tory. Until these results are available, comparative analysis of the results from different laboratories should not be undertaken, in order to avoid premature conclusions.

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[1] Crowe, C., *Nature*, **182**, 470 (1958).
[2] de Vries, Hl., *Proc. K. Ned. Akad. Wetensch.*, B, **61**, 94 (1958).
[3] Münnich, K. O., *Science*, **126**, 194 (1957).
[4] Suess, H. E., Proc. Conf. Nuclear Processes in Geologic Settings, Williams Bay, Wisconsin (Sept. 1953); *Science*, **122**, 415 (1955).

IN a recent communication, C. Crowe[1] uses published dates on samples of known age in an attempt to investigate variations of the concentration of carbon-14 in living material during the past 5,000 years. He concludes that the activity has followed a cycle with a maximum change of 10 per cent and with some evidence of a sharp peak of about 10 per cent about 2,000 years ago. His proposed curve is most striking, for the effect, if real, would imply, for example, that all 1,000-year old samples should give radiocarbon ages of more than 1,700 years, a result which has not yet been obtained in practical measurement despite the growing number of accurate measurements on tree rings and other materials of known age.

Crowe assumes in the first place that the observed difference between the radiocarbon age and the known age of a sample is due entirely to the initial carbon-14 activity of the sample being different from that of present living material. This would only be justifiable if all other errors could be shown to have been taken into account, and if the statistical error of the radiocarbon estimation were small compared with the difference between the two ages. This is manifestly not so. Laboratories have differed to some extent in the past in dealing with the errors associated with radiocarbon dating, at first taking into account only the statistical errors of the radioactivity measurements; more recently, as other contributory factors have been discovered (for example, isotopic fractionation effects) these have been taken into account or eliminated when the necessary ancilliary instrumentation was available. Errors arising from the history of the sample before it enters the laboratory or from the lapse of time between the death of the sample and the event being dated are not included, although it is recognized that these effects, which are not amenable to mathematical treatment, may on occasion assume significant proportions compared with the statistical errors.

Secondly, Crowe attempts to eliminate systematic errors by comparing the ages obtained in the cases where laboratories have dated the same sample. This again is open to grave objection on the grounds that there are so few published examples available for such comparisons; no sample is common to all the laboratories mentioned, and in practically all cases the statistical errors are large compared with the observed differences, and thus it is very difficult to understand how his Table 1 was compiled. The only accurate approach to this problem of the elimination of systematic errors is that which is taking place at present and is being sponsored by Dr. K. O. Münnich of Heidelberg, in which all laboratories engaged in radiocarbon research are being asked to make extended measurements on the same homogeneous sample so that statistical and other errors are reduced to a very small value compared with the normal dating error.

Crowe's Table 1 is thus valueless on the above grounds alone, apart from the fact that one finds it difficult, if not impossible, to relate the values he quotes and the estimated error of $\pm$ 100 years with the available figures in the publications cited by him.

It is doubly important that the accuracy and validity of these corrections should not be allowed to go unquestioned. In the first place, one must at least attempt to prevent their use by the unsuspecting archæologist, and secondly, it is necessary to point out that Crowe's conclusions regarding the large cyclic variations in carbon-14 activity during the past 5,000 years depend almost entirely on the use of these corrections. Thus, the large depression in the trend line in the range of 1,000–2,300 years is due in the main to the influence of a group of Lamont and Stockholm samples which would occupy a much higher position nearer to the zero line were it not for the very large corrections applied to them by Crowe. Similarly, the evidence of a sharp peak at about 2,000 years seems to rest mainly on the large correction applied to the Heidelberg dates.

A more important point is that de Vries[2] has recently shown that the 'modern' standard in use in Groningen is 3 per cent lower in carbon-14 activity than the average for German trees and that consequently all Gröningen dates are in fact about 240 years too young. Crowe would have us believe that Lamont and Michigan dates are all 400 years younger, and Stockholm dates 525 years younger, than Groningen dates, and that therefore corrections of some 700 and 825 years respectively are required to convert results from these laboratories into calendar years. It is unlikely, to say the least, that three laboratories could be set up independently of each other and pass through the necessary proving and checking phases without detecting discrepancies of this magnitude.

Variations of carbon-14 activity during the past are clearly of importance to radiocarbon dating. It is known that they exist, but certainly at a lower order of magnitude than is implied by Crowe's calculations. The accurate approach to the problem of their evaluation is clearly an extension of the work of Münnich[3] and de Vries[2].

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[1] Crowe, C., *Nature*, **182**, 470 (1958).
[2] de Vries, Hl., *Proc. K. Ned. Akad. Wetensch.*, B, **61**, 94 (1958).
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