

Two other prescriptions of the Law are of particular importance today. The commandments against sexual contact outside marriage would protect Israel against one of the commonest groups of infections worldwide. In some parts of the world the prevalence of sexually transmitted diseases in the adult population is measured in tens of per cents. One sexually transmitted disease is of particular importance. It is remarkable that, from its first recognition, HIV/AIDS spread around the world within a couple of years. In parts of South Africa the prevalence of HIV in the general adult population may be as high as ten to twenty per cent. Globally, the World Health Organisation reports that there are now 30 million infected people.

HIV, as with many other infections, such as hepatitis B and C, can also be spread by blood-to-blood contact, as when drug users share needles or when knives are used for scarification rituals, or indeed in tattooing parlours and for any unhygienic body piercing. We do not know whether HIV was around in Bible times. Diseases do come and go throughout the course of history. But it seems to me highly likely that blood-borne infection would have been a threat then as now. It is therefore particularly interest-

ing that scarification and piercing were prohibited by the Law: "Ye shall not make any cuttings in your flesh for the dead, nor print any marks upon you: I am the LORD" (Lev. 19:28).

Conclusion

The only possible explanation for the fact that the Law was three-and-a-half thousand years ahead of its time is the claim the Scriptures themselves make for it. It was not in fact the Law of Moses, but the Law that God gave to Moses. The absence of direct reference to the medical value of the Law should not throw us. It is in fact a remarkable additional point. If the Law had been a human work then we would have expected to see among the rituals designed by human imagination at least some things that would be dangerous as far as modern medicine is concerned. The fact that the whole tenor of the Law promoted health is a truly remarkable sign of its inspiration. The contemporary societies surrounding Israel knew nothing of these principles. Theirs was a world of magic and incantations. The complete absence of error in Scripture is a strong rebuff to the idea that Moses learned the wisdom of the Law from Egyptian or Sumerian society.

Calibrated radiocarbon dating

John Watts

THESE ARE difficult times for believers, and the confident assertions of scientists can erode faith. We are assured that there are scientific 'facts' that prove or demonstrate this or that about the past and that flatly contradict Scripture. The uninformed listener is easily persuaded; but a closer, more informed look at science always shows that this confidence is an illusion.

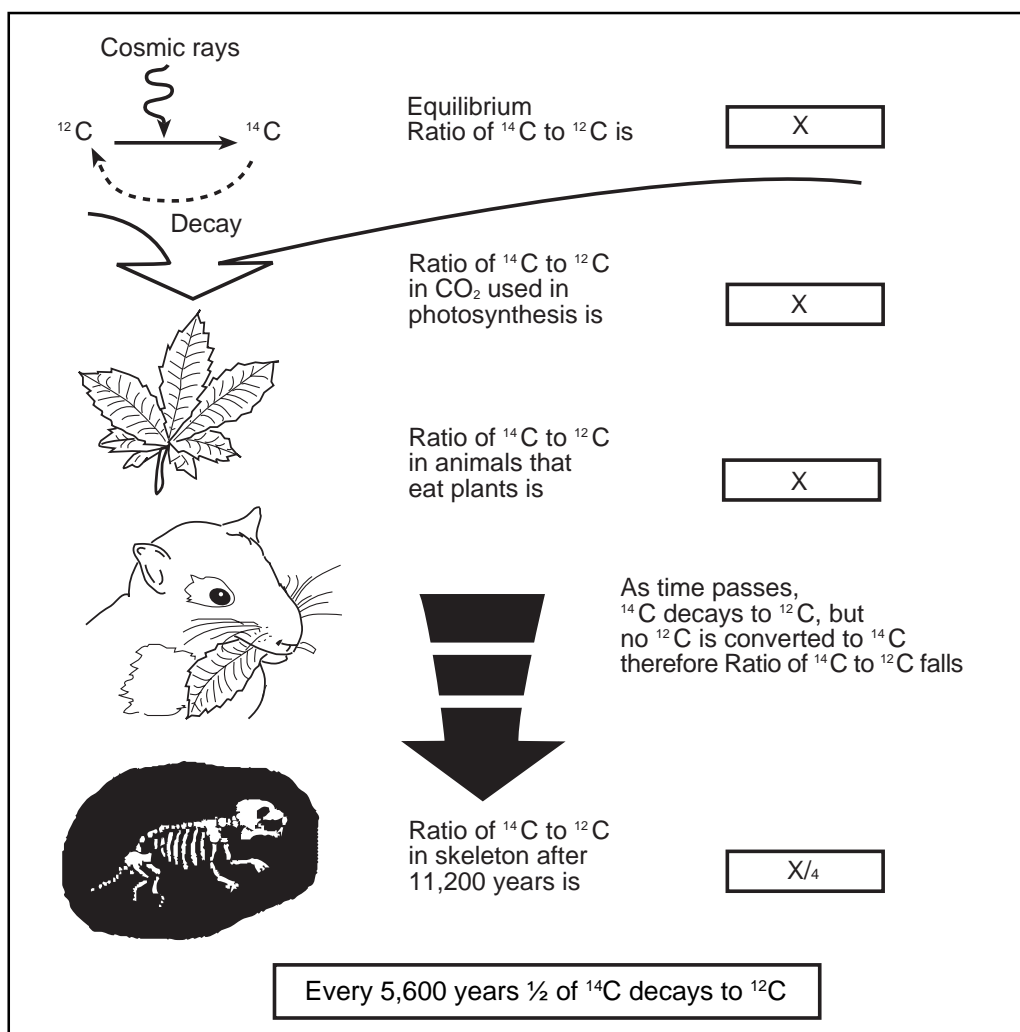
The reason for this rather technical survey of radiocarbon dating is to show that there is little reason to be concerned about the claims of the chronologists. These notes are in fact a revision and expansion of a short article on radiocarbon dating published over thirty-five years ago in another *Testimony* Special Issue.¹ All that has really changed is that the method then acclaimed by scientists as totally reliable has been found untrustworthy, and has been replaced with a

new approach, which is also claimed to be most certainly reliable. We have been here before; theories come and go, but God's Word still stands.

The method

The introduction of the radiocarbon method of dating during the 1940s was welcomed with enthusiasm as an independent, objective, scientific approach that would once and for all allow precise dating of the past. It was based on very simple principles. Atmospheric carbon, almost entirely in the form of the gas carbon dioxide, contains a small amount of the radioactive isotope carbon-14 (C14). By the conventional laws of radioactivity, this isotope decays at a fixed rate, with a half-life of decay of about 6,000 years. Decayed C14 is replaced by the formation

1. "Carbon 'Fourteen' Dating", Sept. 1965, p. 353.



The principle of carbon-14 dating

of more C14 through the action of cosmic radiation (neutrons) on the nitrogen in the atmosphere.

When the method was first proposed by Libby over fifty years ago, it was assumed that the amount of C14 in the atmosphere is constant, with decay balanced by replacement. Plants, by means of photosynthesis, and animals, by respiration and feeding on plants and on one another, incorporate atmospheric carbon into their tissues, a process that is assumed to cease when the tissues die. C14 in the dead tissues will decay, and is assumed not to be replaced. The ratio of carbon-12 (C12) to C14 is thus fixed at death, but will steadily change as C14 decays, and its value at any time will depend on the time that has elapsed since the tissue died. Thus the age of the

tissue can in principle be determined by comparing the ratios of C12 to C14 in the tissue and in today's atmosphere.

The measurement of radioactivity is a scientific process, but the dates calculated by the C14 method are part of a speculative rather than a scientific process. The case looked very plausible, even self-evidently true, but real confirmation was never possible and discrepancies were noted. The passage of time has shown that the original enthusiasm for the method was naive, and various problems were soon identified. A scepticism based on experience warns us that this is always the case. Unanticipated problems often invalidate what seemed to be self-evident truths, and render supposedly assured conclusions worthless.

The problems

It is strictly not atmospheric carbon, but the total carbon available to plants and animals, that must have a constant proportion of C14. Depending on environmental factors, trees and plants may derive up to thirty per cent of their carbon from ground water, and this, particularly in limestone areas, may have an apparent age of hundreds or thousands of years. Similarly, the inorganic carbon of the sea is in places the equivalent of 500 to over 1,000 years old.

There are also often great technical difficulties involved in sampling material for age determinations, and a certain amount of subjective judgement has to be exercised. The objects under investigation have usually been invaded by water containing carbonates, humic acids and even pitch, which contain carbon with quite different levels of C14. All these contaminants must be extracted from the sample with acid, alkali and organic solvents, and even after this some degree of contamination is probable. A further unquantified uncertainty, believed to be negligible, is the possibility of actual exchange of carbon between the tissue and the surrounding environment. It is known, for example, that amino acids in proteins racemize with time, implying potential for exchange in proteins and, by extension, in the cellulose of wood. These are technical considerations and should not be allowed to loom too large; they concern accuracy rather than the general applicability of the method. Unfortunately, other limitations to the method were soon recognised.

Even in the 1960s there was good evidence that the amount of C14 in the atmosphere had not remained constant, but had varied, even in the past 2,500 years. Such variations destroy the whole rationale of the method. In practice, it requires relatively small effects to change the level of C14. For example, the burning of coal and oil, which contain virtually no C14, had during the period 1850–1950 lowered the proportion of C14 in the atmosphere by an amount equivalent to 400 years. Even more disturbing, the explosion of hydrogen bombs between 1955 and 1970 increased the amount of C14 by more than fifty per cent, an amount equivalent to several thousand years.

Enter dendrochronology

Help, however, was at hand. The bristlecone pine of California is a slow-growing tree of great longevity. Tree ring counts suggest lives of thou-

sands of years in some cases. If we make the assumption that each ring represents one year's growth, then here is a method for obtaining wood of known age which can be used to calibrate the radiocarbon method. Carbon from sequential annual rings was therefore analysed, and a calibrated sequence of C14 content at different times in the past was produced. The first calibration curve, produced towards the end of the sixties, confirmed that there was indeed no simple relationship between apparent age and C14 content.

Subsequently, dendrochronologists in Britain and in Europe, using oaks, produced tree ring sequences stretching back, by their judgements, for six to ten thousand years. This material was used in a high-precision calibration of radiocarbon dating, and the result makes interesting study. The non-linearity of the calibration curve is indeed considerable, particularly beyond 1,000 B.C.

The effort and sophistication that workers put into their methods would be commendable in any field. For example, the procedures for measuring the C14 in a sample no longer require measurement of radioactivity; the relative numbers of C12 and C14, as well as C13 atoms, can be measured directly in some laboratories, using accelerated mass spectroscopy on tiny samples. This is not quite as straightforward as it sounds since there is only one C14 atom to every million million C12 atoms. Where samples of wood are found on an archaeological site, it is now possible to measure the C14 in a number of successive rings and use this to find the best place on the master calibration curve to fit the sample—'wiggle matching', as it is called.

Further difficulties

Dendrochronology has a simplicity and apparent certainty that the uncritical observer finds compelling, exactly the same response produced by the simplicity of the original radiocarbon method. This certainty is emphasised by the accuracy claimed by the dendrochronologists. The reality is, however, not so simple or so certain. Any scientist appreciates that all experimental methods have errors, which are normally estimated and stated along with the results. The dendrochronologists appears to be above these, claiming absolute precision—sometimes to the point of stating whether the tree was cut down in the late summer or spring of a precise year two thousand years ago.

This precision is in reality something of an illusion. Oaks seldom live longer than 400-500 years, and a master sequence of tree rings stretching back millennia can only be constructed from dozens of oaks that have grown at different but overlapping times. The dendrochronologist tries to match patterns of growth rings to establish links between trees of different ages. An overlap of at least a hundred years is desirable, since the match is heavily dependent on statistics. Further, the trees in the master sequence did not all come from the same region; most were from Ireland, but some from England and Scotland were crucial for linking discontinuous sections of the Irish sequence. These were all 'wiggle matched' statistically.

In practice, then, there is no simple match but a statistical comparison of measurements of growth rings to establish a best fit. Workers have observed that there can be several different matches, all 99.9 per cent reliable by the statistical test. Indeed, workers in the field attempting to date archaeological finds by dendrochronology have encountered this problem of 'autocorrelation' and have been forced to choose the match and 'date' they preferred!

There is strictly no good reason to suppose that growth rings from different trees should match. Even dendrochronologists acknowledge that oaks from Germany cannot be matched with those from Ireland, because the climates and growing seasons are too different. They claim, however, that Irish and English oaks can be matched, as can English and German oaks. That claim makes nonsense of precision, because it is simply statistics being used to make the matches, and it is known that mismatching seems to be the rule rather than the exception. No two trees are identical in character (genetic make up) or in location, nor can they be expected to grow in the same way. Variations in soil quality, rainfall, attack by pests, and so on, can dramatically influence growth. Far from there being zero experimental error, it seems probable that there are substantial uncertainties in the tree ring matches and hence in the calibrated radiocarbon dates derived from them.

The historian has doubts

Those actually interested in historical chronology are clearly uneasy with calibrated carbon dates. The figures differ so widely from the historical dates, particularly before about 1000 B.C., that both the archaeologist and the historian feel

justified in suspecting that there are underlying flaws in the basic assumptions. David Rohl gives a short but lucid account of the problem of calibrated radiocarbon dates in his book *A Test of Time*. He notes that before about 1000 B.C. calibrated dates diverge increasingly from accepted historical chronology, making objects increasingly older than they were thought to be. (Libby's early results in the 1950s indicated exactly the opposite for Egyptian chronology before 2000 B.C.) The problem cannot be resolved simply by changing accepted chronology, since the actual documented historical evidence imposes its own constraints.²

The more it remains the same

A sceptic remarked of cosmologists that they are always wrong, but never uncertain. Perhaps the same can be said of chronologists, and more particularly of those who use 'scientific' methods. Ever since the radioactive methods of dating were introduced almost ninety years ago, their supporters have expressed total confidence in the results. Yet most of the ages determined by the uranium methods prior to 1940, and by the C14 method prior to 1970, were discarded when it was clear that the methods then in use were unsatisfactory. The use of dendrochronology to calibrate radiocarbon dating has only served to emphasise the problem. Considering the frequency of mistakes in the past, we can only expect more to be discovered in the future. The confidence of the dendrochronologists is due to their personal faith in their results; objective criticism will in due course reveal the uncertainties of the method and relegate it to the same regions of uncertainty where previous dating methods reside.

The greatest weakness of both dendrochronology and radiocarbon dating is that they ignore or contradict Biblical chronology. Biblical chronology does not support these great ages, although we recognise that God created the earth with an appearance of age. It is just conceivable that the increasing deviations between historical and calibrated carbon dates are a reflection of changes subsequent to Creation and the Flood. All this is really of little importance to us, since the Truth is not concerned with worrying about the past but with preparing for the future.

2. See "Who stole King Solomon's mines?", John Watts, *The Testimony*, Nov. 1996, p. 435.