ENZYMES AND RECEPTORS COULD NOT HAVE EVOLVED TOGETHER

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Endocrinologists have just begun to deal with the homology of hormone and receptor structure. Of particular interest is the relationship of arginine vasopressin to its receptor site in the kidney of the rat and other mammalian vertebrates including man.

Vasopressin acts as an anti-diuretic hormone when its release by the posterior pituitary is followed by its uptake at a specific receptor site of the kidney. This release and absorption causes water to be retained by that organ. These two factors (hormone and receptor) must bear a precision key and lock relationship to one another in order to function properly.

A puzzle for the evolutionist lies in the fact that the pressor substance of non-mammalian vertebrates is arginine vasotocin. Supposedly not only the hormone itself evolved from vasotocin to vasopressin, but the lock or receptor site evolved to receive it with the same precision in both instances.

In his *Textbook of Endocrinology*[1] Robert Williams, M.D., asked how these structural changes came about in two widely separated organs. How were they coordinated in evolution? He draws the conclusion that no answer is yet completely acceptable.

Apparently this system produces an evolutionary contradiction, for a successful trait in two organs of the non-mammalian (amphibia, birds, bony fish, reptiles) endocrine system would have to be completely changed in the evolutionary stream for no reason. It is highly questionable that random chance could lead to the simultaneous mutations necessary for two mutually dependent regions to change exactly to meet each other's needs. If this were so, where are all the unsuccessful "experiments" that didn't make the grade? It is up to the evolutionist to substantiate these claims with fossil evidence.

Mutually dependent organs are useless without each other. Their simultaneous precision changeover is a lot to ask of natural selection! Special creation would appear to be a preferable explanation for the known data.

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THE CRISIS IN RADIOCARBON CALIBRATION

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A comparison of radiocarbon dates obtained from Egyptian archaeological samples and from contemporary tree growth-rings shows significant discrepancies over an extended period of time. On geophysical grounds, however, a single calibration curve for the whole of the Northern Hemisphere of the Earth is predicted. Further, there is no justification for suspecting the tree growth-rings used for calibration to be contaminated in any way. The author concludes that the discrepancies are due to chronological errors in assigning ages to the Egyptian samples and the dendendrochronological samples, and shows that calibration before about 500 B.C. may be justifiably questioned. Additional C-14 calibration anomalies resulting from measurements of a number of dendrochronological samples are also discussed to indicate that, if they are correct, the fundamental principles of the dating method require revision.

1. Introduction

Any archaeological dating technique must yield satisfactory results with samples of known age. Libby's initial presentation of the radiocarbon dating method demonstrated validity with a number of dendrochronological and archaeological samples.

Following this, when experimental techniques substantially improved and provided greater accuracy and reproducibility of radiocarbon age determinations, it became apparent that measurements using both tree growth-rings and archaeological samples showed significant deviations from the expected values. As a result, the initial assumption of a constant atmospheric radiocarbon activity was challenged, and it became necessary to calibrate the radiocarbon timescale using samples of known age.

Tree growth-rings, especially from the Bristlecone Pine, have been used widely for calibration purposes because samples are readily available over a long period of time. Archaeological samples suitable for calibration purposes, however, are relatively few. Nevertheless, Egyptian tombs and temples provide a unique supply of uncontaminated materials which date from a period when important variations of atmospheric radiocarbon activity appear to have occurred. If radiocarbon calibration is to be carried out with confidence, there must be agreement between the results obtained from dendrochronological and archaeological samples of the same age.

It has certainly been possible to say that there is general agreement between the two sets of data, but

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because of uncertainties in the ages of many archaeological samples, and because of inherent errors in the measurement of radiocarbon age, the comparison is subject to certain limitations. Greater rigor is practicable in the period represented by the well-defined Egyptian samples, and it is the purpose of this paper to compare the radiocarbon measurements obtained from Egyptian materials and from contemporary tree-growth-rings, and to consider the implications of the result.

2. Comparison of Radiocarbon Dates obtained from Samples of Known Ages

Limitations of the results obtained from historically dated samples from Pharaonic Egypt were recognized by participants of the Twelfth Nobel Symposium in 1969, and this was formally expressed in a resolution, printed at the end of the Proceedings.[1] Using specially selected short-lived samples, a number of new radiocarbon measurements were made at the British Museum and the University of California, Los Angeles, Radiocarbon Laboratories, and the results, together with some of the earlier measurements, were published by Edwards[2] and Berger.[3]

The data have been reviewed by McKerrell[4] in consultation with colleagues at the British Museum, and this has led to a few minor revisions and the exclusion of seven doubtful samples. Consequently, from well-defined archaeological samples, there are 63 radiocarbon age determinations which provide a basis for comparison with the dendrochronological data.

Bristlecone Pine and Giant Sequoia trees have supplied the growth-rings assigned to the period under discussion. Renfrew and Clark[5] have reviewed most of the different approaches that have been made to prepare a radiocarbon calibration curve based on the tree-ring results, and have pointed out a number of unsatisfactory aspects. Clark[6] claims to have derived a calibration curve which is statistically sound, and is free from the deficiencies noted in the earlier work. In my judgment, Clark has largely succeeded, and his curve is the best available analysis of the tree-ring data.

Before proceeding with the comparison, it is necessary to point out that McKerrell and Clark have considered the data with the intention of identifying possible systematic errors in the measurements of any particular laboratory. Such errors would be apparent if the radiocarbon dates published by one laboratory were consistently higher or 'ower than those of other laboratories testing the same samples. No such errors have been found, and so all the data may be used with confidence.

Egyptian data, as tabulated by McKerrell, and Clark's calibration curve, which is based upon the tree-ring data, are plotted in Figure 1. The error limits applicable to the Egyptian data have been omitted for the sake of clarity. For the two sets of results to be compatible, the Egyptian results should be evenly distributed about the tree-ring calibration curve. It is clear from Figure 1 that this even distribution does not always occur. Whilst agreement is fair after 600 B.C., the Egyptian dates clustered at 600 B.C., 1200 B.C. and 1900 B.C. are obviously displaced from the tree-ring curve.

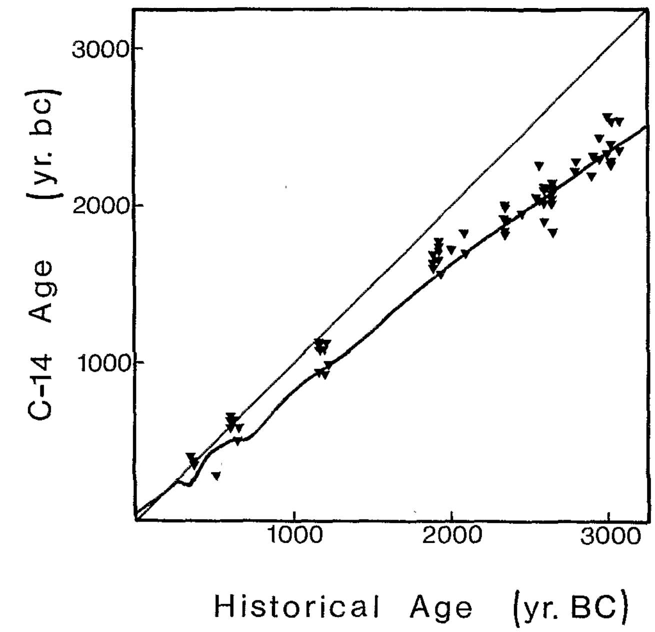

Figure 1. A comparison of Egyptian radiocarbon dates and Clark's tree-ring calibration curve. (C-14 half-life = 5570 years.)

The period 2300-2700 B.C. shows very good agreement, and before 2700 B.C. the agreement is good, but with a slight tendency for the Egyptian radiocarbon dates to be older than the equivalent tree-ring dates.

A t-test to compare all the Egyptian dates in the range 600-1900 B.C. has been carried out using Clark's calibration curve as a baseline. The t-test compares the deviations of the tree-ring radiocarbon dates from the curve with the deviations of the Egyptian radiocarbon dates. There are 171 tree-ring dates (n_1) within this period, and 17 Egyptian dates (n_2). The mean value of the tree-ring deviations (x_1) from Clark's curve is, by definition, zero, and the standard deviation is 80 years. The mean deviation of the Egyptian dates (x_2) is 93 years, and the standard deviation is 70 years. The value of t has been calculated using the equation:

$$t = \frac{|\bar{x}_1 - \bar{x}_2|}{\left\{ \frac{\sum(\bar{x}_1 - x_1)^2 + \sum(\bar{x}_2 - x_2)^2}{n_1 + n_2 - 2} \cdot \frac{n_1 + n_2}{n_1 n_2} \right\}^{1/2}} = 4.65$$

The value of t for 0.001 probability and 186 degrees of freedom is 3.32 and the calculated value is greater than this. Therefore, it is more than 99.9% probable that there is a real difference between the mean values of the two sets of data.

A further test has been made by taking the earliest possible historical ages for the Egyptian samples, instead of the most probable values. The relevant data has been tabulted by McKerrell.[4] In this case, the value of t is 3.80, and is still greater than 3.32 which represents the 0.001 probability level. Therefore, even if the most favourable conditions for reconciling the two sets of data are granted, the probability that there is a real difference is still greater than 99.9%.

Thus, the general analysis of McKerrell is fully justified: that the Egyptian data in the period 600-1900

B.C. are virtually incompatible with the tree-ring data. McKerrell has made a number of statistical tests on groups of data within comparatively short time intervals to show that the discrepancy is marked throughout the period.

The tendency of the tree-ring calibration curve to overcorrect radiocarbon dates by comparison with Egyptian chronology has also been noted by Berger,[3] and Harkness and Burleigh.[7] Derricourt's study[8] briefly discusses the calibration of Middle and New Kingdom radiocarbon dates and comments that in this period the tight historical chronology and the radiocarbon dates are hard to unite.

Whilst there is a continued need to clarify the situation by obtaining the radiocarbon dates of additional well-defined Egyptian samples, it is the argument of this paper that the discrepancy must now be regarded as proven beyond reasonable doubt. Archaeological controversies about the radiocarbon/historical chronologies of the Aegean, Wessex and North European cultures[4, 9-11] are the inevitable consequences of the existence of two radiocarbon calibration curves, the tree-ring and the Egyptian, during the Mycenaean period.

A detailed study of the C-14 dates of samples coming from the Late Bronze Age in the Aegean has been made by Betancourt and Weinstein,[12] and they provide partial confirmation of the discordance. They find significant discrepancies between the calibrated radiocarbon dates and the archaeological ages in the early and middle periods of the Late Bronze Age.

There are several papers published which compare Egyptian and tree-ring radiocarbon data and conclude that agreement is satisfactory. Probably the most widely cited is that of Clark and Renfrew.[13] However, they confine their attention to the period 1800-3000 B.C., and it is admitted by all that there is a common calibration curve over most of this range. Since the critical period is 600-1900 B.C., it is necessary to reconsider their conclusion: "the present harmony gives some grounds for optimism concerning the validity of the bristlecone pine calibration as applied to prehistoric studies in general." In the subsequent sections of this paper, the anomalous radiocarbon results are accepted as proven, and far-reaching implications are shown.

3. Radiocarbon in the Atmosphere

Studies of atmospheric mixing rates, made possible by large amounts of radiocarbon injected into the atmosphere during nuclear weapons testing, have shown that a uniform global distribution of radiocarbon is to be expected. Fairhall and Young[14] have reviewed the relevant information. Longitudinal mixing of the troposphere is rapid, with a timescale of the order of a few weeks. Meridional mixing is slower, and in this case the timescale is several years long.

The work of Libby, Anderson and Arnold[15] showed that throughout the world, the radioactivity of living things was uniform. Lerman, Mook and Vogel[16] have updated this work using the growth-rings of trees collected from different continents. They conclude that there is no longitudinal effect at all in the distribution of C-14. However, a latitude effect was found: samples from the Southern Hemisphere were slightly depleted in radiocarbon and appeared to be about 40 years older than contemporaneous samples from the Northern Hemisphere.

These latitude differences were thought to be caused by a combination of two effects: (1) the surface area of the ocean in the Southern Hemisphere is about 40% greater than that in the Northern Hemisphere, resulting in a greater rate of C-14 transfer from the atmosphere to the ocean waters in the Southern Hemisphere; (2) the C-14 absorption rate is increased in latitudes 40°S -50°S because of the higher average sea-level wind speeds, and needs to be about three times the normal value in order to account for the reduced C-14 activity levels. (Experimental confirmation of this greater absorption rate has not yet been reported.)

The radiocarbon activities of European tree growth-rings, covering the period from the 11th century to the 19th century A.D., have been measured by Suess.[17] Further measurement of the samples has resulted in some minor revisions, and the data has been tabulated by Houtermans.[18] Comparison of the results obtained from European and from American wood[19-21] gives good agreement, with no apparent geographical effects.

The radiocarbon dates of some known-age European parchments have been obtained by Berger et al.,[22] and they are fully consistent with the trends which are present in both the European and American tree-ring results. Cain and Suess[23] report that the European Oak chronology has been extended to about 350 B.C., and the radiocarbon activities of samples from the period 190-338 B.C. have been measured. There is close agreement between these results and those obtained from Bristlecone Pine and Giant Sequoia samples of the same period.

One conclusion that may be drawn from this evidence is that a single calibration curve should apply to all samples in the Northern Hemisphere. Thus, a tree-ring calibration curve derived from measurements on American samples should apply in Europe and the Near East. It follows from this that the discrepancy between the tree-ring results and some of the Egyptian results should not be attributed to the geographical separation of the sample localities, and other explanations for the difference should be sought.

4. Possible Contamination of Tree-Ring Samples

Tree-ring samples are of particular relevance to radiocarbon calibration for at least four reasons: the atmospheric C-14 activity at the time of growth may be calculated following measurements on the wood; many samples are available; the tree-ring chronologies are claimed to be accurate; and the chronology of Bristlecone Pine is very lengthy.

It is necessary to consider whether there is any possibility of the wood being contaminated so that the calculated C-14 activity of the wood at the time of its growth is different from the genuine value. Since calibration based on tree-ring measurements is of major importance to the radiocarbon dating method, there have been many investigations into a number of possible sources of contamination.

The cellulose and lignin constituents of wood are remarkably strong and stable polymers and are very resistant to chemical changes after they have been formed. Consequently, preliminary treatments are employed either to isolate the cellulose and lignin, or, at least, to remove obvious contaminants.

For example, some trees are very resinous, and the resin may diffuse across the growth-rings. This has been clearly demonstrated by Jansen[24] from some measurements on a New Zealand rimu tree. In the discussion following Jansen's paper, Damon stated that the Bristlecone Pine has a resin which permeates the wood, but that all the resin is removed by treatments given prior to measuring the radiocarbon content of each sample.

Damon also indicated that even when the resin is not removed, there is no noticeable difference in the test results. Another source of contamination, applicable to both the tree-ring and the Egyptian samples, is the possible degradation of wood by bacterial or chemical attack.

Here again, the standard pretreatments are able to remove any contaminants. Some trees have the capacity to store food on the periphery of the heartwood. This is true of a Western Red-Cedar, reported by Fairhall and Young.[14] In trees that have this ability, there exists a possible mechanism for the transmission of C-14 across the sapwood.

Cain and Suess[23] consider that the retention of sap material by heartwood formation is the most significant mechanism by which carbon can be incorporated in a ring many years after the time of its growth. However, even if such growth characteristics are representative of Bristlecone Pine and Sequoia trees, the effect on C-14 dating would be negligibly small. Cain and Suess comment that the increase in C-14 due to such effects cannot be more than 0.2-0.3%, which is below the ordinary limits of carbon-14 measurement precision.

Berger[3, 25] has made direct checks on the diffusion of C-14 across tree-rings, and his observations confirm the isotopic stability of the wood macromolecules. One of the checks compared the C-14 activities of growth-rings of Bristlecone Pine and Oak trees with contemporary atmospheric concentrations of C-14, which have varied greatly in recent years because of nuclear weapons testing. There is close correspondence between the two sets of results, and no evidence of any transmission of radiocarbon from recent to older wood.

It is highly significant that the Bristlecone Pine wood was not pretreated to extract for resin prior to measurement. The implication is that if food storage, heartwood formation and resin migration effects are present, their influence on C-14 levels in the wood is so small as to be outside the limits of detection.

The possibility of in situ production of carbon-14 in wood has received some attention. Libby and Lukens[26] have suggested that lightning bolts may generate neutrons which are capable of entering wood, interacting with nitrogen atoms and forming radiocarbon. This reasoning is equally applicable to neutrons generated by cosmic ray particles which penetrate to low altitudes.

Fleisher[27] has shown that neutron production by lightning is negligible when compared with that resulting from the cosmic ray flux at ground level. Harkness and Burleigh[7] have irradiated Bristlecone Pine wood with a dose of neutrons equivalent to a natural environment exposure of 6000 years, and have reported no enrichment of carbon-14. Even if some nitrogen was transmuted, the release of energy was thought to be sufficient to rupture the chemical bonding of the cellulose or lignin molecules, enabling the products to be removed by pretreatment procedures.

The evidence, therefore, is that tree-rings are ideal samples to use for radiocarbon calibration. After the pretreatments, there is no reason to doubt that the wood is unchanged, except for radioactive decay, since its time of growth.

Whilst it is of importance to study all possible sources of error, it should be noted that, even if there was a reason to doubt the integrity of the wood samples, the discrepancies between the Egyptian dates and the tree-ring dates would be unresolved. A correction which might remove the disagreement within the period 600-1900 B.C. would also have the effect of producing disagreement in the preceeding millenium.

5. Chronological Errors

It has been shown that the results obtained from tree-rings and from the Egyptian samples should be in agreement. Atmospheric mixing is very good, and it should be possible to establish a radiocarbon calibration curve which is applicable to the whole of the Northern Hemisphere. Dendrochronological samples appear to be ideal for use in the preparation of this calibration curve. However, discrepancies are observed between the two sets of results.

On the basis of this evidence, there is only one conclusion that can be drawn: chronological errors must be present. It is recognized that such a conclusion has far-reaching implications, because high accuracy is claimed for both the Egyptian chronology and the tree-ring chronology. The problem of finding the errors is therefore a problem of no small magnitude.

Egyptian chronology has been briefly discussed by Edwards.[2] The chronological data from documents and inscriptions are extensive but of varying quality. A few anchor points for the chronology of the Middle and New Kingdoms are believed to have been provided by the Sothic dating method; and it is this that gives Egyptian chronology its authority and claim for accuracy.

The time lapse between the beginning of the Old Kingdom and the beginning of the Middle Kingdom is taken primarily from information provided by the Turin Royal Canon. The Saite Period and the following dynasties are dated by cross-reference to the well-defined chronologies of Assyria, Babylonia, Persia, Greece and Rome.

Consider first the possibility of errors in Egyptian chronology. If the tree-ring calibration curve is used as a basis for this revision, the radiocarbon dates obtained from Egyptian samples should be corrected in the customary way. For example, the Twelfth Dynasty C-14 dates associated with the death of Sesostris II are 1633, 1600 and 1691 b.c. When these are corrected by Clark's calibration curve, they result in a mean figure of 2025 B.C., with a standard deviation of 65 years. This should be compared with the currently accepted historical date of 1880 B.C., with limits of ± 25 years. The basic difference between the two dates is 145 years.

Since Sesostris II reigned only a few years before the most important of the Sothic dating anchor-points, there is little doubt that the revision of 145 years effectively destroys the validity of the Sothic dating method in the Middle Kingdom. If the accepted chronological relationship between the Old Kingdom and the Middle Kingdom is valid, a correction of about 145 years should be made to the whole of the Old Kingdom period. However, the radiocarbon dates for the Old Kingdom are generally in agreement with the tree-ring calibration curve.

From this evidence, therefore, no changes should be made to the currently accepted historical dates for the Old Kingdom. Thus, another consequence of the revision is that the transition period between the Old and Middle Kingdoms is, at present, incorrectly understood. It follows that the observed agreement between the calibration curve and the Old Kingdom dates is coincidental. A similar calibration of the New Kingdom radiocarbon dates shows that the Sothic dating method has to be abandoned for this period also.

It should be noted that Egyptian chronology provides the basis for dating other cultures and civilizations in the Old, Middle and New Kingdom periods because it alone is supposed to be independently derived; and it is precisely for this reason that it is of such importance to archaeologists. A revision of Egyptian chronology must necessarily have far-reaching implications in revising the chronology of many ancient Near East civilizations.

However, the situation is quite different when the radiocarbon dates representing the Saite period are corrected. During this period a number of excellent synchronisms between Egyptian, Assyrian and Babylonian history are on record; and the Assyrian and Babylonian chronologies are independently derived, and an analysis of a number of solar eclipse observations greatly enhance their authority.[28] The historical dates assigned to the Saite period can therefore be regarded as firmly established. The conclusion that follows from the available evidence is that the tree-ring calibration curve fails to give accurate results during the Saite period.

The tree-ring radiocarbon results for the period under consideration are obtained primarily from Bristlecone Pine samples. The principles governing the construction of the Methuselah chronology have been outlined by Ferguson.[29,30] The growth-ring sequence has been built up by extensive cross-matching of large numbers of living and dead trees, and published results include statistical statements of sample growth characteristics, and of the correlations between them. There are two possible sources of error: the cross-matching of growth-ring sequences, and the claim that the ring indices in the chronology represent annual growths of the constituent trees.

Criticisms of Ferguson's statistical justification of the reliability of his chronology have been made by Sorensen.[31,32] Whilst admitting the force of Sorensen's arguments, I consider it most unlikely that confusion in the cross-matching of tree-ring sequences has occurred in the time interval under consideration in this study. This is because the Methuselah chronology has proved to be reproducible, for it has been checked in two ways. Bristlecone Pine samples from 1900 A.D. to before 1100 B.C. have been obtained, dated and processed by the University of Pennsylvania Laboratory[21] and this indicates that the Methuselah chronology can be used to positively identify the growth periods of wood samples.

Of greater significance is the formation of the Campito chronology by LaMarche and Harlan.[33] Bristlecone Pine trees from Campito Mountain have been used to prepare a chronology extending back to 3435 B.C. Comparison of the Methuselah and Campito chronologies has shown excellent agreement, and LaMarche and Harlan conclude that the error in the Methuselah chronology at 3435 B.C. is probably zero. Consequently, it is accepted here that Ferguson has successfully identified a sequence of tree growth characteristics.

The other possible source of error is that intraannual rings have been mistaken for true annual rings. Tree growth-rings are essentially a response to climate: whilst it is normal for trees to have clearly defined rings in temperate zones of the Earth, tropical trees usually have no distinct annual growth-rings.[34] An intraannual ring may form when the growth activity of a tree is modified by unfavorable climatic conditions.

Glock and Agerter[35] have studied trees in which many intraannual rings have formed in a growing season, and they report that these rings are as distinctly formed as true annual rings. However, intraannual rings are generally identifiable because, although the normal growth behavior is affected, the characteristic latewood/earlywood boundary is imperfectly formed.

The growth behavior of Bristlecone Pine has been studied by Fritts,[36] and from this work it is clear that these trees are resistant to the formation of intraannual rings. This is confirmed by the fact that no intraannual rings were formed in a sample of 70 trees growing on Campito Mountain in the period from 1953, the final year of an earlier series of ring width measurements, to 1971.[33]

Ferguson[29] reports that multiple growth-rings are extremely rare in Bristlecone Pine, and especially infrequent in the sites studied for chronology building. In the growth-ring analyses of about 1000 trees in the White Mountains, only three or four specimens were found with incipient multiple growth layers. LaMarche and Harlan[33] describe the intraannual growth bands of Bristlecone Pine as having diffuse boundaries, and contrast them with the sharp boundaries observed in true annual rings.

Consequently, the Bristlecone Pine chronologies are thought to be free from errors due to intraannual rings. However, it is the argument of this paper that strong evidence for the inaccuracy of the tree-ring chronology is found in the radiocarbon results of wood dated at about 600 B.C., and the most likely source of error is the presence of intraannual rings in the chronology. These could only have been produced if the climatic conditions at the time of growth were substantially different to what they are today.

Giant Sequoia samples have contributed to the calibration curve up to about 1350 B.C., and there is good agreement between the Sequoia and the Bristlecone Pine results. If intraannual rings are included in the Bristlecone Pine chronology, it would appear that the same climatic conditions that produced these growth-rings have produced similar effects in the Giant Sequoia trees.

The claim for accurate dating of the tree-ring samples is very strong. If it were not so, it is doubtful whether the preparation of a tree-ring chronology would be feasible at all. In the period under discussion, a possible source of error is the presence of intraanual rings in the chronology, produced by climatic conditions radically different from those that are observed today. Nevertheless, such a source of error alone cannot account for the deviations from the Egyptian data plotted in Figure 1. It is not realistic to suggest the addition of 150 rings at about 500 B.C. and the omission of 150 rings at about 2000 B.C. If there are errors in the tree-ring chronologies, then there are almost certainly errors in Egyptian chronology as well.

The argument of this section may be summarized as follows. The anomalous radiocarbon results presented in section 2 are capable of a number of possible explanations. However, most of these possibilities have been carefully investigated, and as a result they may be excluded from further consideration. By default, chronological error is left as the prime suspect. The discussion has shown that the chronologies can be questioned, although to do so is to challenge the main assumptions on which the chronologies rest.

In the case of Egyptian chronology, the Sothic dating method has to be discarded, and in the case of dendendrochronology, the unstated assumption of past climatic conditions being similar to those of today is probably incorrect. It is not the purpose of this paper to develop these points, but merely to identify them as topics requiring further discussion.

6. Anomalous Results from Dendrochronological Samples

Whilst extensive tree-ring radiocarbon measurements have been made using Californian Bristlecone Pine and Giant Sequoia samples, some test results are available from other trees that have grown in different parts of the world. The agreement between American and European dendrochronological sample results has been noted in section 3.

Kigoshi and Hasegawa[37] have measured the radiocarbon content of the growth-rings of a Japanese tree, Cryptomeria Japonica. The most significant feature of these results is that over almost the entire period of 1800 years, the radiocarbon dates are of the order of 100 years older than those obtained from equivalent American samples.

These differences were noted by Kigoshi and Hasegawa, who suggested that the cause might be due to differences in the nature of the air masses over the two areas. However, studies of atmospheric mixing rates, which were discussed in section 3, have shown that this explanation is inadequate as it stands. In the Northern Hemisphere, geographical variations of the atmospheric radiocarbon activity level ought not to be found, and these Japanese results must be classed as anomalous.

Jansen[24] has obtained results using the growth-rings of Australian and New Zealand trees, and although the data covers only the last 1000 years, it is sufficient to identify a trend. Again, throughout the period, the radiocarbon dates are older than those applicable to American and European trees of the same age.

Whilst some doubt exists about the age of one of the trees studied, the deviations that are observed are at least as great as those of the Japanese tree-ring results. As was noted in section 3, there is some justification for saying that the Southern Hemisphere results may be 40 years older than the Northern Hemisphere results, but Jansen's data indicates deviations considerably larger than this. Therefore, these results must also be classified as anomalous.

No serious attempts to account for these anomalies have been published. Experimental or dendrochronological errors may be suggested, but at present there is no evidence to suspect this to be the case. If there have been substantial latitude and longitude differences in atmospheric radiocarbon concentrations persisting for at least 1800 years, it is necessary to revise some of the basic geophysical principles underlying the radiocarbon dating method.

These results are incompatible with current thinking about climatic conditions in the past, atmospheric mixing, radiocarbon production rates, etc. It is regrettable that no further work has been published to either confirm or deny these anomalous results. If they are valid, they provide clear evidence of the need to revise the basic principles of the radiocarbon dating method.

Harkness and Burleigh[7] have suggested that these measurements might have a bearing on the problem of the discrepancies between some of the Egyptian results and the tree-ring calibration curve. Whilst this may be the case, sufficient has been said in this paper to show that, far from assisting to solve one anomaly, the Japanese, Australian and New Zealand tree-ring results must stand as anomalies in their own right.

7. Summary

Whilst there is general agreement between the Bristlecone Pine/Giant Sequoia radiocarbon calibration curve and the results from known-age archaeological samples from Europe and the Near East, significant differences are observed in the period 600-1900 B.C. Geophysically, there is no basis for thinking that at any particular time the atmospheric radiocarbon activity in the Near East has been any different from that in America. Neither is there any basis for questioning the integrity of the tree-ring samples used for constructing the radiocarbon calibration curve. Consequently, the evidence is very strong that there are chronological errors in the ages assigned to the samples.

The presence of errors in Egyptian chronology during this period has been shown to have serious implications for the dating of the Old Kingdom. One of the concluding sentences of Clark and Renfrew's study of this earlier period is as follows:

> The conjunction of the bristlecone-pine-calibrated Egyptian radiocarbon dates and the historical dates for Ancient Egypt from 3100-1800 B.C. carries with it the implication that, within the error limits discussed, both chronological systems are correct.[13]

However, this study has shown that discordant results for the Middle and New Kingdom and Suite periods are of greater importance than concordant results for the Old Kingdom, and that the opposite conclusion is warranted:

> The discrepancy between the bristlecone-pine-calibrated Egyptian radiocarbon dates and the historical dates for Ancient Egypt from 1900-600 B.C. carries with it the implication that, within the error limits discussed, both chronological systems are incorrect.

There is, consequently, a need to rethink the whole question of radiocarbon calibration before about 500 B.C.

Tree-rings from Japan, Australia and New Zealand are found to have anomalous levels of radiocarbon activity. At very least, this means that the principle of worldwide radiocarbon calibration should be regarded as tentative until the cause of these geographical variations is known. However, since the principle of worldwide calibration is so well-founded, it is possible that these anomalous results indicate the need for a fundamental revision of current thinking about the whole radiocarbon dating method.

8. Concluding Remarks

The Bristlecone Pine and Giant Sequoia wood samples and the Egyptian archaeological samples have been tested with meticulous care in highly reputable laboratories, so that the radiocarbon results can be justifiably claimed to be among the most accurate that have ever been obtained. This point is accepted by all students of radiocarbon calibration.

The argument of this paper is that the best results reveal anomalies which imply that, before 500 B.C., the real ages assigned to the samples must be questioned. This study, therefore, challenges the widespread confidence in the validity of current thinking about radiocarbon calibration, with all its implications for the uniformitarian interpretation of the past and for the evolutionary development of man. In addition, it provides a foundation for further discussion of radiocarbon calibration, and a paper is in preparation in which the author, seeking to be guided by the Biblical framework of history, will explain the principles underlying a revised calibration curve.

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ON THE RECOMBINATION OF RARE RECESSIVE MUTATIONS

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In *Biological Science - An Inquiry into Life*[1] an attempt is made to show how a mutation for larger wing (possibly harmful because too big for a bird's wing muscles) and one for stronger muscles (of no use and possibly harmful since they might break the wings) could be combined to give an advantageous combination of a bird with stronger muscles with larger wings.

Assuming this combination would be advantageous, what are the chances for it to be established in a population?

According to the textbook authors, a mutation to the recessive condition such as large wings, symbolized according to Mendelian terminology by lower case letters *lw*, in distinction from the normal type or normal wings symbolized by the capital letters *LW*, might occur in 1% of the population. This is a reasonable assumption. Similarly the gene or mutation for stronger muscles (*sm*) might well occur in 1% of a population.

Though conceivably both mutations could occur in the same population at about the same time, this is rather unlikely; but it has no real bearing on the problem involved in the question of their recombination in one bird.

Specific Calculations Cited

According to the Hardy-Weinberg principle[2,3] the mutation for large wing (*lw*) would remain in the ratios shown in Table 1.

Combining the 0.0099 heterozygote classes one finds about 2% of the population heterozygous for the gene for large wing (*lw*).

Similarly considering the gene for strong muscles (*sm*) one may postulate its occurrence in 1% of the population; and it would similarly stabilize as shown in Table 2.

Again combining the 0.0099 heterozygote classes one finds about 2% of the population with the gene for strong muscles in heterozygous condition. So far the textbook authors referred to above have postulated quite reasonable assumptions. But they then go on to state:

> There will be many individuals in the population that will carry the mutant gene over many generations, giving time for environmental change or new combinations to occur.

Table 1. The ratios of the mutation for large wing (*lw*), according to the assumptions made in the text. The letters across the top represent the genes from one parent, those at the left the genes from the other parent. Since only 1% of the population carries the recessive factor only 1% of the genes are recessive (*lwSM*). On the other hand, 99% of the genes are dominant (*LWSM*). The union of the gametes results in the four classes of bird represented in the table. Note that only one bird in ten thousand is homozygous recessive and thus actually has the large wings.

	0.01 lwSM male	0.99 LWSM
0.01 lwSM	0.0001 lwSM/lwSM	0.0099 LWSM/lwSM
0.99 LWSM female	0.0099 lwSM/LWSM	0.9801 LWSM/LWSM

Table 2. This shows the ratios of the mutation for strong muscles (*sm*). It is similar in construction to Table 1; and similar remarks could be made about it.

	0.01 LWsm male	0.99 LWSM
0.01 LWsm	0.0001 LWsm/LWsm	0.0099 LWSM/LWsm
0.99 LWSM female	0.0099 LWsm/LWSM	0.9801 LWSM/LWSM

> Thus we can see that any species will carry a load of mutations for natural selection to work upon. (p. 615)

But what in reality are the chances of the genes for large wing and strong muscle being brought together in the double recessive condition, and so presumably conferring an advantage for the bird?

To get at this one must consider *all* members of each population as having an equal chance of mating with each other. I am indebted to Dr. John Klotz of Concordia Lutheran Seminary for giving me the formula for working out this interbreeding problem.

First it must be remembered that both dominant or normal factors occur in 99% of each population. There

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