tarsiers, lorises, bush-babies and lemurs, belong together in a special Order of Mammals. Like other mammals, we and the apes and others have body hair, are warm-blooded, and (in the case of the females) suckle the young with milk; but unlike other mammals, we all

have grasping, dextrous hands (and, usually, grasping feet too), large brains, and eyes that face forward giving us widely overlapping fields of vision. There are many other features — in teeth, skull, skin, reproductive anatomy and so on — that unite this whole group from people to lemurs. The name of the order to which we all belong is Primates.

There is disagreement how to classify the different groups of primates, but there is no disagreement that apes and humans belong together in a superfamily, Hominoidea. We share a very large number of anatomical characteristics with the apes. For example we and the apes are truly tailless; the other primates all have some tail, at least, even those monkeys that are so short-tailed that they in the past have been designated 'apes' (Dictionary definition no.1), such as the Barbary 'Ape'. In the Hominoidea, the tail is so much shortened that its vertebrae, 3 to 5 in number, are merely nubbins of bone, fused together, and turned inwards (rather than outwards as in a tail) to form a small bony shelf, called the Coccyx. All the Hominoidea can sit and even stand upright with some facility. The lumbar vertebrae are a different shape, and 4 to 6 in number (less than in other primates). The chest is broad, not narrow like monkeys, lemurs and the others. And so on: the whole skeleton is different from that of other primates. And there are non-skeletal differences too: for example, that much-maligned organ, the Appendix, is possessed only by the Hominoidea.

Since all these features are found only in the Hominoidea, and not in any other primate — nor, as far as I know, in any other mammal — we deduce, on an evolutionary model, that the common ancestor of the *Hominoidea* possessed them all, having changed from the primitive condition found in other mammals. There have been a number of hypotheses as to why this common ancestor would have developed these features (locomotion by arm-swinging in the trees, called brachiation, is a commonly held theory), but the point is that the hypothesis that there was such a common ancestor is the one which, at a stroke, accounts for the similarities which we and the apes share and the monkeys do not. A hypothesis that human beings and the four genera of apes were created separately, independently, leaves the common possession of so many anatomical features utterly mysterious.



The dictionary says that the anthropoid apes all belong to the family Pongidae. This is certainly the classification that was universally adopted up till about 1963; then it began to change, as it became quite clear that the different genera of apes are not more closely related to each other than some of them are to ourselves. It is quite clear, for a start, that the ancestor of the gibbons separated from the common ancestor of all the other apes a very long time ago. The gibbons have the long, sharp canine teeth, a primitive condition; the chimpanzee, gorilla and orang utan (the Great Apes, as they are called) have shorter, stumpier canines, and the human canine is of course shorter still. The gibbons have a thick coat of fur, with 700 or more hairs per square centimetre of skin: another primitive character, shared with monkeys; in Great Apes and humans the hair is much sparser, at most 200 hairs per square centimetre on the back and 100 on the chest (the difference between us and apes is that our body hair, while only slightly sparser, is much shorter and less heavily pigmented). The wrist is much more flexible in humans and Great Apes, due to anatomical modifications. And so on.

Humans, gorillas and chimpanzees

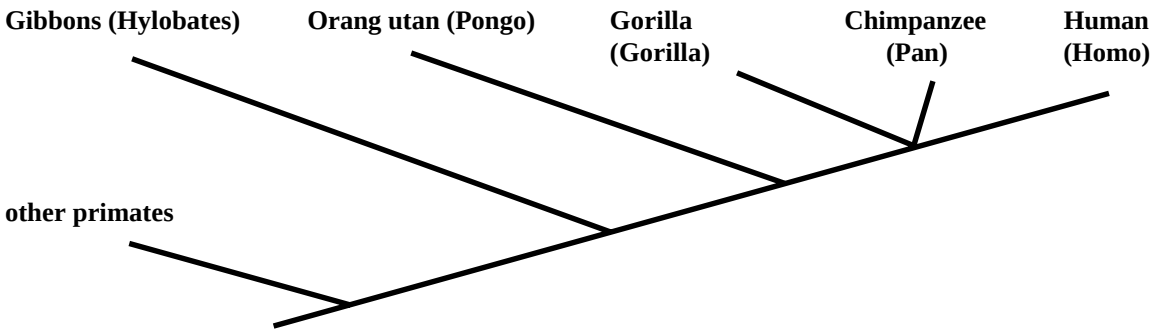
So there is no doubt of it: we and the Great Apes have a common ancestor separate from that of the various species of gibbons. So, then, do the Great Apes share a common ancestor separate from ours, or are we closer to one or more of the genera of Great Apes than to others?

Again, opinion has shifted over the past twenty years. Before then, most specialists assumed that there were Great Apes and then again there were humans, and that we have to look for their evolutionary lines separating 15, 20 or 25 million years ago; especially from study of DNA, the material of heredity itself, which is 98% identical in humans and chimpanzees (King and Wilson, 1975). Then fresh study began to accumulate evidence that it was the orang utan's ancestor, not ours, that separated first from the hominoid stem. Recently (Groves, 1986) I have listed the anatomical features which we share with gorillas and chimpanzees, and which separate us from the orang utan: characters in which the orang utan has remained primitive, and in which we and the gorilla and chimpanzee are changed from the primitive state, include the following:

1) humans, gorillas and chimpanzees have an Axillary Organ: a cluster of apocrine sweat glands in the armpit whose secretion gives off a characteristic smell. 'Underarm odour' is not merely sweat: it is a special secretion, which presumably communicates at a subconscious level. (What? In humans and chimpanzees it is often not consciously detectable, but in gorillas it certainly is, by the human nose: it is a pungent, choking smell, and it communicates alarm. If you come suddenly and unexpectedly across a group of wild gorillas — and I have — the odour pervades the air and silently, magically, the gorillas vanish into the distance).
2) humans, gorillas and chimpanzees share modifications of the legs, ankle and feet for a terrestrial life: the legs are long compared to the trunk, the heel is long and broad, and so on. Chimpanzees spend at least half their day on the ground, gorillas most of it, and humans — well . . .
3) humans, gorillas and chimpanzees all have a thickly haired scalp: the hairs on the top of the head, quite contrary to other primates, are much thicker than those on the body.
4) humans, gorillas and chimpanzees generally have lobes to their ears. You can look at as many orang utans, gibbons and monkeys as you like, but you won't find an ear lobe among them.
5) humans, gorillas and chimpanzees have frontal sinuses: a space between the inner and outer bony tables of the forehead. A few people and a few chimpanzees have only traces of them; but no other primate has them.
6) Need I go on? Delayed dental eruption, loss of os centrale, reduced baculum, low brachial index . . .

I am rubbing home the point that we are well and truly primates, hominoids, and members of a close-knit group whose other members are the two African genera of apes, the gorilla (*Gorilla*) and the chimpanzee (*Pan*). And that the numerous anatomical features in common between the members of this close-knit group are haphazard, pointless whims of a capricious sorcerer's apprentice if we adopt the view that the three genera have been specifically and separately created; but can be brought down to a common origin if we accept the view that they descended from a common source.

The evolutionary tree which nearly all specialists would accept is the following, though there is some evidence suggesting that the chimpanzee may be even closer to us than to the gorilla (Groves, 1986; Sibley and Ahlquist, 1987):



A few further points, and we can leave the living primates and enter the hallowed halls of fossils. I have been citing 'about twenty years ago' and 'around 1963' as turning points. What happened then? It happens that 1963 saw the publication of a seminal book, *Classification and Human Evolution*, edited by S.L. Washburn. In this book were published the first papers since the 1920's on the blood proteins of primates. If evolution has occurred, then not only gross anatomical features should have evolved, but biochemical features too. Immunologists such as Goodman and Zuckerkandl,

publishing in Washburn's book, showed that there are only very slight differences between the corresponding blood proteins of humans, gorillas and chimpanzees; those of the orang utan are more different; those of the gibbon more different still; and so on. Later workers in the same field have confirmed and extended these results; Sarich, Wilson, Cronin and others have even claimed that whereas gross anatomical features evolve at varying rates, fast or slow, protein molecules, and the DNA structures that form their blueprints, evolve at a constant rate, so that by knowing the amount of difference between two species in, for example, their albumin molecules or their mitochondrial DNA, it is actually possible to calculate (within limits) the time since those two species shared a common ancestor! All very controversial, naturally, but it has led to some testable hypotheses: for example, Andrews and Cronin (1982) surveyed the fossil evidence for the ancestry of the orang utan, and found extremely good agreement with the date indicated by various molecular methods — that the ancestors of the orang utan separated from the common ancestor of humans, gorillas and chimpanzees about 10 to 12 million years ago.

Further, evolutionary hypotheses are scientific hypotheses, and, like all such, generate predictions which can then be tested. If anatomical characters have evolved, other characters — behavioural, psychological — should have evolved as well, as there should be similarities in these features between the same groups that show similarities in their anatomy (and their molecules). It is now an open secret that the Great Apes do share behavioural characters with humans. They are skillful manipulators: in captivity, all three Great Apes play with and sometimes modify objects; in the wild chimpanzees even use natural objects as tools (as by using stones to crack palm-nuts), and in some places modify them first, actually making tools (as by stripping off side-branches from twigs and grass stems to make probes to obtain food). All three make themselves elaborate nests each night, whose modes of construction, use, and social aspects are, in rudimentary form, similar to those made by human nomads (Groves and Sabater Pi, 1985). Great Apes recognise themselves in mirrors: a gibbon or a monkey will threaten its mirror image, as if it were another member of the same species, even after a thousand hours of exposure to the mirror, but a chimpanzee or orang utan will, after only a few hours' exposure, realise that it is looking at itself — and act appropriately, for example examining parts of its body which it cannot otherwise see. The mirror-recognition story is told by Gallup (1982), who thought then that gorillas cannot recognise their own images; but it is now known that gorillas can, in fact, if they are reared under proper conditions: not surprising, really as human children also fail to develop mirror recognition if reared under impoverished conditions. Gallup also grasps the nettle: do Great Apes have a concept of self?

Finally there are the efforts to teach Great Apes forms of sign language. These experiments are highly controversial, mainly because too much seems to have been claimed for the apes' linguistic abilities by some of the experimenters: but no-one has cast any doubt on the claim that apes can indeed employ symbols for concepts, and use these symbols appropriately and spontaneously. Whether they mean the same things, precisely, as we do by these symbols (hand-signs, computer symbols) is moot, and whether they can put the symbols together to make anything like sentences seems very dubious, but that a previously unsuspected capacity of the ape mind has been revealed is beyond question (see Patterson and Linden, 1982). Are there any psychological features shared by humans, gorillas and chimpanzees, which even orang utans do not share? This is unknown simply because no-one has yet looked for them. But, again, it is a prediction of the evolutionary model given above that such features will be discovered. (Since that was written, an excellent study by Ghiglieri (1987) has pointed out that some such features can be found.)

Classification is required to serve the needs of evolutionary theory: and it will be quite clear by now to the observant reader that the family *Pongidae*, while it may be favoured by *The Macquarie Dictionary*, is not a concept that has any meaning in modern primatological thought. Several authors in Washburn's (1963) book proposed to classify humans, chimpanzees and gorillas together in a category that excludes orang utans, and indeed gibbons; and this has in recent years become standard practice. The classification which I favour (Groves, 1986) is as follows:

Superfamily Hominoidea
- Family Hylobatidae (gibbons)
- Family Hominidae
  - Subfamily Ponginae (orang utan)
  - Subfamily Homininae (gorilla, chimpanzee, human)

The descent of man

Have we, then, descended from apes? Well, yes, we have. Remember that our ancestors *separated* from the ancestors of gorillas and those of chimpanzees: they did not *evolve* from *actual* gorillas or chimpanzees. The living apes, in the period in which their evolutionary lines have been separate, have evolved in their own directions: none of them is identical to the common human/other ancestor. But if gorillas and chimpanzees are apes, and the orang utan is an ape, then it follows from the evolutionary diagram above that our ancestors (prior to our separation from other hominoids)

were apes. Because all an ape — strictly, an Anthropoid Ape — really is is 'a member of the superfamily Hominoidea that is not on the separate human lineage'. I must communicate this intelligence to the compilers of *The Macquarie Dictionary* as soon as possible. Five hundred pounds, indeed.

Fossil apes' remains abound throughout the early and middle Miocene periods, from about 22 million years ago until 10 million or less. Because most of the remains are no more than jaws and teeth it is often not possible to tell whether a particular fossil is on one line of evolution or another, or represents a phase before the ancestors of even the gibbons had become separate; in some cases it is even impossible to tell whether we have the remains of an ape or something still more primitive, such as a protomonkey. In a few cases however the remains are quite well preserved, and we can tell a good deal from them. In one particular case, a fossil genus that was formerly known by only a few jaw fragments has become much better known, and some red faces have resulted, because it is not what some people had previously hypothesised.

The fossil in question is the well-known *Ramapithecus*. This name was given to a few very fragmentary jaws found in places as far apart as the Himalayan foothills (India and Pakistan), Kenya, and Turkey. Some primate specialists stuck their necks out: these specimens, it was said, have characteristics of the molar teeth that are rather human, and the way one can reconstruct the jaws makes them short-faced and with small front teeth, again a human characteristic. The oldest specimens were 14 million years old, the youngest (as is now known) about 8 million. Now the proponents of the 'molecular clock', mentioned above, had a common ancestor for humans, gorillas and chimpanzees existing about 5 million years ago — perhaps 8 million at the outside, but not the 14 million required by earliest *Ramapithecus* fossils! The proto-human status of *Ramapithecus* was proposed in the late 1930's, revived in the early 1960's, became harder to maintain in the 1970's, and was finally exploded in 1982 (Andrews and Cronin, 1982). What had been thought to be specifically human characters of the molar teeth were found to be primitive hominoid features; the short face and small front teeth turned out to be a product of faulty logic in making the early reconstructions. Moreover, the more was discovered about the Kenyan, Indo-Pakistani and Turkish fossils, the more different they turned out to be from each other: under the one rubric, *Ramapithecus*, had been masquerading several distinct species, even genera. It now looks, from Andrews and Cronin's work, as if the Indo-Pakistani form is a small species of a previously described genus, *Sivapithecus*, and on or near the ancestral line of the orang utan; the Turkish form is another species of the same genus; while the Kenyan one, which is earlier than the rest, belongs in a genus by itself, *Kenyapithecus* — this last could be on or near the common stock of all humans and Great Apes, but this is only a working hypothesis.

Fossils are as precious as gold, and as hard to find. We now have quite good collections of these proto-orangs (truly excellent specimens have recently been found in China), but nothing that is identifiably on the common human-gorilla-chimpanzee stem. The time slot in which one might expect to find such creatures is late Miocene, 12 to 5 million years ago; the place, Africa (because chimpanzees and gorillas are found only in Africa); but there are very few sites so far known in the right region and of the right age. Bad luck, then: keep looking. It should also be said that we have not a single fossil of either chimpanzee or gorilla lineage: again, it may simply be that sites of the right age (after 5 million years ago) have not been discovered in the right places (presumably, central and west Africa, where they now live). By contrast, we have abundant fossils of the third African lineage: the human one. And so we come to the fossil hominids, proto-humans, ape-men, or whatever we wish to call them. (Since this was first written, several years ago, one of these long-sought "common stem" fossils has indeed been found, in the Samburu Hills of Northern Kenya, in late Miocene deposits: see Ishida *et al.*, 1984.)

Fossil hominids

It is first of all necessary to be clear what we would expect a fossil hominid (correctly, I suppose, a hominin, since Great Apes are also now hominids!) to look like. The differences between humans and apes — or, let us say, the characteristics which we have acquired since separating from the ancestors of other hominoids — are, roughly speaking, as follows:

1) Upright posture and locomotion. All hominoids are capable of standing, even walking, upright; but not with much facility on the whole. The human pelvis is lower and broader than that of an ape, and the hip bones (iliac blades) are specially broadened: they anchor a group of muscles, the *glutaei*, which insert in the upper end of the femur (thighbone) and, when they contract, pull the torso laterally so as to balance it over the stance leg when the other leg is taking a step. The vertebral column is S-shaped, being especially curved forward in the small of the back to be under the centre of gravity. The foot is arched, both longitudinally and transversely. The thighbones slope inwards towards the knees, bringing the lower part of the legs underneath the centre of gravity.

2) Large brain. Brain size is estimated by measuring, or calculating, the volume of the braincase of the skull: the cranial capacity. Comparisons with the brain itself, in modern humans, shows that the brain size is about 50cc less than the cranial capacity. The modern human cranial capacity varies from about 1100cc to about 2000cc; but these are extremes, and most people have capacities of some 1200cc to 1600cc, with an average of 1350cc. Apes are round about 400cc; the gorilla, as befitting the largest ape, has the largest capacity; there is a body-size factor as well as a mental capacity factor, and doubtless other considerations too. The largest cranial capacity ever measured in an ape was nearly 750cc in a gorilla (a one-in-a-thousand specimen).

3) Small jaws. The jaws of apes protrude in a muzzle (prognathous); the human face is vertical, the jaws do not protrude much (orthognathous). The human dental battery is smaller, compared to overall skull size, than in apes; especially the front teeth are reduced. It was stated above that the Great Apes have canine teeth that are shorter, less dagger-like, than those of gibbons or monkeys: human canines are shorter still, and do not project above the level of the other teeth. The first lower premolar in apes has only one cusp, and when the jaws are closed the upper canine nestles down in front of it, where the second cusp would be. In humans, the first lower premolar has two cusps the upper canine having withdrawn from the apelike scissor-type occlusion.

There is in detail more to it than this, but in outline this is what happened in human evolution: upright posture, large brain, small jaws. A creature with an intermediate condition in any of these features, or with a human-like condition in one feature and an ape-like condition in another, is by definition intermediate, and we can make a working hypothesis that it is on or near the human evolutionary line; if further evidence is consistent with this hypothesis, we may consider it highly corroborated; if it conflicts, it is falsified. Because we must always be aware of parallel evolution: the same changes happening more than once, independently, in different evolutionary lines.

Of the three gross change-sequences outlined above, which began to change first? Or did two, or all three, begin to change together? There have in the past been adherents of various points of view. At the turn of the century it was widely held that the chief crown and glory of humanity, the brain, must have changed first: indeed, that it had achieved its final condition even before the jaws had begun to change. So when fragments of a modern human skull and a completely apelike jaw were found together, under conditions which convinced most (but not all) specialists that they had belonged to the same creature, it was no surprise to the brain-first school of thought. The date was 1909 (though further 'discoveries' continued to be made for some years); the place was Piltdown, southern England. Discoveries in other parts of the world accumulated: of creatures whose upright posture was fairly advanced, while the brain was still below the modern level and the jaw was approaching the human condition. As such discoveries, all consistent with each other, mounted, Piltdown came to look more and more anomalous. Came the age of first chemical, then radiometric, methods of dating, and in 1952 Piltdown was shown to be a fraud: a nearly modern (perhaps Saxon) cranium, deliberately broken up, and an orang utan mandible with key bits broken off it.

This cautionary tale is of considerable importance in showing why the fossil evidence for human evolution is so convincing. The genuine fossils are entirely consistent in the story they tell: not only do they get more like modern humans the more recent they are, but they do it in a consistent way: upright posture and bipedal locomotion are somewhat ahead of the other changes, and the other changes occur together. An anomaly shows up at once, and announces itself as a prime candidate for special investigation.

The mass of fossil hominin material is by now nearly a continuum from 4 million years ago to the present; but it is easier to handle if broken up into stages. And so we speak of the australopithecine stage, the habiline stage, the pithecanthropine stage, and the modern stage.

(a) The australopithecine stage

The australopithecine stage is represented by abundant material from the sites of Sterkfontein, Makapansgat, Swartkrans (South Africa); Laetoli (Tanzania); Koobi Fora (Kenya); and Hadar (Ethiopia). It is worth emphasising how much material there is: at Sterkfontein, for example, there is one complete cranium; 12 examples of the facial skeleton; a partial skeleton and several isolated postcranial bones; and jaws and teeth amounting to at least 40 individuals. At Hadar there are the remains of again about 40 individuals, mostly jaws and teeth but including a three-quarters-complete skeleton (the one nicknamed 'Lucy'), and the fragmentary remains of most parts of the skeleton of what seems to be a social group of about 12 individuals, all buried together by some catastrophe [No, not Noah's Flood — Eds.]. There are a number of other sites in Ethiopia, East Africa and South Africa, yielding each from one to half a dozen specimens in different states of completeness.

Australopithecines were a very diverse lot: certainly there were several different species, of which two (commonly known as *Australopithecus africanus*, the South African one that is about 2.5 to 3 million years old, and *A. afarensis*, the Laetoli and Hadar species, 3 to 3.75 million years old) may be on the main line of human evolution, while others (such as *A. robustus* and *A. boisei*, the 'robust australopithecines') are certainly not. Opinions about their classification vary: those who think that *A. africanus* is a human ancestor often call it *Homo africanus*, and the robusts are commonly placed in a separate genus, *Paranthropus*: while controversies over whether there is one or two species in the Hadar material go on and on. They had ape-sized cranial capacities: 430-500cc for *A. africanus*, 500-530cc for the larger robusts. Their jaws were protruding, more so in some than in others; but the front teeth were smaller than in apes. One out of 5 specimens

from Laetoli, and 5 out of 10 from Hadar, had one-cusped first lower premolars, and where the canines in the upper jaw are known they are fairly large (though not ape-sized); but in *A. africanus* and the robusts the first lower premolars were two-cusped, in the human fashion, and the upper canines small. Their posture was certainly basically upright; but it seems likely now that their bipedal locomotion was not as modern as was once thought, and their hand skeletons show long, curved, ape-like phalanges as if for climbing. There are excellent analyses of their locomotor abilities and, by inference, their affinities: for example that of the Hadar specimens by Stern and Susman (1983), which shows that the skeleton of 'Lucy' was a very interesting mixture of advanced (human) and primitive (ape-like) characteristics, while the remains of the 'social group' may have been a little more human — giving support to the theory that there were two different species found at Hadar. The earliest australopithecine remains are a humeral fragment from Kanapoi, Kenya (Feldesman, 1982), two jaws from Tabarin and Lothagam, Kenya (Ward and Hill, 1987; Kramer, 1986), and a femoral fragment and partial frontal bone from the Awash Valley, Ethiopia (White, 1984); all are 4 to 5 million years old. The potentially ancestral *A. africanus* disappears after about 2.5 million years ago, but the side-line robusts remain widespread and common until about 1 million years ago, when they died out without descendents.

(b) The habiline stage

The 'habiline' stage is a bit controversial; some authorities prefer to allocate members of this stage to early pithecanthropines or late australopithecines, though it amounts to the same thing. *Homo habilis* was first described from Olduvai, Tanzania, in the early 1960's; remains of other fossils of this stage come from Koobi Fora, Kenya; Swartkrans; and Sterkfontein (a level later than that containing australopithecines). They had larger cranial capacities than australopithecines (ranging from 515 to 770cc), smaller teeth, and (though the postcranial remains are very poorly known) apparently a more modern type of bipedalism. There are certainly several species in this stage; one of the oldest is the famous 1470 skull from Koobi Fora, Kenya, 2 million years old, and they go on until about 1.5 million years ago. All habilines are later than *Australopithecus africanus* and *A. afarensis*, their possible ancestors; but they and the robust australopithecines coexisted in several places.

(c) The pithecanthropine stage

The pithecanthropine stage is known from sites in Asia as well as Africa. The earliest specimen is a newly discovered, nearly complete skeleton from Nariokotome, Kenya, which is 1.6 million years old (Brown et al., 1985). Outside Africa, remains first occur at Sangiran, Java at about 1 million years ago (Leinders et al., 1985); more than 40 specimens are now known from Java (including 15 braincases), but the upper limit is unclear. Another prolific site in Asia is Zhoukoudian (Choukoutien) near Beijing (Peking), China, now dated to between 500,000 and 300,000 years ago (Dong Xingren, personal communication). Remains occur in Europe from the Middle Pleistocene onward.

Specimens of the pithecanthropine stage have cranial capacities ranging from 750 to about 1300 cc: the largest specimens, therefore, are within the modern range. They are small-toothed; some are rather prognathous, others quite orthognathous. Their postcranial skeletons show consistent differences from modern humans, but these differences are not great and their meaning is unclear: certainly they were fully bipedal in the modern sense. Until recently all fossils of this stage were put as one species, *Homo erectus*, but recently it has been pointed out that (1) the early African specimens (over 1 million years old) differ from all the later specimens, in for example their smaller cranial capacities and greater prognathism, and (2) the Asian fossils differ from those from Africa and Europe (Wood, 1984; Stringer, 1984; Andrews, 1984). We would thus have three species: an early, primitive one; the genuine (Asian) *Homo erectus*, with its flat braincase and large bony brow ridges; and the middle Pleistocene species from Africa and Europe which Stringer (1984) calls 'archaic *Homo sapiens*' and argues are our immediate ancestors.

(d) The modern stage

Analysis of the final stage of human evolution is complicated by the presence in Europe and western Asia, in the Upper Pleistocene, of a very large-brained form, the well-known Neanderthal race. These people — and people they certainly were; for example, they buried their dead — seem to be independent developments from the 'archaic *Homo sapiens*' type in Europe. Meanwhile *Homo sapiens* of modern type was evolving in Africa: Brauer traces the emergence of the modern high, rounded cranial form, large brain, small jaw with pointed chin, from the 'archaic *Homo sapiens*' of Africa, at a time spanning the late Middle Pleistocene and early Upper Pleistocene, i.e. about 200,000 to 100,000 years ago; after that time, all hominin fossils, the Neanderthals excepted, are anatomically modern. After about 35,000 years ago the Neanderthals disappeared, and it is presumed that they were either completely replaced or perhaps genetically absorbed by people of modern type.

Creationist ideas

If the above scenario seems convincing to you, it is because the dating and anatomical developments of the fossils are entirely consistent. There are no Piltdowns among them; certainly with the aid of chemistry and nuclear physics it would today be an easy matter to detect them. But that is not the way our creationist friends see matters. I have pored earnestly over the books by Gish (1978) and by Bowden (1977), and have diligently considered the arguments advanced (some of them by Bowden in person) in the *Origins* films. Bowden's book sums up the other sources, so I will concentrate on the matter therein expounded.

A number of themes recur in Bowden (1977). Thus:

1) **Sweeping generalisations**. For example in the Conclusion, p. 186, he writes:

> 'But the fossil links between man and the animals consist only of fragments of jaws, some broken skull pieces, part of a foot, etc., no complete skeleton or even a reasonable proportion of one ever having been discovered'

Now, I do not approve of students writing in library books. But I was amused to observe that, in the A.N.U. library's copy of Bowden, beside the above paragraph someone — presumably a student; it was not me — had scrawled, 'Bullshit — turn back a page'. I did so. There, with an arrow pointing towards it in the same ink, I read:

> '2 . . The jaw and parts of a skeleton (called 'Lucy') . . .'

We have seen above what proportion of the skeleton it was that was found; Johanson et al. (1982) list the parts that were found as: 6 cranial fragments, the mandible; part of a scapula; most of both humeri, both ulnae, both radii; a wrist bone and a hand phalanx; nine vertebrae, most of the ribs, the sacrum; a left innominate (i.e. the left side of the pelvis); the left femur; most of the right tibia and fibula; an ankle bone and two foot phalanges.

2) **A villain**. The villain of the book is Pierre Teilhard de Chardin. This remarkable man was a Jesuit priest who was also a world famous palaeontologist. For him, the very idea of any contradiction between Christianity and the theory of evolution was absurd; his philosophic writings demonstrate his intensely felt theory that evolution was the means of the working out of the divine purpose on earth. I would not like to speculate on why a creationist would wish to destroy the scientific credibility of a man who may be designated an evolutionary theologian; but it is remarkable how old Teilhard crops up again and again like a bad penny: here he is, planning the Piltdown forgery; here he is again proclaiming 'Pekin Man' to be a genuine ape-man and covering up the fact that modern human skulls had been found at the same site; there he is arriving ominously in Java at a crucial moment; and lo, here he is once more laying down the law about australopithecines. How very significant. Of something or other.

3) **Innuendo**. The original 'Pekin Man' specimens (i.e. the *Homo erectus* from Zhoukoudian, found in the 1920s and 1930s) have been lost. Suspicious, eh? Well, a few more have been found in the 1950s and subsequently (including a previously missing part of one of the 1930s skulls) but Bowden does not mention that. Dubois, discoverer of 'Java Man' (i.e. *Homo erectus* in Java), failed to reveal, until much later, that he had discovered totally modern-looking skulls at

Wadjak! Trying to conceal the inadequacy of his 'ape-man' find, perhaps? Read the whole story and you may get some idea of why Dubois took umbrage and became so secretive — if you ignore the innuendo the story is all there.

4) **The anatomists don't know what they're about**. Bowden implies throughout that the discoverers of fossils, and the anatomists who analysed them, were so anxious to find 'ape-men' to support the tottering Darwinian edifice that they indulged in unwarranted extravagance in their reconstructions, put together bits that shouldn't have gone together (at least, not in the way they did it), and generally indulged in shady practice, often with a good measure of incompetence thrown in. Bowden, of course, can do much better. There, for example, on p.145, are two earlier attempts to reconstruct a *Homo erectus* specimen from Sangiran, alongside Bowden's own (much better) reconstruction, placing the Sangiran fragments on the outline of a gorilla skull. Is he suggesting, one wonders, that an ancient gorilla wandered out of Africa and lefts its remains in Java? No, 'This is not to say that these fossils *were* of a gorilla, but simply to show how these same few fossils can be rearranged to give an ape-like appearance if required'. I wonder if he has ever taken the trouble to examine casts of that Sangiran specimen and compared them to an ape? A glance at actual specimens (or casts) will be sufficient to reveal how very un-apelike they are: to place a drawing of the one over a drawing of the other and presto! is just a little unscientific. Incidentally, anyone who wants to know how very informative even an unprepossing scrap of fossil can be, in the hands of a first-rate anatomist, is referred to the recent brilliant analysis of the 4 million year-old Belohdelie frontal bone by Asfaw (1987).

5) **Negativism**. Nothing is what its describers say it is, but Bowden rarely ventures an opinion as to what anything actually is, beyond 'an ape'; usually, not even that. He has not actually described the apes; whether he thinks that known species of apes are involved, or some other species, now extinct, is unclear. If he truly believes that the Zhoukoudian skulls are those of apes or monkeys, for example, he has to explain why they have such huge cranial capacities: the six measurable, or calculable, crania have a mean capacity of 1055cc, and I dread to think of what size ape would be implied by such a huge capacity. (Actually, he seems to think he has thrown cranial capacity measurements out of court, by dint of some very simplistic exercises on pp.48-49. He seems quite ignorant of how it is actually done).

6) **Out-of-context quotations**. For example, on p.84, Bowden quotes Boule as saying that Black, having described *Sinanthropus pekinensis* on the basis of a single tooth, 'was naturally concerned to legitimise this creation when he had to describe a skull cap'. The way Boule is quoted makes him appear to be saying that he doubted whether *Sinanthropus* was anything but an ape. In fact, what he was doubting was whether Black's new genus was really any different from the previously described *Pithecanthropus*! Black's culpable over-enthusiasm, and Boule's unquenchable cynicism, are facts of history — but not in the way Bowden makes them appear.

7) **Cover-ups**. I have already indicated, under the heading 'Innuendo', how Bowden imputes dishonest motives to palaeoanthropologists and their colleagues; and on pp.49-50 he has a short section on 'Subconscious motivation', which indeed is something we all have to watch out for (creationists included). Mostly he implies that specialists have seen features in fossils which aren't there; but in Section III, which I suspect he considered the most important in his whole book, he implies that there has been a conspiracy of silence about fossils of perfectly modern *Homo sapiens* which are early in date. He states (p.63):

> 'Clearly, these early fossils completely contradict the present theory of man's development, and for this reason they are rejected as frauds or intrusive burials . . . Sometimes such fossils are subjected to various tests, and a discrepancy in any one result is considered to be sufficient to reject the fossil as being an intrusive burial. Thus the eyewitness accounts of the original discoverers are completely ignored.'

The first specimen he cites is the Calaveras skull, from California. This is a bad place to start, for the skull was a hoax. It was said to have been found in gold-bearing gravels, yet was coated with a calcareous matrix! Bowden does not mention this discrepancy, at least as such; rather, he makes it sound like a reason for accepting the skull's genuineness ('. . . it had a calcareous coating, similar to some other skulls which had been found in caves . . .'). Boule, whom Bowden fails to quote on this occasion, refers to it as 'une farce des mineurs'. The *Handbook of North American Indians*, 8:14 (1978) remarks, 'California has produced its share, perhaps even more than its quota, of hoaxes like the Calaveras skull'.

He goes on to the Castenedolo skull, found near Bescia, Italy, in 1860; several skeletons were found at the same site in 1880. They were found, as Bowden states, in Pliocene deposits; and he quotes approvingly the espousal of their antiquity by the anthropologist Sergi. He does not mention, however, the reason why all subsequent enquirers have rejected the idea that they are of Pliocene age: that the deposits in which they were found were marine! To explain their presence in marine deposits, Sergi imagined the drowning of a family . . .

The supposed Pliocene origin of the Foxhall jaw was based on hearsay only; as were those of the Olmo, Clichy and Abbeville specimens. Bowden's rejection of the evidence for the recency of the Galley Hill skeleton and, in a later section, of the Olduvai skeleton (which even its discoverer later accepted was an intrusive burial) can only be called flying in the face of the evidence.

Conclusion

And so it goes on. I raise the question: are Bowden, Gish (who brings up much the same sort of argumentation) and other creationists really so poorly informed as to criticise a field about whose norms and methods they know so little? Did they really read their sources so carelessly that they could lift quotes out of context without realising what the writers were really saying? — or that they could miss the salient points of an argument? Do they really misrepresent facts without realising it? Are their standards of argument really so deficient that they think that if they have (to their way of thinking) proved a certain set of remains not to be what is claimed for them, that the remains vanish into thin air?

There is no secret about all this. Some curators actually welcome visits from the public, even from creationists, as it helps to dispel the myth that palaeoanthropologists have something to hide. Most of the misinformation which Bowden and Gish propound about the nature and characteristics of some of the fossils would not survive an examination of a good set of casts. Fossil sites — Sangiran in Java, Zhoukoudian in China, Olduvai in Tanzania — are often tourist places; guides, generally with practical experience of excavation there, are happy to show tourists around and discuss matters of moment with them. It is surely time that creationist writers started examining the hard evidence, as indeed professional palaeoanthropologists take pains to do, instead of sniping from a position of ignorance.

I have tried to show that from the moment western scholars became familiar with anthropoid apes they realised that they were not in the presence of ordinary monkeys, and that modern research has confirmed and extended that realisation; and that even theologians were not immune from feelings of the same nature. I have tried to show, too, that the fossil evidence for human evolution is very substantial, very consistent, and thoroughly convincing; and that creationists (as represented by Bowden) have set up straw men to knock down, misrepresented facts, and generally made a lot of to-do, appearing superficially impressive but on close examination insubstantial. There is an old cliche about empty vessels making the most noise; but perhaps Shakespeare, in *Measure for Measure* (see quote at head of this essay), as usual, said it better.

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THE RELIABILITY OF CREATIONIST CLAIMS

Martin Bridgstock

> 'Virtually every critic of "scientific" creationism has commented on the apparently unfailing propensity of its advocates to use out-of-context quotations to support their various arguments against evolution. The out-of-context quotation constitutes one of the high sins of legitimate scholarship.'
>
> Leon H. Albert, The Skeptical Inquirer, vol.9, no.4, p.364

Anyone encountering creationist claims for the first time is bound to be struck by the amount of scientific evidence they produce. Major scientists are quoted, scientific papers referred to, and important findings detailed. Given the sweeping nature of the creationist challenge, it is logical to ask a simple, basic question: how reliable is the evidence that creationists produce? I will briefly summarise the results of my studies of creationist literature, and give one or two examples. Then I will look at some fresh evidence, more recently uncovered.

Checking Creationist literature

I have described in a number of places (see Bridgstock 1985a,b,c,d,e) how I examined the creationist literature, and checked claims that creationists made. Two rough statistics summarise my findings. First, on average, each creationist reference to science has two errors: these comprise a minor error (e.g. a wrong page, date, or an error in a quote) and a major error. The latter is an error which gravely misrepresents, and changes the meaning of the evidence quoted. The second statistic is that roughly 90 per cent of creationist references to science have something gravely wrong with them: that is, they have major errors.

This result — repeated many times — shocked me profoundly. It meant, if correct, that creationist claims could not be believed without careful checking. It also meant that the normal give-and-take of discussion simply could not exist: how can you discuss something with people who have made so many errors?

It is hard to credit that such poor work exists, unless one has actually seen it. I will give examples — some new, some old — of what I have discovered.

The Zuckerman misquote

The second creationist claim I ever checked was a quote, purportedly written by Lord Zuckerman. It appears in several places, most notably in the creationist *The Quote Book* (Mackay et al. 1984, p.11). In it there is a heading 'Did humans ever evolve?', and several quotes appear beneath. One of these is credited to Lord Zuckerman, and runs:

> '. . . if man evolved from an apelike creature he did so without leaving a trace of that evolution in the fossil record.'

The trouble is, that when one checks Lord Zuckerman's actual words, one finds that he really wrote:

> 'For example, no scientist could logically dispute the proposition that man, without having been involved in any act of divine creation, evolved from some apelike creature in a vary short space of time — speaking in geological terms — without leaving any fossil traces of the steps of the transformation.'
>
> Zuckerman (1970, p.64)

This is an astounding change, and one wonders how it could have occurred.

Right figures - wrong meaning. Henry Morris and elements in the oceans

Misquotes are not uncommon in creationist literature. More common is taking a quote, or some information out of context, so that its meaning is altered.

Henry Morris, the founder of modern creationism claims that a range of scientific evidence indicates that the Earth is much less than billions of years old. As an example, he claims that Riley and Skirrow (1965) have made calculations about how long it would take certain elements to accumulate in the oceans from river inflow. He then quotes a table as follows:

Chemical Element	Years to accumulate in Ocean from River Inflow
Sodium	260,000,000
Magnesium	45,000,000
Silicon	8,000
Potassium	11,000,000
Copper	50,000
Gold	560,000
Silver	2,100,000
Mercury	42,000
Lead	2,000
Tin	100,000
Nickel	18,000
Uranium	500,000

All of these figures are well below billions of years, of course, and Morris comments that:

> ‘This situation is difficult to understand if the earth’s lithosphere and hydrosphere are indeed billions of years old, and if uniformitarianism is a valid assumption in geochronology.’
>
> Morris (1984, p.154)

In fact, it is difficult to understand only as long as one does not check Morris’ claims. Finding the book reveals a minor error; the calculations are not by Riley and Skirrow at all, they are the editors of the book. The table appears in a paper by Goldberg (1965), and some extracts from the table follow:

Abundance of the elements in sea water and residence times

Elements	Concentration in mg/l	Residence times (years)
:	:	:
Na	10,500	2.6×10^8
Mg	1,350	4.5×10^7
Al	0.01	100
Si	3.0	8.0×10^3

Goldberg (1965, p.164)

There are many more elements, but here is the source of Morris’ figures. Is he right? The question hinges about the term ‘Residence time’ in Goldberg’s paper. Goldberg defines it fairly clearly, as follows:

> ‘The residence time of an element, τ, can then be defined as the average time which it remains in the sea water before removal by some precipitation process.’
>
> Goldberg (1965, p.172)

Goldberg’s work has been totally misinterpreted. It says nothing whatever about the time taken for these elements to build up in the oceans, but how long they remain in the oceans before removal. Morris has got the numbers right, but their meaning totally wrong.

We also have here a good example of another creationist ploy — that of selective citation. It is quite common to find creationists quoting only part of a scientific paper, if the part they do not quote conflicts with the point they wish to make. Note that here Morris did not quote any results for aluminium, which has a residence time of only 100 years. Everyone knows that the oceans are much older than 100 years. Had Morris used this figure, it would have cast grave doubt on the whole of his argument.

Using outdated data

It is common for creationist literature to quote established authorities’ opinions. Indeed, this is perfectly valid, provided that certain obvious rules are observed. One rule (breached in the Zuckerman example, above, and many other places) is that if quotation marks are used the authority must be quoted exactly. Another rule is that the authority’s views must be fairly represented, and not distorted by selecting words. A third rule is frequently breached by creationists; the judgement must not be outdated by subsequent events. Science is a fast-moving field. The most eminent expert’s judgement may be outdated in a few years by new discoveries or information. If creationists use old expert judgements, we are entitled to ask whether they are outdated.

Albert (1985) has shown that the attack on human evolution has been made using outdated judgements. For example, Lord Zuckerman's judgements about the human fossil record — written in 1970 — are used to comment upon discoveries made in 1974! (Albert 1985, pp.367-8).

Another example of this distortion appears in a recent book by a couple of Australian creationists (Harvey and Pallaghy, 1985). On pages 92-93 of the book, a barrage of nine quotes is presented, purporting to show that the fossil record is not continuous, and indeed is characterised by '. . . the sudden appearance of billions of highly complex forms of life in each strata right back to the Cambrian period with not one intermediate life form' (Harvey and Pallaghy 1985, p.92).

Two of the quotes concern the Precambrian rocks, and are worth quoting as they appear:

> 'If there has been evolution of life, the absence of the requisite fossils in the rocks older than the Cambrian is puzzling.' Stratigraphy and Life History, M. Kay and G.H. Colbert, p.102.

and

> 'One of the major unsolved problems of geology and evolution is the occurrence of diversified multicellular marine invertebrates in Lower Cambrian rocks and their absence in rocks of greater age . . . when we turn to examine the pre-Cambrian rocks for the forerunners of these early Cambrian fossils, they are nowhere to be found' Science, vol. 128, p.7.

Notice that neither of these quotes has a year given; when I checked, I found that none of the nine quotations was less than 19 years old! One went back to 1947, yet they were presented as evidence for the current state of opinion!

The two quotes detailed above are of particular interest. Tony Thulborn's paper in this book shows the discovery of the complex forms of Precambrian life; the paper by Kaveski and Margulis (1983) is a good exposition of this, too. However, these two quotes are to literature before these discoveries were widely known. They are therefore outdated judgements.

A multi-layer misquotation!

In this last section, I wish to extend my examination of creationist errors, by testing a logical deduction. We have seen that many creationist quotes and much of their 'evidence' is composed of distortions and errors. Looking through the creationist literature, one notices also that they quote themselves and other creationists extensively. It follows that, from time to time, one will find creationists misquoting themselves, or misquoting their own misquotes. A good example of this was spotted by Ken Smith. Elsewhere in this volume, Ken examines the claims of creationist Barry Setterfield concerning the alleged decline in the speed of light. While studying this question, Ken noticed this remarkable sequence of misquotes.

Setterfield had presented his ideas in an issue of *Ex Nihilo*, the creationist magazine. Peter Cadusch, a physicist at the Swinburne Institute of Technology wrote a blistering critique of Setterfield's claims, which included the comment:

> 'The sudden change of measured c after the war has already been commented on, and current feeling seems to be that, despite extensive re-working and reanalysis, pre-war determinations are now mainly of historical interest.'
>
> Cadusch (1982, p.81)

Cadusch's conclusions were strongly negative. He concluded: 'The author's case appears to me at least decidedly 'not proven'.' (Cadusch 1982, p.82)

Setterfield replied to this in the same issue, in which he wrote:

> '. . . Dr. Cadusch points out, 'despite extensive reworking and analysis these determinations' cannot be brought into harmony with today's values . . .'
>
> Setterfield (1982, p.86)

Note that a couple of minor errors have already crept into the quotes. There is worse to come, however. In 1983 Setterfield released a large monograph setting out his claims. In the back of the monograph, Cadusch is quoted as writing that:

> 'Despite extensive reworking and analysis, these determinations (of c prior to 1940) cannot be harmonised with today's values'.
>
> Setterfield (1983, p.172)

This is truly remarkable. Setterfield, in this quote, has not only repeated his errors in quoting Cadusch. He has also attributed his own words to Cadusch as well! Even this is not the whole story. The section in the monograph is entitled 'Some positive professional comments about this research in c-decay'; Cadusch's comments were decidedly not positive, before being changed.

Setterfield seems, therefore, to have accomplished the remarkable feat of changing his own misquote of what Cadusch didn't say anyway! By any standards this is a major feat.

Conclusions

I cannot stress too strongly that these are not isolated instances. As one works through the creationist literature, one constantly finds errors, changes and misquotes of this type. On top of these major errors, there is also a thick scattering of trivial errors. This suggests to me and to other researchers that creationist claims are not reliable. Ultimately, this lack of accuracy appears as a form of arrogance. The one thing any researcher needs is humility before the majesty and complexity of the universe. It is this lack which renders creationism a menace to scientific enquiry.

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A QUOTABLE QUOTE

'To demonstrate that evolutionary theory was not true, they did not hesitate to misquote, distort, take out of context, and in other ways violate the biblical injunction against false witness. And even so they proclaimed their own view as true only by default and never, at any time, have presented rational evidence in favor of their creationism, which they solemnly (but ridiculously) call "scientific creationism." '

Isaac Asimov (1985): *Asimov's New Guide to Science*. page 780.

A QUOTABLE QUOTE

'It could still be that Darwin was deceived by the Devil, or that his whole age was so deceived, or even that most of mankind throughout history have been so deceived. However, one can easily imagine other, more optimistic explanations. For example, citing Biblical passages which indicate that mankind was made in God's image (Genesis 1:27) and that "happy is the man that findeth wisdom, and the man that getteth understanding" (Proverbs 3:13), one might conclude that science involves God-like thinking and that God intends us to view the natural world through conclusions reached by scientists. Divine inspiration, not Satanic deception, would then be the guide of scientific research. This could mean that 19th-century thought allowed man for the first time to understand how God made him (i.e., by evolution) and also to attain an improved understanding of God and the Bible. One variation of this view would be that the Devil deceived mankind until 19th-century thinkers finally formulated a proper, evolutionary theory. According to this interpretation, the only ones still being deceived by the Devil would be creationists themselves.'

David B. Wilson (1982): *Proceedings of the Iowa Academy of Sciences*, vol.89, p.48.

CREATION PHYSICS AND THE SPEED OF LIGHT

Ken Smith

> 'One of the most rewarding things to come from my involvement in the creationism issue has been the opportunity to meet scientists from other disciplines somewhat removed from my own. Probably the most common question I am asked by my newfound colleagues is whether the creationists perform the same sort of intellectual distortion to geology that they do in other fields of science. Let me assure you that the creationists' geology and geophysics are every bit as bad as their biology and biochemistry, if not worse!'
>
> G. Brent Dalrymple (1983): *Federation Proceedings*, vol.42, p.3033.

One of the few original Australian contributors to creationism is Barry Setterfield, who claims that the speed of light has been decreasing. It might be expected that such a world shattering discovery would be widely circulated throughout the scientific world But no, it is restricted to creationist publications (Setterfield 1981a, 1981c, 1983a, 1983b, 1984c).

In an article on pseudoscience (Frazier 1976, p.348) L. Sprague De Camp is quoted as saying

> 'If I undertook a thorough analysis of one of Von Daniken's books, the result would be a book several times the size of the original. It would take years of my time; and, if I were mad enough to write it, who then would read it?'

A quick count of the first 20 pages in Setterfield (1983b) produced over 30 errors, misinterpretations of physics and dubious assertions. For the reasons De Camp gives only a few of the errors are mentioned here. Various items relating to Setterfield's work which have appeared in *Ex Nihilo* are listed under Setterfield's name, and are referred to by year only.

Pseudoscience and ignorance

Setterfield's work appears to be a choice example of pseudoscience. He is clearly an amateur in physics about which he attempts to write. He does not appear to realize that the constancy of the speed of light, usually denoted by c, is one of the foundation stones of modern physics. As a consequence he glibly quotes various formulae in which c appears, and draws conclusions about the effects of changes in c on various phenomena such as radioactive decay rates and radiation pressure in stars, not realising that the formulae he uses have been derived under the assumption that c is constant. The most notable example of this is his ignorance of relativity, both special and general. On p.8 of 1983b he writes:

> 'Einstein's theory of relativity requires c to have the same value at any point in time throughout the universe, but says nothing about the value of c being constant with respect to time itself.'

This statement is simply wrong, as will be verified by anyone who has made more than a cursory study of relativity. In Einstein's first paper on the topic (Einstein 1905) the third equation, which deals with the propagation of light rays, reads

$$\text{velocity} = \frac{\text{light path}}{\text{time interval}}$$

which, as any student of elementary mechanics knows, is only true if the velocity is constant. On p.32 of 1983b Setterfield quotes Einstein's famous mass-energy relationship $E = mc^2$, and states that this can be derived without using relativity theory. To justify his claim he refers to a book on electromagnetic theory, again not realizing that this theory is based on the assumed constancy of the speed of light and other electromagnetic waves. Truly, as Alexander Pope wrote in 1771, 'A little learning is a dangerous thing'.

The experimental data

Setterfield's handling of experimental data is at complete variance with normal scientific methodology, as Bridgstock (1986) shows. Setterfield also appears to be unaware of the significance of errors associated with measurements. On page 20 of 1983b we have the following table:

EXPERIMENTER	YEAR	VALUE OF C (Km/sec)
Mittelstaedt	1928	299,778 ± 10
Anderson	1937	299,771 ± 12
Huttel	1940	299,768 ± 10

Setterfield states, in the passage immediately preceding the table,

> ‘It is important to note that the Mittelstaedt, Anderson and Huttel values all still show the progressive decrease in c with time, but shifted into a lower range.’

In fact, any value for c between 299,768 and 299,778 lies comfortably inside ALL the error bounds, and there is no evidence of any change in c. This is not just a momentary lapse on Setterfield’s part since, on p.124 of 1984c, he states that 303,000 ± 6,000 is ‘. . . well above the current value of 299,792 km/sec . . .’. The current value is clearly well inside the error limits.

Errors in calculation

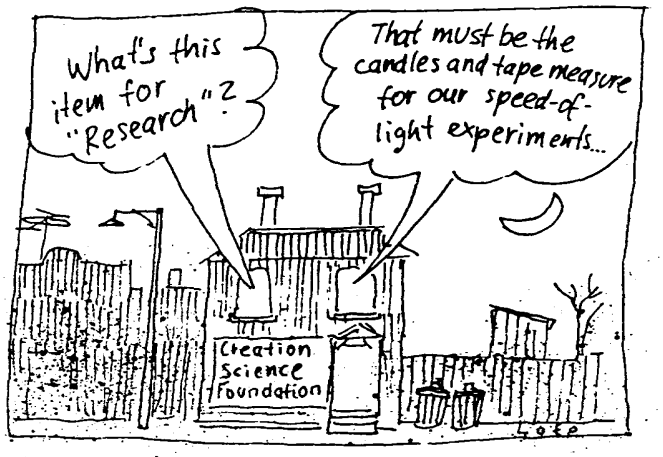
To a mathematician reading his work it is obvious that Setterfield has little knowledge of statistical methods and procedures. In 1981a, p.46, we read that the coefficient of determination (better known as the square of the correlation coefficient) ‘. . . had a value of 1 to nine significant figures . . .’. Anyone who has ever calculated correlation coefficients will immediately react ‘There’s an error somewhere — such a value is impossible.’. Setterfield later repeated this value (1981b, p.40; 1982, p.88). However on p.25 of 1983b we read ‘It was subsequently noticed that it had been obtained at an incorrect point in the computer programme . . .’. The value is then given as 0.998, which is still wrong, and on p.99 of 1984c it is further corrected to 0.986. This sequence of events does not inspire confidence in the rest of the work. These criticisms have also been made by Fackerell (1983).

Setterfield also claims that his cosec^2 curve gives the best fit to the data. In fact, as Fackerell (1983) pointed out, a simple quadratic suggested by Cadusch (1982) gives a slightly higher correlation. Over the period from 1960 back to 1870 the difference between these two curves gradually rises from zero to a value less than 0.1 Km/sec. Since this accuracy was not attained until well after 1960, the claim that his curve fits best is obviously of no value.

Setterfield appears to have difficulty in relating various mathematical curves to physical phenomena. On p.131 of 1984c he states:

> ‘Again, the decay of light output by a nova or supernova is described by a log sine curve which is a periodic mathematical function. . . . Similarly, the behaviour of a top or gyroscope is similarly described mathematically after it has received a change of axis tilt due to the application of some force.’

Both these statements are false. Decay curves of novae or supernovae are close to exponential (see Bartel 1985, pp.153-155), and any discussion of the motion of tops or gyroscopes rapidly becomes involved with elliptic integrals (see, for example, Greenwood 1965, chap.8), neither of which bear the slightest relation to the claimed log sine curve.
According to Setterfield the speed of light stopped changing in 1960, so his ideas are not subject to experimental test. Does he produce any reason for this? Yes, and in so doing provides an excellent example of ‘argument from spurious similarity’ as is found in pseudoscience. On page 131 of 1984b we read:



> 'The situation is similar to a rubber band that has been stretched and then let go. Once it reaches its minimum point it does not restretch itself back to its maximum extension . . .'

Such arguments are usually called 'rubbery'. But Setterfield himself provides another possibility for the cessation of any change in the speed of light. On p.7 of 1983b we read:

> 'In any case, it seems to us more reasonable to assume that before the Fall, there were some principles in operation to help restore the order continually being lost by the operation of the 2nd Law, which principle was then removed.'

But if the speed of light started changing only after man sinned, then when the speed stops changing a perfectly reasonable deduction is that mankind has stopped sinning.

Setterfield also spends much time discussing the well-known red-shift, but attributes all this to changes in the frequency of light waves, and claims that the wavelength remains constant (see 1983b, pp.36,102). But on p.107 of 1983b he states that red-shift changes the wavelength of the 21cm hydrogen line used in radio astronomy. Will the real cause of red-shift please stand up?

Misquotations

Since Setterfield is a creationist it is only to be expected that he will misquote scientists. His abuse of Einstein has already been mentioned, and his misrepresentation of Cadusch is mentioned in the section of this booklet dealing with other misquotations. Just one further example will be mentioned here. It is this misquotation which led me to undertake a close examination of Setterfield's errors. On p.19 of 1983b we read:

> 'The recent critical look at Roemer's data and dates [allowing a precise value to be placed on the orbit diameter] concluded that the best possible result was still 0.5% above the current value[47], or 301,300 Km/sec. Froome and Essen's reworking placed the result somewhat higher.'

The reference is to *Sky and Telescope*, June 1973, p.353. There are five errors in these two sentences! Taking them in order:

(1) The article in Sky and Telescope was simply a news report about another article (Goldstein et al. 1973) and DID NOT contain any 'reworking' of data. Setterfield should have quoted the original;
(2) The work DID NOT allow anything to be said about the diameter of the earth's orbit — it was assumed to be the same in 1675 and 1972 (see Goldstein et al. 1973 p.172);
(3) The work concluded that the speed of light in 1675 DID NOT DIFFER by 0.5% from the current value (see Goldstein et al. 1973 p.125), which is quite different from saying that it was 0.5% higher;
(4) Froome and Essen DID NOT rework any data — they merely quoted Roemer's original value (see Froome and Essen 1969 pp.2,10);
(5) The value they quoted, 214,000km/sec, IS NOT higher, but considerably lower than the current value.

For some time there was a mystery about Setterfield's claim that Froome and Essen attributed to Roemer, in the 17th century, a value higher than the currently accepted speed. This mystery was cleared up when 1984c appeared. A careful reading showed that Setterfield had taken the value from p.2 of Froome and Essen. Investigation of Froome and Essen then revealed the following sentence:

> 'Later Delambre (1790) and Glasenapp (1874) obtained values of 986 sec and 1001.6 sec for the time lag and the mean of these values together with the present day value for the diameter of the earth's orbit (2.99×10^8, km) gives a value for c of 303,000 km/sec with an uncertainty of about 2,000 km/sec.'

Setterfield has slightly misquoted the result (given as 303,100 on p.27 of 1983b), and Froome and Essen made an error in calculation which Setterfield should have checked. The completely incomprehensible blunder lies in Setterfield attributing the average of measurements by two different people in 1790 and 1874 to a third person in 1675! On page 121 of 1984c he writes;

> '. . . this value had been placed against Roemer on a mistaken reading of Froome and Essen.'

Anyone who can make this sort of 'mistaken reading' has little claim to be considered competent in physics, either theoretical or experimental. In how many other places which have not been checked has he done the same, or similar things? In 1984c he responds to some of the criticisms, but not in the way expected. He claims that the original work by Goldstein et al. has a fundamental flaw. His evidence for this statement? Believe it or not, a message transmitted over a computer network! The reference (No. 17 on p.125 of 1984c) reads, in full:

‘Lew Mammel Jr, A T and T Bell Labs, USA computer network, News Group, Net Astro, Friday, December 2, 1983 and Wednesday December 7, 1983.’

Alleged ‘Theoretical derivation of the decay’

The final section of 1983b is headed ‘Theoretical derivation of the decay equation for c’. One might have anticipated, in this section, some interesting mathematics. What is found is erroneous physics and, in fact, a proof that the speed of light is CONSTANT, which is not surprising since he tries to base his work on electromagnetic theory. Rather than give a detailed list of errors, it is sufficient to simply look at p.159. Equation (35) reads

$$c = \frac{h\beta}{E_0^2} \operatorname{cosec}^2 2\pi\nu t \,,$$

which he states is of exactly the same form ‘. . . as that derived from the computer as the curve of best fit to the data . . .’. However, in the 4th line on the same page can be found the result

$$\frac{h\beta}{c} = E_0^2 \,.$$

My 14 year old daughter was able to put these two together and show that

$$\operatorname{cosec}^2 2\pi\nu t \; = 1,$$

and so the speed of light must be a CONSTANT! Up until 1984b (August 1984) Setterfield was regularly claiming that theory supported his analysis of the experimental data. However, in 1984c (late 1984) there is not a single mention of the theoretical derivation. Has it quietly been forgotten, in the hope that yet another of his blunders will not rise up to haunt him?

Alleged support from scientists

It has been claimed that a number of prominent scientists have commented favourably on Setterfield’s work. It is true that in 1984a there are 13 comments by 12 different people, but a close examination of the comments made and the credentials of those making them discloses a rather different picture to that implied. Two (Cadusch and Tapp) were highly critical (see 1982) and phrases from their letters have been selected and misquoted to give an appearance of support. Two comments are by Norman, who assisted Setterfield with the work, but is NOT a lecturer in mathematics as stated. The other Australian is Malcolm who has contributed to *Ex Nihilo* and presumably is a creationist. There are 5 from the USA, all well-known creationists, including Gerardus Bouw, who believes that the sun goes around the earth (see Schadewald 1984). Two of the remaining three are from Brazil and one from India; no data on them is currently available. The alleged support for Setterfield’s claims is rather weak. Unless and until he can produce favourable comments from people such as Fellows of the Australian Academy of Science or its equivalent he is likely to be regarded as a pseudoscientist.

Update

In September 1987 my attention was drawn to another publication with Setterfield’s name on the cover (Norman and Setterfield 1987). The logos of both SRI International and Flinders University are on the front cover and title page. In April 1988 I heard that Lambert T. Dolphin, described on the cover as the staff member of SRI for whom the “report” had been prepared, was not authorised to “invite” any such “report”, and that SRI had disowned the document. A letter to the Dean of the School of Mathematical Sciences at Flinders University produced a disclaimer (Rao 1988), in which any recipient was asked to

‘1. note that the abovementioned report is not to be considered an SRI invited report,
2. note that the school of Mathematical Sciences does not accept responsibility for the contents of the report,
3. remove the existing covers of copies of this report in your possession,
4. forward this information and request to those institutions and individuals that received copies of the report from you.’

A letter to SRI produced a reply from the Director of the Geoscience and Engineering Center (Baron 1988) which was even more revealing. After saying that even in an earlier position as Assistant Director, Radio Physics Laboratory, Mr. Dolphin would not be authorized to “invite” a paper, the letter went on to say

‘To my knowledge, SRI has never published an “Invited Research Report.” This particular nomenclature is not used. . . . The existence of the Norman/Setterfield report was not known to me until after Mr. Dolphin had left SRI. . . . In summary, Lambert Dolphin’s involvement with the report was in a private capacity, completely outside of his position at SRI. SRI International had no involvement with the report, institutionally or technically.’

It is worth mentioning that Dolphin is the author of *Jesus: Lord of Time and Space* (Dolphin 1988), and is quite clearly yet *another* creationist.

So much for the rather curious provenance of the "report". Is its content any better than Setterfield's previous work? Simply reading the "Abstract" on page 3 is sufficient to assure any scientist that further investigation is not warranted. As well as the oxymoron "time dependent constants", there is a footnote reading, in part:

> 'Atomic time is defined in terms of one revolution of an electron in the ground state orbit of a hydrogen atom. The atomic standard by the caesium clock is accurate to limits of $\pm 8 \times 10^{-14}$.'

Setterfield here has misinterpreted some remarks by Roxburgh (1984, p.6). As any scientist knows, the unit of time, the second, is defined by caesium clocks, and is equal to *exactly* 9,192,631,770 vibrations of a particular radiation from caesium atoms. On page 29 of the "report" Setterfield claims that μo, the permeability of free space, should change with time. He seems quite unaware that this is *defined* to be *exactly* $4\pi \times 10^{-7}$. Then on page 31 we find a ". . . proposal that atomic rest-masses should increase with time . . .". Again, by *definition*, an atom of carbon-12 has a mass of *exactly* 12 atomic mass units. Also the platinum-iridium cylinder kept at Sevres has, *by definition*, a mass of *exactly* 1 kilogram, and this does not change with time. Setterfield's knowledge of the SI units of time, electric current and mass, which are also the only *legal* units in Australia, is so poor that little attention need be paid to anything in the "report".

Even the creationist community is unhappy with this document. No less a person than the Head of the Astro/Geophysics Department in the Institute for Creation Research Graduate School (Aardsma 1988, p.i), after pointing out defects in the method of analysis used, concluded

> 'At the present time, it appears that general support by the creationist community of the decay of the speed of light hypothesis is not warranted by the data upon which the hypothesis rests.'

If the "creationist community" sees the report as sufficiently erroneous that support is not warranted, then certainly no reputable scientist need have any qualms about rejecting it.

Conclusion

Taken as a whole there is nothing in Setterfield's voluminous writings which in any way casts doubt on currently accepted ideas in physics. He follows other writers on pseudoscience in refusing to alter his basic ideas however faulty they are found to be. On the title page of his 'technical monograph' (Setterfield 1983b) he states:

> 'This monograph is in the nature of a progress report. Research is still continuing in many areas and new information is expected from some sources. It is therefore conceivable that subsequent editions may require refinement or minor revision, particularly in the newer, later areas of part 3, that research shows to be required for the satisfactory conclusion of this work, without affecting the well-established concepts upon which it is based.'

It is left to the reader to make a personal decision about any 'well-established concepts'!

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THOSE SENSATIONAL DINOSAUR AND 'HUMAN' FOOTPRINTS

Martin Bridgstock

> 'My students, of course, can visit the Paluxy River to see for themselves how baseless the creationist claims really are, but most students (and parents, teachers, and school board members) in the country cannot easily do so. Therefore they are left to the mercy of relentless antievolutionary propogandists who offer persuasive "evidence" of a worldwide flood and a young earth.'
>
> R.J. Hastings, Creation/Evolution, no.XV, p.15

Probably the most sensational claim made by creationists is that fossilised dinosaur and human footprints have been found together in the Cretaceous limestone of the Paluxy river, in Texas. According to normal science the limestone is over 100 million years old. If humans existed this early, it would certainly cause science to re-think large parts of human prehistory.

Creationists have made much of these claimed footprints. Gish, in his comic booklet, shows the pictures. John Morris has devoted a book to it (Morris, 1980) and the creationist teaching kit Two Models claims that ' . . . the evidence for the authenticity of these footprints is quite compelling.' (Bliss, 1976). In Australia, the Creation Science Foundation has printed pictures of claimed footprints (see Mackay, Snelling et al, 1984). There is no dispute that fossilised dinosaur footprints exist near the Paluxy. They are clear, numerous, and often form coherent trackways (See, for example, Figure 1). The questions involve the 'human prints'. Are they genuine?

Figure 1. Example of a dinosaur track.
(Courtesy of F. Edwords and *Creation/Evolution*.)

At this point one notices something rather embarrassing. Of the researchers in the Paluxy argument, the only people who have seen human prints are convinced creationists. Others see merely erosion marks, parts of dinosaur prints and in some cases the results of fakery. Even some creationists brand some of the prints as fakes. Figures 2 and 3 (see next page) show some examples of marks that creationists have listed as human footprints.

In this paper, I propose to address two questions. First, how reliable are the creationist investigations in the Paluxy Valley? Can we take their studies seriously? Second what about the very striking-looking prints pictured in creationist publications, and also in the film *Footprints in Stone*? How do we account for those?

Creationist Research Methods

Craftsmanship is an important part of science. Any investigation requires great care in collecting information and analysing it. How careful are creationists, and can their research be taken seriously?

There is a good deal of evidence that creationist 'research' in the Paluxy Valley is not reliable. First, at least one participant in such research has publicly charged that 'evidence' is in fact not there. Al West, a co-worker of creationist Carl Baugh, stated that Baugh's prints were 'totally contrived from his imagination'. West began the investigations expecting an objective report, but ended by declaring;

'I can safely say I have seen no science in their activities. The facts have been flat dismissed.'

West also commented on claims that human prints showing a clear left-right pattern had been found;

'I've never seen a path, and I've been right there.'

Potter (1984; UPI (1984)

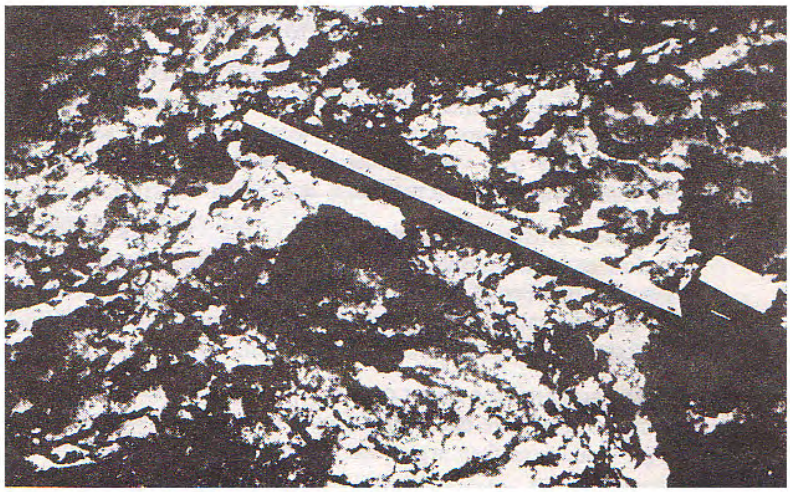

Figure 2 (left) and Figure 3 (right).
Laurie Godfrey beside a 'mantrackway' and a close-up of a 'mantrack'. (Courtesy of *Creation/Evolution*.)

There are many other problems. The same 'footprints' have been measured by creationists, with wildly differing results. One print, for example, was measured as 381mm long by one creationist, and 228.6mm long by another (Godfrey 1984, pp.22). This is not an isolated disparity; the majority of measurements disagree significantly.

Worse than disagreements between measurements is that the size of prints — as measured by the same creationist — varies along trackways allegedly produced by the same feet (Godfrey 1984, p.27).

This is not all. Creationists have also disagreed about whether footprints are left or right. In some cases, a print was identified by one creationist as a 'clear left' and by the next as a 'clear right'. Perhaps the worst case, though, concerns the accidental manufacture of a footprint. Milne and Schafersman describe it like this;

> 'The excavators of trail H1 apparently couldn't find the print that they expected see in location H1-7 — so they dug a sizeable hole in the rock, hoping to find the missing print in the layer below. This is comparable to searching the soil beneath a sidewalk for the missing prints of a three-legged dog that ran across the surface when the cement was wet. Beierle, apparently unaware that this hole was artificial, dutifully pictured it as a 'man track' in his map.'
>
> Milne and Schafersman (1983, p.121)

In other cases, scientists were able to examine 'footprints' soon after creationists had made casts of them. Clearly, taking casts requires scrupulous cleaning. In fact Hastings (1985, pp.8,12) reports repeatedly finding mud in 'cleaned' prints, thus robbing any casts made of validity.

All the evidence points to a pitiful inadequacy in creationist research methods. Their approach seems to fall well below that expected of proper scientific investigators. But, despite this, if convincing-looking prints have been found and photographed, is this not powerful evidence by itself? We will look at the most convincing tracks in the next section.

The most convincing 'human' footprints

It is impossible to comment upon all the creationist claims. Milne and Schafersman (1983) have investigated many, and it is worth taking a few of the most striking cases as examples.

The 'Morris Print' is a clear-looking human footprint, about the correct size, and with clear toe-marks. The problem is that two creationists photographed it at different times, and in between it seems to have deepened considerably. Milne and Schafersman describe it in the first photograph as;

> '. . . a vague mark, newly exposed with the gravel recently brushed away, with a rough resemblance to a human footprint.'
>
> Milne and Schafersman (1983, p.117)

There is also no heel print and there are ridges across the big toe and second toe prints. In the second photograph, the whole print is deeper, a heel has appeared and the ridges across the toes have disappeared. Milne and Schafersman attribute this to fraud.

Creationists Mackay and Snelling have sought to refute this. They accuse both Milne and Schafersman and myself of implying that nine years elapsed between the photographs, when it was really two hours (we didn't), and also quote creationist researchers as giving assurances that the differences are innocently explained. My own view is that self-deepening footprints are inherently suspect, and that readers should form their own views of creationist assurances.

The other sensational-looking print is the 'Dougherty track'. It has been printed many times by creationists. It certainly looks human (except that by my count it has six toes!), but Milne and Schafersman point to a number of problems. The print is huge (21 inches long), part of a larger, dinosaur impression, and there are suspicions — by creationists — that a couple of toes were added with a chisel (Milne and Schafersman 1983, p.117).

Mackay and Snelling rather contradict themselves in trying to answer this. They argue that it is implausible for the print to have been carved, as it is so unbelievably large (Mackay and Snelling 1983, p.37) while on the previous page they argue that it is not unbelievably large! Certainly, clouds hang over this print, too.

The Turnage trail is described by at least one creationist as the 'most humanlike of all' (Morris 1980, p.214). Milne and Schafersman, however, found many problems. Two of the eight prints in the 'trail' are missing, and most of the rest are very vague. The first print — 13.5 inches long and 16.5 inches wide at the ball of the foot — resembles 'the impression that would be left by a bent mangled giant cucumber' (Milne and Schafersman 1983, p.119). The evidence here appears very weak.

Mackay and Snelling deliver a wrathful rebuke; 'How many scientists have actually seen a bent mangled giant cucumber, let alone the impression left by one in lime mud?' (Mackay and Snelling 1985, p.38). After inspecting the photograph, it seems an excellent description and the dimensions of the print are so strange (even neglecting cucumbers, mangled or otherwise) as to make human origin most unlikely.

These are the best prints the creationists have to offer. In combination with the evidence about their research methods, it seems difficult to take their 'evidence' very seriously.

It might also be worth mentioning the creationist film Footprints in Stone. This has left a considerable impression in the minds of many people. However, Lang (1984) and Godfrey (1981) have looked critically at the film. Lang points out that:

> 'While elderly people were describing tracks they had seen 50 years earlier, the film showed pictures of modern footprints made in soft mud, and pointed to the features being described. This might suggest that viewers were actually seeing fossils instead of modern prints.'
>
> Lang (1984, p.34)

Godfrey points out that the film is a 'distorted pseudodocumentary', and that the 'prints' are often 'human shapes that have been painted on stone' (Godfrey, 1981).

Update

Apart from the deletion of one figure and some consequential alterations, the foregoing is exactly as it appeared in the first edition of this book (January 1986). Both Milne and Schafersman (1983) and the *Creation/Evolution* team (see

Creation/Evolution, no.15, 1985) came to the conclusion that the evidence for "human" footprints on the Paluxy is non-existent. Recently this view has received sensational corroboration — none other than Dr. John Morris, the principal creationist researcher into the topic, has supported the scientific view!

In the Institute for Creation Research publication *Impact*, Morris (1986) begins by defending the plausibility of earlier creationist views. Both creationist investigators and the tales of 'old-timers', he argues, give credence to the idea of human footprints. However Morris then continues:-

> 'The only way creationist claims could be invalidated was for (1) features of the prints not visible beforehand to be exposed by erosion and (2) for the testimonies of the old timers to be discredited. As unlikely as this may seem, such a scenario may be taking place today.'
>
> Morris (1986 p.ii)

Many of the best "man-tracks" in the Paluxy Valley, says Morris, are now weathering, and developing tridactyl (three-toed) outlines, evidently of dinosaur origin. For example:-

> 'The Taylor Trail appears, obviously dinosaurian, as do two prints thought to be in the Turnage trail. The Giant Trail has what appears to be dinosaur prints leading towards it, and some of the Ryals tracks seem to be developing claw features also.'
>
> Morris (1986 p.iii)

That weathering can reveal new features in prints is well-known to palaeontologists, but it seems to have astonished Morris. His conclusion (after some dark remarks about reddish stains on some prints) is:-

> 'Even though it would now be improper for creationists to continue to use the Paluxy data as evidence against evolution, in the light of these questions there is still much that is not known about the tracks and continued research is in order.'
>
> Morris (1986 p.iv)

The last point is certainly correct — the dinosaur tracks alone are of major scientific interest. The creationist case for human footprints, though, seems to have collapsed.

The one exception to this appears to be the Australian creationist, Dr. Clifford Wilson. He claims to have made a convincing cast of a human footprint in the Paluxy Valley (see Wilson 1985). However Wilson is not an established researcher in any relevant field; he is a retired lecturer in psycholinguistics. In view of the collapse of the other evidence, it seems best to reserve judgment on Wilson's claim until it has been evaluated by properly qualified people.

Conclusion

The collapse of the creationist case regarding the Paluxy Valley seems almost complete. Circumstantial evidence of poor research methods and of outright fraud made the claims difficult to accept in the first place. The retraction by Morris — and the withdrawal from circulation of the creationist film *Footprints in Stone* (see Snelling 1986) — appear to complete the process.

We have now seen, since 1983, the withdrawal of two major claims creationists have been making in support of their case. Which is going to be the next retreat they make, after Precambrian fossils and the Paluxy footprints?

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NOAH'S ARK AND A FLOOD OF ABSURDITIES

Martin Bridgstock

> 'Pseudoscience differs from science in several fundamental ways, but most notably in its attitude toward hypothesis testing. In science, hypotheses are ideas proposed to explain the facts, and they're not considered much good unless they can survive rigorous tests. In pseudoscience, hypotheses are erected as defenses against the facts. Pseudoscientists frequently offer hypotheses flatly contradicted by well-known facts which can be ignored only by well-trained minds. Therefore, to demonstrate that creationists are pseudoscientists, one need only carry some creationist hypotheses about Noah's flood to their logical conclusions.'
>
> Robert J. Schadewald (1982): Creation/Evolution, no.IX, p.12.

A crucial feature in creationist thought is the Flood, including the survival of Noah's Ark. Creationists flinch from public discussion of this matter but they cling to the existence of the Flood and the Ark. In their view, it explains the thick mantle of rock strata which girds the earth and the apparent order of the fossil record.

How did it happen? According to Morris (1984), a few thousand years ago heavy rains fell, the fountains of the deep opened and so did the flood gates of the sky. Noah built his giant Ark and saved the creatures aboard. During the year-long Flood the 20 kilometre-thick (on average) layer of Phanerozoic sedimentary rock was laid down. Fossils were sorted into apparent order by several processes: some quick-moving creatures would be able to flee ahead of the flood and so be buried higher in the sediment. Also, victims' hydraulic drag would dictate that the bodies would be sorted according to size.

Problems with the flood

Morris' ideas are breath-taking in their audacity. It is also breath-takingly easy to see scientific problems with them. Let us look at a few of the problems.

(i) Where did all the water come from ?

The Bible is quite explicit that the highest mountains were covered. If we compute the total amount of water needed to cover Mount Everest, it would be about 4.4 billion cubic kilometres extra to the 1.37 billion cubic kilometres in the oceans (Soroka and Nelson 1983, p.135). The minor amounts in the atmosphere and earth can nowhere near account for this vast mass of water (Newell 1982, p.38).

Some creationists have postulated a 'vapour canopy' which condensed to form the flood. Exactly how this vast mass of vapour was maintained over the earth is never stated. Worse, exactly how life survived with an atmospheric pressure 840 times that of today is not clear, nor how the living creatures of the day could have breathed an atmosphere composed of 99.9% water vapour (Soroka and Nelson 1983, p.135).

There is another problem with all this vapour, too. To condense a kilogram of water vapour liberates 2.26 million joules of energy. To condense 4.4 billion cubic kilometres in 40 days would liberate 10^{28} joules; this would increase the earth's atmospheric temperature to over 3,500°. No wonder creationists can't find the remains of the Ark on Mount Ararat; it was burned to ash long ago . . .

Well, perhaps the 4.4 billion cubic kilometres of water came from beneath the earth? Well, not quite, because this would require the crustal rocks to have a porosity of 50 per cent, when we know it is less than one per cent. And the water, if stored in rocks of earth's actual porosity, would take up so much space that it would have to be the same temperature as deep-lying rocks. The Ark would be boiled when the waters emerged! (Soroka and Nelson 1983, p.135).

Could the water have come from space? A comet, perhaps? Well, not quite. A comet that size (say, a sphere of frozen water over 2,000 kilometres in diameter) would impact the earth like a 12 trillion megaton bomb! If we assume many small droplets hitting the atmosphere, its energy release would heat the atmosphere by over 6800° (Soroka and Nelson 1983, pp.136-7).

Some creationists have sought to modify the idea that the flood must have covered Everest. Morris (1984, p.16) has suggested that mountain-building was triggered by the flood. However, we know that Mount Ararat existed, and LaHaye

and Morris (1976, p.8) tell us that Mount Ararat more than doubled its height during the flood. Right. Mount Ararat today is 5,185 m high, so let us assume that the flood covered the infant Ararat and was perhaps 2,500 m deep. Even then, using Soroka and Nelson's formula (p.138), the amount of extra water is 1.17 billion cubic kilometres, and the creationists have the additional problem of explaining how Everest and hundreds of other high mountains were formed standing several kilometres taller than the flood.

(ii) Where did all the water go ?

This hardly needs elaboration. It is rather comic that the creationists spend endless effort trying to locate Noah's Ark, but do not try to locate billions of cubic kilometres of water. Where is it, and how was it removed?

(iii) Effects of the Flood.

The unparalleled catastrophe of the flood, we are told, laid down most rock strata (e.g. Morris 1984, pp.102-111). It certainly must have been an amazing event. Perhaps the most amazing effect is the production of the Green River varves (varves are annually deposited layers of clay and silt).

The Green River formation, in North America, covers tens of thousands of square miles. In at least one place, there are some twenty million varves, each varve consisting of a thin layer of light sediment, and a thin layer of dark, finer sediment.

Varve can be observed forming in modern lakes. The light layer is deposited in summer, the dark layer in winter. To normal geologists, therefore, the twenty million varves represent about twenty million years of deposits (Schadewald 1982, p.14).

Creationists, though, believe that the Green River complex was laid down during the flood, by '. . . a complex of shallow turbidity currents . . .' (Whitcomb and Morris 1961, p.427). Exactly how this could have laid down millions of alternating light and dark layers is not explained. Nor is the rate of deposition; there are only 25 million seconds during the 300 days of the flood so the layers must have been deposited at a rate greater than three every two seconds (Schadewald 1982, p.14).

Another problem for creationists concerns the fossil record. Creationists avoid discussing their ideas about the fossil record. Schadewald explains why:

> 'Creationists argue that the Flood would first engulf marine animals, then slow lowland creatures such as reptiles, while wily and speedy humans escaped to the hilltops. . . A scientist might test the mobility hypothesis by examining how well it explains the fact that flowering plants don't occur in the fossil record until early in the Cretaceous era. A scenario with magnolias (a primitive plant) heading for the hills, only to be overwhelmed along with early mammals, is unconvincing.'
>
> Schadewald (1982, pp.15-16)

We could also enquire why flying reptiles could not avoid burial until the very end, or why not even a few slow-witted or incapacitated humans were buried along the with dinosaurs. And when, as Schadewald (1982, p.16) points out, marine fossils are often found above land fossils, the whole idea loses credibility.

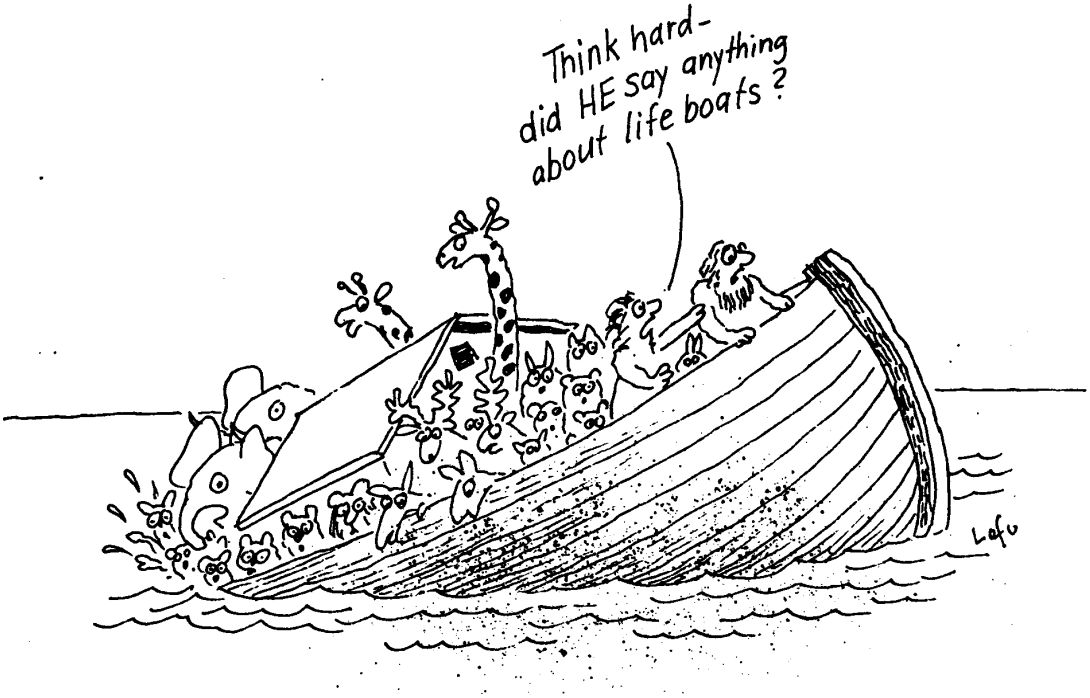
(iv) The Ark and its voyage

Moore (1983) has assembled an enormous array of problems with Noah's Ark. We will look at only a few of them here.

First, could the Ark survive the flood? Creationists rarely do proper research, but Balsiger and Sellier (1976, pp.117-8) tested a scale model of the Ark, and concluded that it would withstand waves of over two hundred feet before capsizing. The trouble is that the waves caused by an ordinary hurricane can exceed one hundred feet (Moore 1983, p.23) and, according to the creationist Meyer (1977, p.57) the flood waves might be several miles high! Schmich (1974, p.121) seems to agree, saying that:

> 'The worldwide ocean of the Genesis flood was swept by windstorms that would make modern tornadoes seem like a zephyr.'

Clearly, the ark was doomed. Yet, we are to believe, it survived with its precious cargo intact.



As the ark was pitched, spun and buffetted by the monstrous flood for the best part of a year, what must it have been like inside? Many animals are so sensitive that they cannot be kept alive in zoos, let alone wildly lurching wooden arks (Moore 1983, p.24). Others need fresh plant food, or living prey to eat, or fresh meat. How were they fed on the ark for a year?

Surprisingly, as both Schadewald (1983, p.15) and Moore (1983, p.19) point out, the biggest problems with the ark concern its smallest inhabitants; viruses, bacteria and parasites. Schadewald points out that humankind is the only known reservoir for many communicable diseases:

> 'Well-known examples include measles, pneumococcal pneumonia, leprosy, typhus, typhoid fever, smallpox, poliomyelitis, syphilis and gonorrhoea . . . Note that the argument covers every disease germ or virus which can survive only in a specific host. But even if the ark was a floating pest-house, few of these diseases could have survived. In most cases, only two animals of each 'kind' are supposed to have been on the ark. Suppose the male of such a pair came down with such a disease . . . He recovered but passed the disease to his mate. She recovered, too, but had no other animal to pass the disease to, for the male was now immune. Every disease for which this cycle lasts less than a year should therefore have become extinct.'
>
> Schadewald (1983, p.15)

Moore goes further than this. He points out that a whole range of parasites can only exist inside humans (and other parasites can only exist inside other creatures). So the ark's human inhabitants must have carried four types of malarial parasite, two types of tapeworm, one intestinal worm, the hookworm, the pinworm, three types of lice and dozens more (Moore 1983, p.19). And every creature on the ark had similar problems! Truly the ark was a pest-house without parallel!

Granting the dreadful plagues afflicting the creatures on the ark, a more basic question remains; what were these creatures? Creationists do not accept the scientific concept of species; they use the biblical term 'kind' or their own made-up word 'baramin'. Instead of the conservative 1,677,920 different species which Moore (1983, p.14) calculates as minimum, we have a vague number of 'kinds', such as pigeon-kind, dog-kind and so on. This is considered in more detail in the article "The myth of created kinds" elsewhere in this book.

Moore points out the problems for dogs:

> '. . . the original canine baramin in Eden would have needed a fantastic set of giant chromosomes with alleles for every trait that would someday be manifest in coyotes, wolves, foxes, jackals, dingos, fennecs and the myriad of minute variations in hair colour (twenty-four genes at nine loci), height, face shape, and so forth that are seen in the domestic dog . . .'
>
> Moore (1983, p.6)

This applies to all the animals. Now Bodmer and Cavalli-Sforza have shown that nearly a third of human genes are polymorphic, and some, such as the two controlling A and B antigens, with 30 varieties, would need more people than the ark held. This argument can be applied across many 'kinds'. The pairs of animals alleged to be on the ark simply could not have carried all the variation we see in living things today.

Moore discusses in detail the problems of feeding, watering and cleaning the creatures on the ark, but space forbids this. Let us now imagine that the ark has grounded on Mount Ararat. What then?

(v) After the Flood

The strange cargo of disease-ridden creatures emerges blinking into daylight. What do they eat? Since the flood laid down our present rock strata, plants and seed would be buried beneath hundreds of metres of mud. There might be year-old carrion from before the flood, but who could eat that? And the carnivores could not turn to their obvious food supply — the herbivores — for obvious reasons: that would be the end of the food supply!

Let us assume as Moore (1983, p.34) suggests, that maybe they ate dust (or mud). The dispersal begins. Somehow, the marsupials trekked across Asia to Australia, crossing a land bridge to our continent before the bridge disappeared. This is truly remarkable: how did the marsupials know that the flood would deposit marsupial fossils in such a way as to suggest that they had evolved there? We are also to believe that the koala, the platypus and the blind marsupial mole journeyed ahead of the Malaysian tiger, and beat it across the land bridge.

Moore (1983, p.35) lists other amazing events:

> 'In a similar vein the ceboids (New World primates) found their way to South America . . . the very region where their fossil ancestors had thrived. The elephant bird, a nine-foot, thousand-pound giant, decided not to remain on the mainland but splashed across the sea to Madagascar. In a similar fashion the dodo headed for Mauritius, the solitaire to Reunion, the white dodo to Rodriguez, the kagu to New Caledonia, and the kiwi to New Zealand — all flightless birds who swam to remote islands to make their only homes.'
>
> Moore (1983, p.35)

Now this is barely credible. Exactly how or why did all these flightless birds head for all these remote spots? When one comes to the plants, however, the mind truly boggles:

> 'Two thousand species of cactus had to find their way to the New Worlds while avoiding the arid lands of Asia and Africa. The giant sequoia and redwood trees had to reach the Pacific coast of North America and produce, from the handful of seed in the ark, the magnificent forests that date to within a few centuries of the flood. Who carried the double coconut to the Seychelles, its only home, or planted endemic flora atop the towering Venezuela's 'Lost world'?'
>
> Moore (1983, p.35)

Of course, questions about Australia's unique flora are just as perplexing — to creationists! From an evolutionary viewpoint, biogeography is one of the strongest corroborations of the theory.

How to believe in the Ark and the Flood

These are only a selection of the points that can be made. Moore (1983) goes on for dozens of pages, listing inanities and impossibilities involved in the creationist story of Noah's Ark. The only way to accept the story is to repeat to oneself, over and over, that it was a chain of miracles.

Miracle after miracle, all perpetrated in the effort to save Noah's Ark. Of course, the only people who can take it seriously are those utterly committed to a literalistic interpretation of the Bible. They have every right to their views, and indeed to have their viewpoint represented in religious instruction. However, to offer such a hotch-potch as science is to insult both true religion and science, and the intelligence of school students.

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A QUOTABLE QUOTE

'In the beginning, I thought that antievolutionists were simply mixed up epistemologically, that they did not understand the structure of knowledge, that they could not differentiate between data derived through a theological system versus that derived through a scientific system. I was so naive that I felt logic, reason and the facts of the case would be enough to convince people who were scientifically uninformed. I soon became disabused of the concept that this was an innocent group with which I was dealing. I found, instead, that it was a group whose reception of ideas contrary to their own was blunted by a shield of ignorance proudly borne.'

William V. Mayer (1984): *American Zoologist*, vol.24, p.424.

A QUOTABLE QUOTE

'The works of eminent evolutionists have been scanned with care and isolated comments are quoted right out of context. Perusal of creationist works give the impression that the leading spokesmen for the cause are Mayr, Simpson and Dobzhansky. There seems something incongruous to the point of dishonesty in this willingness to accept the occasional queries, doubts and side-comments of evolutionists, and yet to reject absolutely every one of their main claims. If these men are so untrustworthy in essentials, what ground is there for referring to them at all?'

Michael Ruse (1981): *Is Science Sexist?* page 44.

WHAT IS THE CREATION SCIENCE FOUNDATION LTD ?

Martin Bridgstock

The most effective propaganda for creationism in Australia has come from the Creation Science Foundation Ltd, of Queensland. This was established in 1980 and the latest information available was for the year ending March 31st, 1985. Even with this inadequate information, some intriguing points emerged. The information comes from the Queensland Department of Corporate Affairs.

The beliefs and aims of the Creation Science Foundation

According to the articles of association of the foundation, members believe the following:

> '(a) (i) The scientific aspects of Creation are important but are secondary in importance to the proclamation of the Gospel of Jesus Christ, the Sovereign Creator of the Universe and Redeemer of Mankind.'

and

> '(b) (i) The Bible is the written Word of God. It is inspired and inerrant throughout and the supreme authority in all matters of faith and conduct. Its assertions are historically and scientifically true in all the original autographs.'

and

> '(iii) The account of origins presented in Genesis is a simple but factual presentation of actual events and therefore provides a reliable framework for scientific research into the question of the origin and history of life.'

There are a total of nineteen statements which members believe, and these three are the only ones which mention science. All three clearly state that science must be subordinate to a religious perspective, and two of them specify that this perspective is a literalist reading of the Bible. The other sixteen statements are almost totally religious, and include the following

> 'The great flood of Genesis was an actual historic event, world wide in its extent and effect.
>
> (vi) The special creation of Adam (as one man) and Eve (as one woman) and their subsequent fall into sin through rebellion is the basis for the necessity of salvation for mankind.
>
> (vii) Death, both physical and spiritual, entered into this world as a direct consequence of man's sin.'

And so on. This writer confesses to complete incomprehension of how man's sin could have condemned billions and billions of blameless animals to the agonies of death.

After the nineteen statements are a further four, which 'All persons wishing to become members of the Foundation are expected to hold.. .'. These include:

> '(i) The Scripture teaches a recent origin for man and for the whole Creation,
>
> (ii) The days in Genesis do not correspond to Geologic ages but are six (6) consecutive twenty-four (24) hour days of Creation.
>
> (iii) The Noachian flood was a significant event and much fossiliferous sediment originated at that time.
>
> (iv) The Gap Theory has no basis in Scripture.'

For a Creation SCIENCE Foundation, the science is almost neglected, and is clearly subservient to one particular view of the meaning of the Bible. To become a member of the Foundation one has to believe in a young Earth, Noah's Flood, the creation in six days and that human sin caused not only human but also animal death. This, it should be noted, is to be taught in the science syllabus in Queensland.

The objects of the Foundation are similar in nature — science is barely mentioned, but there is a heavy stress on proclaiming the Gospel, winning people to Christ and propagating creationist ideas.

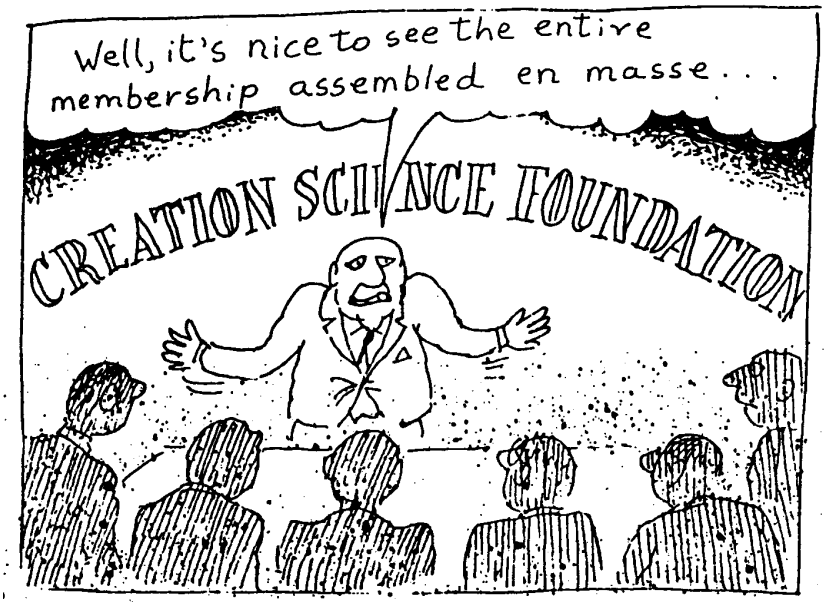
Indeed, it is clear, looking at the articles, that the object is to push one particular fundamentalist version of religion, and to use 'science' as a means to do this. The idea of science as a tentative way of finding out how the material universe works simply does not appear in the articles of association of the Creation Science Foundation.

Who are the members of the Creation Science Foundation Ltd?

The articles of association limit the number of members of the Foundation to a maximum of one hundred. Even so, one hundred members professing the beliefs of the articles would be an amazing assemblage. Except that there are not one hundred members. At the beginning of the foundation, in 1980, there were just seven members, and in March 1984, there was just the same number. What is more, they were just the same people in 1980 and 1984. Their names and given occupations in 1980 were

Kenneth Alfred Ham - missionary,
John Barry Mackay - teacher,
John Andrew Thallon - accountant,
Tyndale John Rendle-Short - medical practitioner,
David John Denner - teacher,
Alfred John Maynard Osgood - medical practitioner,
Robert Stephen Gustafson - solicitor.

Note the occupations of people who are founding members of the Creation SCIENCE Foundation, and are going to challenge the whole of modern science.
By 1984 the membership of the Foundation was exactly the same seven people. The only difference was that John Mackay had changed his occupation from 'teacher' to 'missionary'.



What is more, the Directors of the Creation Science Foundation Ltd, in both 1980 and 1984 are the same seven people as listed above! Far from being a broad-based movement with mass membership, the Creation Science Foundation consists of seven members who regularly re-elect themselves to the Directorships and who, one assumes, report to themselves about how things are going at the Annual General Meetings. From the articles of association, it is clear that nobody can become a member of the Foundation without approval and so they remain as a small group in complete control of the foundation's affairs.

The Foundation's current chairman, Emeritus Professor Rendle-Short, has attempted to answer these points. Writing in the evangelical magazine *New Life* (Rendle-Short 1986) he claims that:

> 'The Foundation is not a membership organisation.'

Exactly how an incorporated organisation with a stipulated membership of up to 100 and an actual membership of seven is 'not a membership organisation' is rather unclear. Rendle-Short goes on to claim that the large number of people (about 12,000) on the Foundation's subscription and mailing lists 'could loosely be described as our "membership"\0'. The looseness is extreme, and legally wrong. Members would be entitled to vote at general meetings, to demand a full explanation of the finances (see below) and, if the explanations were inadequate, to replace the directors. To our knowledge the subscribers and supporters were not told about the Foundation's financial problems until the first edition of this book brought the subject into the open.

The finances of the Creation Science Foundation

The financial statements of the Creation Science Foundation make interesting reading, as much for what they do not say as for what they do.

The income of the Foundation has grown explosively throughout the period 1980-1985. Donations alone grew as follows:

1981	$33,052.52
1982	$57,492
1983	$119,132
1984	$152,398

The total income in 1984 was $539,542. In 1984 the only source of income larger than donations was the bookshop, which took $220,552. The costs of bookshop sales, however, were $135,646, which means that donations were much the largest single source of creationist funds.

The 1985 returns appear incomplete, but the pattern of growth continues in the year ended March 31, 1985. The trading surplus with other items of income rose from $293,457 in 1984 to $442,228 in 1985. The income also includes a grant from the Export Market Development Board of $24,693.

No mention of this grant, or the grant of $3,177 to the Creation Science Association Inc of South Australia was made in the *Creation Science Prayer News or Ex Nihilo*.

Questions have been raised about the constitutionality of these grants. Section 116 of the Australian Federal Constitution prevents the Federal Government from establishing a religion. This section is based on the First Amendment to the American Constitution. In America, Federal Courts have ruled unconstitutional payments similar to those made to the Creation Science Foundation.

In Australia there have been only four cases dealing with section 116 of the constitution, and it is difficult to assess whether or not the High Court would find these payments unconstitutional.

The Export Development Grants Board did not ask the Attorney-General's Department for an opinion as to the constitutionality of the grants. The Board refused to make public details of the CSF's submissions on the grounds that it would not reveal information about an applicant's affairs. However Dr C. Wieland, President of the Creation Science Association Inc, said "two of their people went to the United States to promote the sales of that [Setterfield's] book. That was regarded by the government, and quite correctly so, as a straight commercial undertaking, which benefits Australia as far as export revenue was concerned."

It would appear that any writers of Australian pseudo-science books can also go overseas to promote their books at taxpayers' expense. However, a study of other grants made does not reveal authors as common recipients of such grants.

Clearly, the Federal Government has to clarify its position. It is encouraging that Senator Button, in response to Senator Puplick's question, is reported to have undertaken to refer the tax status of the Creation Science Foundation to the Treasury for investigation, and also ask the Trade Minister, Mr Dawkins, to investigate.

Where does the money go?

With the Foundation's title associating it with science, I expected considerable expenditure upon assorted scientific projects and research enterprises. The actual results came as a shock.

For 1982, I could find NOTHING listed as expenditure on research at all. For 1983, I found under 'Research - Ex Nihilo' a grand figure of $398. In 1984 this had rocketted to $860. To put this in perspective, the total overhead expenses in 1983 were listed as $161,968 and in 1984 were $245,358. It follows that the listed research expenditure in both years is a small fraction of one per cent of the Foundation's overhead expenditure. It is possible that scientific research is under some other heading, but on the face of it the Creation Science Foundation seems to be doing virtually nothing to produce new knowledge supporting its cause. This seems to support the allegation that creationism is parasitic upon normal science. Instead of producing worthwhile knowledge, they seek to use existing work to give the impression that they have something worthwhile to say.

What *does* the money go on, if not research? Overhead expenses in the year ending March 31, 1984 totalled $245,358. The largest items under this heading (accounting for over three-quarters of it) were:

Salaries and wages	$117,625
Postage	$26,144
Printing	$18,096
Travelling expenses	$17,817
Rent	$13,649

Library expenses totalled $291 and subscriptions (presumably to magazines) totalled $139. Both of these are very small amounts for a supposedly 'scientific' organisation — most professional scientists would personally spend more than this.

It is when one asks where the money went, apart from overheads, that the most surprising item appears.

Where did all the money go?

The year ending March 31st, 1983 seems to have been a good one for the Creation Science Foundation. A sum of $34,388 appears in the balance sheet under 'investments' compared to nothing at all the year before. The nature of the investments is not stated. A further $13,553 is listed as 'purchase of investments' in the 1984 statement. Alas for the CSF, something seems to have gone wrong. Parts of the 1984 statement appear below. In the statement of income and expenditure, the following appears:

'Net surplus before extraordinary item	48099
Less Extraordinary Item - loss of investments	47939
Net surplus after Extraordinary Item	160'

We are not enlightened about the nature of the extraordinary item, but its magnitude increases markedly:

> '4. Extraordinary items
>
> This item represents the amount required to write down the company's investments to the directors' estimates of their realisable value at 31st March 1984 as a result of the failure of the company's investment agents(Note 6).'

and

> '5. Investments

1983 $		1984 $
34 388	Investments at cost	47 941
NIL	Less Amounts written off	47 939
34 388		2

> 6. Event subsequent to Balance Date
>
> Since 31st March, 1984 the company has invested a further $44 419 with the failed organisations mentioned in note 4. As a result of the failures mentioned, this amount is also no longer recoverable.'

The total amount written off because of the 'failure of the company's investment agents' is therefore $92,358. The documents do not state exactly who were these investment agents, and what sort of failure led to such a catastrophic loss.

There is another way of looking at this surprising figure. The total donations received by the foundation in the year ending March 31st, 1984 was $152,398. Thus the amount written off was equal to about 60% of the total amount donated in the statement of March 1984. We feel that the people who gave so generously to the foundation would be interested in knowing what happened to such a large sum of money, who the failed investment agents were and exactly how the failure happened. Because the Creation Science Foundation is involved in public lobbying for changes to education, it is in the public interest that there be a full disclosure of this loss. So far full disclosure has not been forthcoming.

What happened?

Two creationist attempts to explain what happened have appeared, one by the Foundation chairman, Emeritus Professor Rendle-Short (1986), the other in the Creation Science Prayer News (Ham 1986). Neither gives a full account. Rendle-Short writes as follows:

> 'The facts are that about 18 months ago about 100 creditors, including Creation Science Foundation and many individual Christians, were fraudulently dealt with by what we believed to be a trustworthy investment company that is now in liquidation and whose directors are now under investigation.'

The CSF was told in writing that the money would be held in a trust account, but this did not happen:

> 'The money, supposedly in trust, was in fact invested with a group in Sydney. The Sydney group was liquidated in mid-1984 after the New South Wales Corporate Affairs Department found it owing $7 million. The organisers of the Sydney group are facing criminal charges.'

The Creation Science Prayer News gives a similar account, but somewhat vaguer. The key points are that two organisations are involved. The Sydney one is believed to be the International Commodity Traders Association of Australia. The CSF has not, however, revealed the name of the other company. The other company appears to be Goldcom International, a company with a share capital of two dollars run by Lindsay and Wendy Bates of Mansfield. A meeting of creditors of this company was held in September 1984. There appear to be over 100 unsecured creditors, and the Creation Science Foundation was shown as being owed $85,370.24.

An interseting sidelight is that, in their report of 1984, the Creation Science Foundation entered into a contract with Tralil Pty Ltd for 'provision of management consulting services', and in the 1985 return, this was reported to have cost $8,119. In its return for 1984 Tralil, whose directors are John Thallon and Esther Thallon, described itself as 'only a trustee for the Thallon Family Trust'. Another of Goldcom's creditors is listed as Tralil Pty Ltd, which was owed $83,689.90.

The 1985 accounts are drawn up by different accountants from the earlier ones. The Queensland-based solicitors have been replaced by C.L. Lunt of West Perth. The currently listed CSF representatives for Perth are Col and Bev Lunt.

In July 1986 three of the directors resigned their positions in the Creation Science Foundation. They were John Thallon, the accountant, Robert Stephen Gustafson, the solicitor, and David John Denner. In 1987 other changes have occurred. John Mackay, perhaps the major force driving the organisation, has quit. Ken Ham, another important person, is on an extended contract in the USA.

What can be done?

A leading Australian evangelical journalist, Rev. John A. Coleman, edits the magazine *New Life*. He commented on the loss of $92,358 by saying that such losses 'will doubtless happen again'.

If supporters of the Creation Science Foundation do not want to see such a loss again, they should make some things clear to the CSF. They should demand full consultation on any future investments and full disclosure of all financial affairs.

In the USA, after similar financial losses by evangelical organisations, the Evangelical Council for Financial Accountability (ECFA) was set up. By 1981, 162 American evangelical fund-raising organisations were associated with ECFA, with a total turnover of $US700 million.

ECFA principles include making financial statements available on request, avoiding conflicts of interest and using contributions for the purpose for which they were raised. On February 17th, 1986, at the Randwick Baptist Centre, the national president of the Australian Skeptics, Mark Plummer, called for the setting up of an Australian ECFA. His call was supported by Dr John W. Montgomery, a visiting American theologian.

Summary and conclusions

An inspection of the articles of association and annual returns of the Creation Science Foundation Ltd revealed a number of interesting points.

1. The organisation is predominantly religious, with its members committed to believing in a literalistic, fundamentalist view of the Bible.
2. The membership of the Foundation stands at seven, as does its Board of Directors. The seven people have not changed since the foundation began.
3. The foundation's finances show explosive growth. A large percentage of the income comes from donations.
4. The amount of money spent on research is tiny.
5. In the 1984 return, a large amount of money was written off, owing to the (unspecified) failure of the company's (unspecified) investment agents. The nature of the loss is not spelt out anywhere in the returns, nor in subsequent publications.

The Creation Science Foundation's explanations have not, so far, specified the name of the investment company involved. Since the CSF is both a recipient of Government money, and engaged in lobbying for changes in the public education system, it is in the public interest that such information should be made public.

Considering the massive turnover of the CSF with such a loss, its supporters should demand a more active role in the running of the Foundation. This should include a say in its research priorities and the efficiency of its campaigns. If they do not, then they must share the blame for any further financial disasters in the Foundation.

References

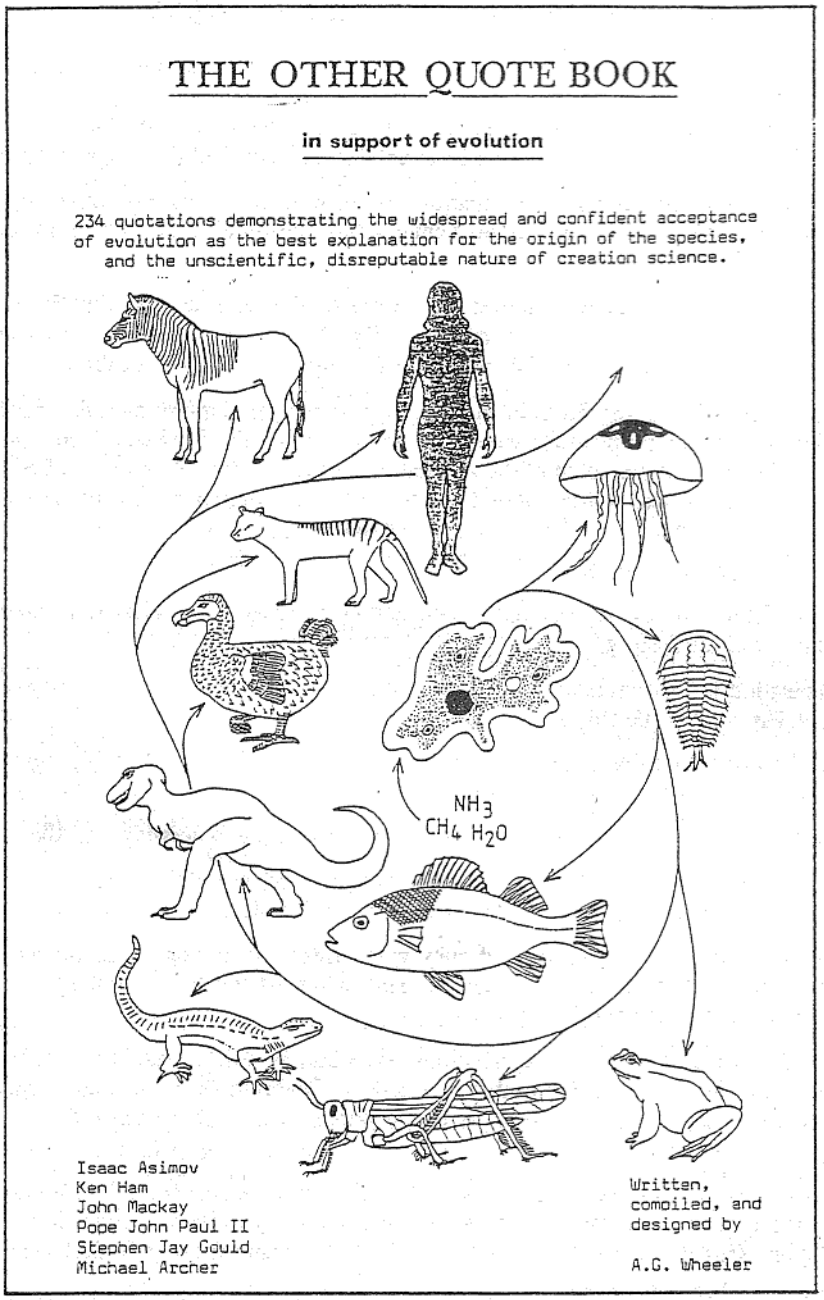
Rendle-Short, J. (1986): Creation Science Attacked! Letter in *New Life*, February 6.
Ham, K. (ed.) (1986): *Creation Science Prayer News*. February. page 3.

A QUOTABLE QUOTE

‘So it goes on. One scientist after another receives Creationist treatment. Any qualifying comment, any deviation from orthodoxy is a potential target. Ripped from its context, it can be made to serve the Creationist’s purpose, namely, to convince the uninitiated that Creationist theses are sometimes advanced by scientists in scientific debates. But anybody can play the same game. In conclusion, I cannot resist turning the weapon against the Creationist who has used it to greatest effect. Referring to the controversy about transitional forms, Gish writes, “There should be no room for question, no possibility of doubt, no opportunity for debate, no rationale whatsoever for the existence of the Institute for Creation Research” (Gish 1981, ii). How true.’

Philip Kitcher (1982): *Abusing Science*, page 185.

(The quotation may be found in Morris & Rohrer, *Creation The Cutting Edge*, p.167)



STRANGE REMARKS BY CREATIONISTS

Martin Bridgstock and Ken Smith

Ploughing through creationist literature in detail is a tedious and rather frustrating business. However, from time to time, the task is enlivened by coming across a phrase or sentence which can only be described as bizarre. These strange remarks appear to reveal more about the person who wrote them than about the topic under discussion. The following selection of some of the remarks we have encountered is presented, with a minimum of comment, so that you can draw your own conclusions.

The dire origins of evolution . . .

'If something like this really happened, early in post-diluvian history, then Satan himself is the originator of the concept of evolution.'

H. M. Morris: *The Troubled Waters of Evolution*. C.L.P.Publishers. San Diego, 1974, pp.74-5.

. . . and its dire consequences

'Evolution provides the scientific orthodoxy for the philosophies of Marxism, fascism, racism, apartheid and unbridled capitalism.'

J. Rendle-Short; What should a Christian think about evolution. *Ex Nihilo*, vol.3, no.1, February 1980, p.16

'. . . this monkey mythology of Darwin is the cause of permissiveness, promiscuity, pills, prophylactics, perversions, pregnancies, abortions, pornotherapy, pollution, poisoning and proliferation of crimes of all types.'

Judge Braswell Dean, a Georgia lobbyist for creationism. *Time*, March 16, 1981, p.62.
(Editors' comment: We wonder what caused pregnancies *before* 1859.)

On the Creator

'All that creation-science requires is that the entity that caused creation have power, intelligence and a sense of design. There are no attributes of personality generally associated with a deity, nor is there necessarily present in the creator any love, compassion, sense of justice, or concern for any individuals. Indeed, under creation-science as defined in Act 590, there is no requirement that the entity which caused creation still be in existence . . .'

Trial brief for the creationist case, Arkansas creationism law trial, 1981. Quoted in La Follette, M.C. (1981): *Creationism, Science, and the Law*, p.41
(Editors' comment: Funny. We thought creationists totally rejected the "God is dead" theology.)

On people who disagree with creationist views

'It is a contest between the ideology which says man can think as he likes, and the theology which states man has intellectual freedom only within the limits of truth. . . Trains and brains have real freedom only when they do not go off the rails.'

Ex Nihilo, vol.7, no.1, August 1984. Editorial.

'People fed a diet of toleration lose certainty about Genesis.'

Ex Nihilo, vol.6, no.2, November 1983. Editorial.

'Men are not only carrying on this war because of any honour they wish to pay to reason and enlightenment. Rather, their irrational faculties are enlisted and misused as servants of their irrational hatred of God. . . The Bible tells us that behind the program of resistance to God's absolute claims are all the armies of spiritual wickedness.'

R. Pike and E. Munday; Psalm 8 verse 2. *Ex Nihilo*, vol.5, no.1, June 1982, p.25.

On choosing the scientific theory which best fits the evidence

'Under the canopy of evolutionary theory nestle some strange bedfellows . . . If I had to be, I would prefer to be wrong in my belief in creation in company with the people of God down the centuries, than right with such an odd conglomerate.'

J. Rendle-Short; Man: Ape or Image - The Christian's Dilemma. Creation Science Publishing, 1981, p.126.
(Editors' comment: There are NO circumstances under which we would prefer to be wrong rather than right!)

‘They (i.e. creationists) are not open to any disproof of the question ‘Did God Create?’ since their starting-point is ‘in the beginning God created’. To allow any other conclusion would destroy their faith. This position of acceptance of a revelation is no more unscientific than the biologist accepting the chemist’s word that thermodynamics is relevant to the origin of life.’

J. Mackay. Creation as science. *Ex Nihilo*, vol.2, no.3, July 1979, p.10.

‘The only Bible-honoring conclusion is, of course, that Genesis 1-11 is actual historical truth, regardless of any scientific or chronological problems thereby entailed.’

H.M. Morris: *The remarkable birth of planet earth*. Dimension Books. Minneapolis. 1972. p.82

(Editors’ comment: Wouldn’t science be easy if we could ignore any scientific or chronological problems!)

On less fortunate peoples

‘. . . each racial group started at a common point - Noah! Each began with . . . a sophisticated ocean-liner technology. The current cultural status of the races . . . is a direct consequence of whether the ancestors of any race worshipped the living God or deliberately rejected Him. There is no such thing as a primitive race evolving upwards.’

J. Mackay: The origin of races. *Ex Nihilo*, vol.6, no.4, May 1984, p.11.

‘They are not primitives in need of education and technical aid so that they can understand the gospel, but degenerates in need of the gospel of the Creator Christ so that they can appreciate education and the relevance of technology.’

J. Mackay. As above, p.12

(Editors’ comment: Don’t tell the Japanese, they might get discouraged!)

‘No race of the world today comes from a background of zero technology or of innocent ignorance of God. All cultures which do not have a correct knowledge of God have got that way by deliberate rejection.’

Ex Nihilo, vol.3, no.3, August 1980. Editorial.

On garments

‘Many Christian girls go bra-less and wear clingy T-shirts or wear clingy clothes to show off their breasts and sexual parts. You can see the boys’ eyes follow them around.’

Ken Ham (Director of Ministry of the Creation Science Foundation); *The Relevance of Creation*, 1983, p.3.

‘Genesis is the only book that provides an account of all the basic entities of life and the universe - the origin of life, of man, of government, of marriage, of culture, of nations, of death, the chosen people, of sin and clothes: so it goes on and on.’

Ken Ham, as above.

The practical uses of creationism

‘Any creation model must be practical. For example, since creation is the correct explanation, a geological prediction based upon the creation model must enable geologists to find oil better than predictions based upon evolutionary thinking.’

Ex Nihilo, vol.2, no.3, July 1979. Editorial.

(Editors’ comment. It’s nearly ten [over twenty in 2001] years now. We [still] await with bated breath the announcement of the first creationist oil strike.)

MORE QUOTABLE QUOTES

‘The reason evolutionary science does not make references to a creator is for the same reason that mathematics, cell biology, organic chemistry, and hydraulic engineering do not make reference to a creator: none of these are theological subjects. They are nontheistic, as all scientific and mathematical systems must be. Imagine how ridiculous Dr. Gish would have sounded had he declared, “Thus, while not all those who do long division are atheists, the practice of long division is an atheistic practice”. After all, “no supernatural intervention of any kind” is involved. It must be that elementary school teachers who instruct our children in nonmiraculous math are teaching “a basic dogma of agnosticism, humanism, and atheism.” ’

Kenneth Miller (1982): *Creation/Evolution*, no.VII, page 3.

‘You know where I stand, of course. But, let me be quite categorical. I believe Creationism is wrong: totally, utterly, and absolutely wrong. I would go further. There are degrees of being wrong. The Creationists are at the bottom of the scale. They pull every trick in the book to justify their position. Indeed, at times, they verge right over into the downright dishonest. Scientific Creationism is not just wrong: it is ludicrously implausible. It is a grotesque parody of human thought, and a downright misuse of human intelligence. In short, to the Believer, it is an insult to God.’

Michael Ruse (1982): *Darwinism Defended*, page 303.

‘As for alternative sciences, they are of interest to many students. Thus an elective course that presented astrology, pyramid power, “ancient astronauts,” dowsing, flat-earth science, scientific creationism, and other “alternate” explanations, and allowed students to hear all sides of these issues, could be quite valuable. It would go well with instruction in critical thinking.’

Frederick Edwords (1983): “Is It Really Fair to Give Creationism Equal Time?”, in Laurie R. Godfrey (ed.): *Scientists confront Creationism*, pages 314,315.

‘We’ve been trying to explain all this to the protein “experts” at ICR for the last seven years. We have told them that new proteins could indeed form from the random ordering of amino acids. We have warned them that their calculations were based on faulty assumptions and soon someone would document the natural formation of a new protein from the random association of amino acids.

Now it has happened! Not one, but two, new proteins have been discovered. In all probability new proteins are forming by this process all the time, but this seems to be the first documentation of this phenomenon.’

William M. Thwaites (1985): *Creation/Evolution*, no.XVI, page 2.

SUMMARY AND CONCLUSION

Martin Bridgstock and Ken Smith

> 'It is the responsibility of knowledgeable scientists, of professional educators, and of their organizations, to expose the extent to which scientific incompetence and intellectual dishonesty prevail in the "creation science" movement. Only then can school officials be held fully responsible for allowing the forced teaching of creationism as science.'
>
> John W. Patterson (1982): *Proceedings of the Iowa Academy of Sciences*, vol.89, p.58.

Quite clearly, in a short book such as this, it is not possible to comment upon all the claims made by creationists. Indeed, some claims seem beyond any sort of comment. For example, American creationist Walter T. Brown presents the 'Scientific Case for Creation' as 108 'Categories of evidence'. Many of these 'categories' have already been dealt with in this book. However, category 9 seems beyond comment. It runs as follows:

> '9. No verified form of extraterrestrial life of any kind has ever been observed.'
>
> W.T. Brown in J.P. Zetterberg (ed.): *Evolution versus Creationism*, pp.208-232'

There are no references, no explanations. There is also not the slightest indication of what this has to do with creationism!

Rather than spend more time on such absurdities, we would like to sum up the major points and make a few general statements.

The 'Scientific Case for Creationism'

One's first impression when dealing with creationism is often that a large amount of impressive scientific evidence is being advanced. Even if not pointing to creationism, it certainly looks as if modern science — and especially the theory of evolution — is in a bad way.

We hope that this book will go a long way towards dispelling such impressions. The evidence for creationism is rotten with error, misrepresentation and distortion. Almost always, whenever one checks creationist claims, one finds that they are unreliable. How, then, can one take their claims seriously? And if a scientist finds blunders in his or her area of expertise, is it not reasonable to assume that other areas are equally full of blunders?

For most people, detailed checking is not possible. The average teacher, school student or employee has neither the time nor the necessary access to big academic libraries, and in consequence, most people simply cannot evaluate creationist propaganda.

This is what makes creationism so pernicious — its claims are blatantly false, yet most of the population are not in a position to detect this. What is worse, the introduction of creationism into science teaching is not simply a case of adding something on. The science syllabus in schools is already crowded. If creationism is to be forced into schools, then genuine science must be excluded. Our children will suffer the loss of genuine education because of political pressure from a fanatical minority.

Where does it stop?

If creationism is to be introduced into schools, it is hard to see where the process would stop. The 1,500 members of the Flat Earth Society in the USA are nearly all fundamentalist Christians. Does geography need to allow time for the presentation of their 'model'? And a large number of members of the various Bible Science Associations are firmly convinced that the sun goes around the earth — most of astronomy would have to be rewritten to accommodate their ideas.

And we still haven't finished with the beliefs of various Christians, let alone other religious groups who make up an increasing proportion of Australia's population. Do the creationists really want their ideas placed alongside, and treated as of equal value with, those of Muslims, Hindus, Buddhists, Confucians, Taoists, Shintoists . . . ?

The religious issue

As John Knight has pointed out in this book, creationists are an extreme minority. By itself, that does not rob their views of validity. In our view, every person has the absolute right to whatever religious views they wish to hold. We would also defend the right of each person to attempt to persuade others of the truth of a religious viewpoint. Further, if appreciable

numbers of people hold certain beliefs, we think that children should be made aware of these beliefs in religious instruction classes.

Creationism goes far beyond this, however. Creationists want their religious viewpoint — and theirs alone — to be taught in the science syllabus. They have attempted to justify this by claiming that evolution is as religious as creation. The problem with this view is that evolution — and the other theories of mainstream science — are accepted by people holding a tremendous range of religious views. Evangelical Protestants (three of the contributors to R.M. Frye's *Is God A Creationist?* are evangelical), liberal Protestants, Catholics, Jews, Muslims, atheists and many more are all committed to the scientific view because it explains the evidence best. By contrast, only some extreme fundamentalists believe in creationism. Creationism is based on religion, while science in general and evolution in particular are not.

To associate a sectarian belief with science in this way is desperately dangerous. First, of course, it associates religious belief with one particular view of how science should be done. It therefore cripples scientific enquiry — remember that almost no scientific research has been done — and also by implication derides religion. The implication of creationism is that religion, our relationship to the Divine, is so fragile that it needs the support of a purely human, purely material activity, science, to make it believable. This would astonish any true religious believer, and yet it is a constant theme in creationist writing. One author has evidence of this, in the form of a letter from a science teacher in Northern Queensland. Part of the letter, seeking to justify teaching creationism as science rather than religion, runs as follows.

> 'The point here, I think, is that Creationism in religious studies would be played down merely as a 'belief' with no empirical basis.'

The idea that one's religion must have an 'empirical basis' is bad enough. So is the confusion between a religious doctrine and pseudoscientific creationism. Ultimately, religion is more important than science, as it concerns ultimate reality and the ultimate meaning of our lives. To equate this with the purely human activity of science is to mislead school pupils about science and religion.

What can be done?

Many observers have expressed surprise that creationism, like a hardy weed, keeps springing up. Should not the advance of science make such beliefs ludicrous? We suspect that there is no reason why it should. Creationism has almost nothing to do with science, and not much to do with religion. Reading the utterances of creationists, one is struck by their fear and insecurity in the modern world. They want a simple world, where right and wrong are clear, and justice is always done.

We may sympathise with the fears of these people. However, it would be folly to allow the fears of a minority to endanger the future of all. For creationism is a danger. Science rests on clear statements, of a theoretical nature, which are then tested against observation. As this book has shown, creationism does neither. It violates every canon of scientific behaviour.

The corruption of science, and of science education, would be grave by itself. However, the success of creationism would set a precedent which should be as frightening to fundamentalist Christians as it is to scientists; it would establish that a fanatical minority, armed with errors and misrepresentations, can impose its ideas upon every child in a state school system.

Our duty as responsible adults is clear. We must defend the integrity of our science and our education, and do our best to give our children the best start we can for the morrow.

A QUOTABLE QUOTE

> 'I would defend the liberty of consenting adult creationists to practise whatever intellectual perversions they like in the privacy of their own homes; but it is also necessary to protect the young and innocent.'
>
> Arthur C. Clarke (1984): *1984: Spring*. page 265.

A LIST OF ITEMS FOR FURTHER READING

Editorial Note (by Ken Smith, July 2001)
This reading list is very much out of date, but updating it properly would be a massive undertaking. In the fourteen years since the last edition there has been a veritable flood of books on the relationship between science and religion, at least partly as a reaction against creationism: most of them, however, dismiss creationism as not being helpful or useful to either science or religion. Some additions have been made of books published up to 1988 and there are five later books of considerable importance: Numbers (1992) for background information on creationism, and Young (1995) for changes in religious thinking about Noah's flood; Plimer (1994) for the Australian scene; and Miller (1999) and Pennock (1999) for criticisms of the more recent creationist ideas of "irreducible complexity" or "intelligent design", and attacks by Phillip Johnson on the whole of modern science. Readers interested in other recent books should try a library, and search under the subject headings "Creationism" or "Religion and Science".

Since the last edition the World Wide Web has become an important source of information (and, regrettably, misinformation). There are a number of sites which contain information about creationism, or cover parts of the debates about the nature of science. Two sites, however, stand out and can be highly recommended, both for the accuracy of their information and the way they are kept up-to-date.

http://www.talkorigins.org
is the archive for the **talk.origins** newsgroup, and is the repository of a very large number of FAQ (Frequently Asked Questions) files on all aspects of creationism. You can search the archive, and there are interesting things like "What's New", "Feedback", and "Post of the Month". There are also links to many other Web sites of interest, including even creationist sites.

http://home.austarnet.com.au/stear/default.htm
is John Stear's "No Answers in Genesis" website, and is morer aimed at Australian audiences. It contains a large number of items relating to almost all aspects of the discussion.

The following list of printed materials is divided into several sections. It is only a selection of the many books and articles which have been published relatively recently in the areas of

(a) criticism of creationism from scientific and/or religious viewpoints;
(b) general popular or semi-popular works on modern science;
(c) background information on creationism and fundamentalism;
(d) the relations between science and religion generally.

For areas (a) and (b) both books and articles in periodicals are given. For (c) and (d) only books are listed. Comments are added to most of the entries to provide some information on the most useful items for different areas of science.

(a) Works criticising the scientific and/or religious errors of creationists

The American Biology Teacher. Regularly contains articles critical of creationism.
Creation/Evolution. A journal published at rather irregular intervals which is devoted to the controversy. Contains articles from both sides.
Creation/Evolution Newsletter. A newsletter published every two months, bringing up-to-date information about the controversy, particularly as it affects USA. Valuable for keeping in touch with happenings overseas.
Interchange. No 33. Australian Fellowship of Evangelical Students Graduates Fellowship. Sydney, 1983. Contains three major articles: 'On reading Genesis 1-3'; 'The Creation-Evolution Debate: Some General Scientific and Biological Issues'; 'The Age of the Astronomical Universe'.
Journal of Geological Education. The issues for January 1982 and March 1983 are almost entirely devoted to articles critical of creationism. The issue for January 1984 has a 7 page bibliography on the topic.
Science and Creationism. National Academy Press, Washington 1984. Subtitled A View from the National Academy of Sciences. Concludes 'It is, therefore, our unequivocal conclusion that creationism, with its account of the origin of life by supernatural means, is not science'.
Statement on Creationism. Australian Academy of Science, Canberra, 1987. Concludes "The Academy sees no objection to the teaching of Creationism in schools as part of a course in dogmatic or comparative religion, or in some other non-scientific context. There are no grounds, however, for requiring that creationism be taught as part of a science course."
Berry, R.J. (1988): *God and Evolution*. Hodder and Stoughton. The Professor of Genetics at University College, London, an evangelical Christian, criticises both the scientific and religious errors of creationists.

Burke, D. (ed.) (1985): *Creation and Evolution*. Inter-Varsity Press. In the series When Christians Disagree. Four evangelical scientists who support evolution write in opposition to three creationists.

Eldredge, N. (1982): *The Monkey Business*. Washington Square Press. Subtitled A Scientist Looks at Creationism. Presents the main ideas about evolution, as well as criticisms of creationism.

Frye, R.M. (ed.) (1983): *Is God a Creationist?* Scribner. Subtitled The religious case against creation-science. Contains articles by authors of a wide range of theological views — Protestants ranging from evangelical to liberal, Catholics and Jewish.

Futuyma, D.J. (1982): *Science on Trial*. Pantheon Press. Subtitled The Case for Evolution. A cogent attack on creationism, stressing the biological aspects.

Gilkey, L. (1985): *Creationism on Trial*. Winston Press. Subtitled Evolution and God at Little Rock. An account of his experiences as an expert theological witness at the Arkansas trial, together with mention of some of the scientific evidence.

Godfrey, L.R. (ed.) (1983): *Scientists Confront Creationism*. W.W. Norton. Contributions by many different authors, all pointing to errors made by creationists. Written at a fairly readable level.

Hanson, R.W. (ed.) (1986): *Science and Creation*. Macmillan Publishing Company. Subtitled Geological, Theological, and Educational Perspectives. As well as criticisms of creationist errors, both scientific and theological, the papers reveal some of the creationists' political manoeuvering in some states in USA.

Hayward, A. (1985): *Creation and Evolution*. Triangle SPCK. Subtitled The Facts and the Fallacies. The second part is a hard-hitting criticism of creationist errors and blunders about the age of the earth.

Hyers, C. (1984): *The Meaning of Creation*. John Knox Press. Written by a theologian, it is subtitled Genesis and Modern Science. The first chapter, entitled 'Dinosaur Religion and Religion as Dinosaur' is a scathing criticism of creationism. The remainder of the book is mostly a theological exposition of the early chapters of Genesis.

Johnson, M.R. (1988): *Genesis, Geology and Catastrophism*. Paternoster Press. Subtitled A Critique of Creationist Science and Biblical Literalism. The author, a Christian geologist, criticises both the scientific and theological errors of creationists.

Kitcher, P. (1982): *Abusing Science*. MIT Press. Subtitled A Scientist Looks at Creationism. A thoughtful account, stressing more the nature of science, and why creationism cannot be regarded as science.

La Follette, M.C. (ed.) (1983): *Creationism, Science and the Law*. MIT Press. Contains the full text of the Arkansas creation science law of 1981 and Judge Overton's decision which held that the law was unconstitutional, as well as a number of chapters dealing with various aspects of the trial.

Livingstone, D.N. (1987): *Darwin's Forgotten Defenders*: *The Encounter Between Evangelical Theology and Evolutionary Thought*. Scottish Academic Press. The author shows that many evangelical theologians of the 19th and early 20th century were not opposed to evolution, and that the creationist movement is an offshoot of the fundamentalism of the 1920s.

McGowan, C. (1984): *In the Beginning . . .*. Prometheus Books. Subtitled A Scientist shows why the creationists are wrong. Wide ranging, but with special emphasis on palaeontological aspects. In the last chapter likens creationism to the emperor's new clothes.

McMullin, E. (ed.) (1985): *Evolution and Creation*. University of Notre Dame Press. Concentrates on religious misunderstandings by creationists, but also includes criticisms of their scientific errors.

Miller, K.R. (1999): *Finding Darwin's God*. Harper Collins. The subtitle is A Scientist's Search for Common Ground Between God and Evolution. Miller is Professor of Biology at Brown University and a Catholic. As well as some of the standard criticisms of creationist errors, he attacks recent ideas of "irreducible complexity" and "intelligent design", describing the creationist approach by chapter titles such as "God the Charlatan", "God the Magician", and "God the Mechanic".

Montagu, A. (ed.) (1984): *Science and Creationism*. Oxford University Press. The 20 essays in this book have such titles as 'Scientific Creationism: the art of distortion' and 'Scientific Creationism - marketing deception as truth'. There is also Kenneth Miller's devastating attack upon creationism, and two eye-witness accounts of the Arkansas trial.

Newell, N.D. (1982): *Creation and Evolution*: Myth or Reality? Columbia University Press. From the preface; 'I have written it not only for intelligent and cultivated students and laymen and women, but especially for schoolteachers, young people and their parents, and for all those whose scientific background is not adequate to withstand the high-pressure methods and the misleading arguments posed by the creationists.'

Pennock, R.T. (1999): *Tower of Babel: The Evidence against the New Creationism*. Pennock, a Quaker and Assistant Professor of Philosophy, provides arguments against recent attempts by creationists to put forward cases for "irreducible complexity" or "intelligent design", and gives extensive criticisms of the ideas of Phillip Johnson.

Plimer, I. (1994): *Telling Lies for God: Reason vs Creationism*. Random House. Professor Plimer pulls no punches in his treatment of creationism, mainly as he has experienced it in Australia. He provides a 10 page Bibliography to back up his attacks.

Ruse, M. (1982): *Darwinism Defended*. Addison-Wesley. Subtitled A Guide to the Evolution Controversies. Mainly concerned with the confusion about gradualism versus punctuated equilibrium in evolution, but also very critical of creationism.

Ruse, M. (ed.) (1988): *But Is It Science?* Prometheus Books. Subtitled The Philosophical Question in the Creation/Evolution Controversy. A collection of writings by some of the more prominent supporters of evolution, and some creationists.

Selkirk, D.R. and Burrows, F.J. (eds.) (1987): *Confronting Creationism: Defending Darwin*. New South Wales University Press. Expanded versions of papers presented at a 1985 symposium. Gives evidence for evolution as well as evidence against creationism.

Shapiro, R. (1988): *Origins*. Penguin Books. Subtitled A Skeptics Guide to the Creation of Life on Earth. Criticises creationism throughout, but especially in chapter 10, 'Creationism: Religion as Science'.

Strahler, A.N. (1987): *Science and Earth History*. Prometheus Books. A large book (552 pages, each 21 by 28 cm) concentrating on creationists errors in the geological area.

Van Till, H.J., Young, D.A. and Menninga, C. (1988): *Science Held Hostage*. InterVarsity Press. In the second section of the book, entitled "Science held Hostage by Creationism", the authors, scientists and evangelical Christians, make some scathing comments about the scientific competence and integrity of creationists.

Wheeler, A.G. (1986): *The Other Quote Book*. Contains '234 quotations demonstrating the widespread and confident acceptance of evolution as the best explanation for the origin of the species, and the unscientific, disreputable nature of creation science'.

Wilson, D.B. (ed.) (1983): *Did the Devil Make Darwin Do It?* Iowa State University Press. A collection of essays, mostly by staff of Iowa State University, prepared for a course 'Perspectives on the Creation-Evolution Controversy' offered at the university. Each chapter has suggestions for further reading.

Young, D.A. (1983): *Christianity and the Age of the Earth*. Zondervan. The author, who is a geologist and an evangelical Christian, concludes his book with the words '. . . the fantasies of young-Earth creationism.'.

Zetterberg, J.P. (ed.) (1983): *Evolution versus Creationism: The Public Education Controversy*. Oryx Press. A big (516pp.) book, covering nearly all aspects of the controversy. It has a total of 33 articles, most of high quality, and a 30 page bibliography.

(b) Works which cover various aspects of modern science from a popular or semi-popular angle

A modicum of caution should be exercised in reading any popular work on science, since some of the information in it may be outdated or superseded by more recent findings. This applies particularly to some of the older books in the series listed in this section.

New Scientist. Weekly publication from England. Most of the articles are written at a level the average intelligent person can appreciate, even if not follow in full detail.

Scientific American. Monthly publication from the USA. Articles are longer, but just as readable as those in New Scientist. The September or October issue each year is devoted to a single topic — it was evolution in 1978.

Arthur, W. (1987): *Theories of Life*. Penguin Books. Subtitled Darwin, Mendel and Beyond. Presents the major biological ideas in a fairly simple manner. From the preface: 'Finally, I shall expose the extreme creationist view for what it is — a paranoid and ill-thought-out rejection of the most central biological theory of life, a rejection which is unnecessary for a religious view of the world, unacceptable for a scientific one, and dangerous in that it sees these two views as mutually exclusive, which they are not.'

Asimov, I. (1985): *Asimov's New Guide to Science*. Viking. Asimov is renowned as an expositor. After an introductory chapter 'What is Science', there follow two parts (i) Physical Science and (ii) Biological Science.

Dawkins, R. (1988): *The Blind Watchmaker.* Penguin Books. Chapter 2, 'Accumulating small change', uses a computer model to show that a sequence of small changes, each individually quite probable, can lead to seemingly highly improbable large changes.

Gould, S.J. : *Ever Since Darwin, The Panda's Thumb, Hen's Teeth and Horses' Toes, The Flamingo's Smile, Bully for Brontosaurus, Eight Little Piggies, Dinosaur in a Haystack, Leonardo's Mountain of Clams and the Diet of Worms* and *The Lying Stones of Marrakech*. These very readable books, published between 1980 and 2000, are collections of Gould's essays, and offer a wide coverage of biological areas with an occasional mention of the physical sciences and historical excursions. A number of the essays refer to creationism.

Patterson, C. (1978): *Evolution.* University of Queensland Press. An excellent introduction to the topic. As the author says in the foreword, it is '. . . complete enough to be coherent, but simple enough to be comprehensible to those with little or no technical knowledge of biology.'

Pelican Books. Many of the books published by Penguin under the Pelican label contain popular expositions of various areas of science.

Penguin Dictionaries. These are more like miniature encyclopaedias than dictionaries, since the articles range from a few words to several pages in length. Of particular use are those on Science, Biology, Geology and Physics.

Time-Life Books. The three series *Life Nature Library, Life Science Library* and *Planet Earth* all contain excellent presentations of various aspects of modern scientific findings. Life Nature Library has evolution as a unifying theme, and one of the volumes is entirely devoted to the topic.

(c) Works providing background information on creationism and fundamentalism

Barr, J. (1981): *Fundamentalism*. SCM Press. 2nd edition. A study from the religious viewpoint.

Barr, J. (1984): *Escaping from Fundamentalism*. SCM Press. The noted theologian, who is sometimes quoted by creationists in support of their ideas about the "days" in Genesis, criticises the ideas of fundamentalists point by point. Chapter 14, 'The Bible and the Origins of the World', is particularly critical of creationism.

Gillispie, C.C. (1951): *Genesis and Geology*. Harvard University Press. Subtitled A study of the relations of scientific thought, natural theology and social opinion in Great Britain, 1790-1850.

Larson, E.J. (1985): *Trial and Error.* Oxford University Press. Subtitled The American Controversy over Creation and Evolution. The author, a lawyer, gives a history of legal actions about evolution and creationism in 5 separate chapters. A revised edition (1989) takes the story up to 1987, with creationists still losing in the courts.

Marsden, G.M. (1980): *Fundamentalism and American Culture.* Oxford University Press. Discusses the way American Protestant evangelicals declined from a highly respected group in the 1870s to extreme fundamentalists by the time of the Scopes trial.

Moore, J.R. (1979): *The Post-Darwinian Controversies.* Cambridge University Press. Subtitled A study of the Protestant struggle to come to terms with Darwin in Great Britain and America, 1870-1900.

Morris, H.M. (1984): *A History of Modern Creationism.* Master Book Publishers. The originator of the movement reveals much of the in-fighting which has taken place between various creationist groups, and the extreme dogmatic stance taken by Morris.

Nelkin, D. (1982): *The Creation Controversy*. W.W. Norton. Adequately described by the blurb on the dust jacket; 'A history of the struggle between creationists and scientists from the nineteenth century to the Arkansas trial'. Has useful tabulations of the qualifications of American 'creation scientists'.

Numbers, R. (1992): *The Creationists*. Alfred A. Knopf. The most comprehensive treatment yet of the creationist movement. Historian Numbers shows, by a historical analysis starting at the time of Darwin, that creationism is not part of traditional Christian theology, but is a descendant of the mid-nineteenth century ideas of Ellen G. White, who is known as the "prophetess" of Seventh-day Adventism.

The Open University. Two of the courses run by the Open University are entitled 'Science and Religious Belief'. The first covers the period from Copernicus to Darwin, and the second from Darwin to Einstein. The books and associated teaching material form valuable resources.

White, A.D. (1978): *A History of the Warfare of Science with Theology in Christendom.* Peter Smith. Originally published in 1896, frequently reprinted. Rather biased and dogmatic, but it is an excellent compendium of disputes from the flat-spherical earth controversy of the second century to evolution in the nineteenth.

Young, D.A. (1995): *The Biblical Flood*. William B. Eerdmans. The subtitle, 'A Case Study of the Church's Response to Extrabiblical Evidence', explains the book. Davis covers the period from the first century, showing how the church has, mostly, accepted geological findings. The Appendix, 'Arkeology', covers those who go searching for the remains of the Ark.

(d) Works dealing with the relationship between science and religion

These cover both historical aspects of various controversies and some of the non-polemical writings by Christians of varying degrees of conservative persuasions. Care should be exercised in reading some of the older books on this list, since the words 'creationist' and 'creationism' may be used in a different sense to that understood today.

Asimov, I. (1981): *In the Beginning*. New English Library. A discussion of the first 11 chapters of Genesis, comparing statements found there with accepted modern scientific views.

Barbour, I.G. (1966): *Issues in Science and Religion*. SCM Press. An excellent resource book, although somewhat dated by now. Divided into three parts; Religion and the History of Science; Religion and the Methods of Science; Religion and the Theories of Science.

Birch, L.C. (1965): *Nature and God*. SCM Press. From the preface: 'I have written . . . from the point of view of a biologist who is also a Christian, though one who may not measure up to the judgment of some who regard themselves as the trustees of orthodoxy.'

Coulson, C. (1958): *Science and Christian Belief*. Fontana. The author, former Professor of Applied Mathematics at Oxford, writes in the preface: 'But someone must speak, if only to assert that our science and our religion need not be at loggerheads; and that each can help the other to an enrichment of human life.'

Cupitt. D. (1976): *The Worlds of Science and Religion*. Sheldon Press. Intended for students at the upper levels in secondary schools, but good for anyone who wants an introduction to the relationships between the two.

Durant, J. (ed.) (1985): *Darwinism and Divinity*. Basil Blackwell. The subtitle, Essays on Evolution and Religious Belief, adequately describes the contents. It contains papers from a conference held in 1982 to mark the centenary of Darwin's death.

Dye, D.L. (1966): *Faith and the Physical World*. Paternoster. The author is an evangelical physicist. From the preface 'The development of science as the best means of knowing about our world has precipitated many discussions as to the validity of any other means of knowing.'

Habgood, J.S. (1964): *Religion and Science*. Hodder and Stoughton. The author gained a PhD in physiology from Cambridge before entering the Anglican ministry. He has been Archbishop of York since 1983, and is clearly competent to discuss both science and religion.

Hartshorne, C. (1984): *Omnipotence and Other Theological Mistakes*. State University of New York Press. In chapter 3, 'Creation through Evolution', he describes creation "science" as '. . . bad philosophy, bad science, bad theology, and bad hermeneutics (textual interpretation), and no good thing at all.'

Kidner, D. (1967): *Genesis — An Introduction and Commentary.* Tyndale Press. Written from an evangelical perspective. The author, like Richardson (see below), rejects the view that Noah's flood was world-wide.

MacKay, D.M. (1978): *Science, Chance and Providence*. Oxford University Press. A discussion of the concepts of 'chance' in science, and 'providence' in religion.

Mixter, R.L. (1959): *Evolution and Christian Thought Today.* Paternoster. On the centenary of the publication of The Origin of Species twelve scientists and one theologian, all evangelicals, contributed their thoughts. They see no necessary conflict between evangelical Christianity and evolution.

Polkinghorne, J. (1986): *One World — the interaction of science and theology*. Society for Promoting Christian Knowledge. The former Professor of Physics at Cambridge (now Dean of Trinity Hall, Cambridge), and the only Fellow of the Royal Society who is an ordained clergyman, considers the nature of science, the nature of theology, and some points of interaction.

Ramm, B. (1955): *The Christian View of Science and Scripture*. Paternoster. Rather old-fashioned, but still of interest for an evangelical perspective on the topic. The author condemns what he refers to as 'hyper-orthodoxy', which today would be called 'creationism'. A sentence from the Epilogue on p.241 reads; 'It is not true that all evangelicals believe that evolution is contrary to the faith.';

Richardson, A. (1963): *Genesis I-XI*. SCM Press. Written from a liberal perspective. The author, like Kidner (see above), rejects the view that Noah's flood was world-wide.

Thielicke, H. (1961): *How The World Began.* Fortress Press. Subtitled Man in the First Chapters of the Bible. A series of sermons by the eminent Lutheran preacher and theologian. He is clearly not a creationist.

Westermann, C. (1974): *Creation.* Fortress Press. The theme of the book is summed up in a sentence from the introduction: 'It is much more perceptive to see that in the early period of mankind it was not possible to speak of what actually happened in any other way.'