

State of preservation of the Dead Sea Scrolls

SIR—The article "Dead Sea Scroll parchments: unfolding of the collagen molecules and racemization of aspartic acid"¹ is of interest since any method which will improve on our knowledge of vellum fragments is important. The study on the condition and deterioration of vellum which is known to be approximately 2,000 years old is interesting in itself, although the identification into goat, calf or sheep as to origin of the material examined^{2,3} would improve the information resulting from their tests. This could be accomplished by a comparison made from samples of the scrolls known to be of goat skin and that of modern goat skin prepared as we believe the scrolls to have been prepared³. In this way Weiner *et al.* could make a column to their Table 1 identifying the skin of each scroll as well as the patches and other additions. As the authors state in their paper¹ "Using different skins in one scroll and/or various parchment preparation treatments could conceivably influence the C:G index and the D/L aspartic ratios".

If, however, any relationship is to be drawn to the age of the samples and the agents of deterioration, then the tests they carried out gave insufficient evidence, as we have seen even within the scrolls there is variation. There must be a more comprehensive sampling to form a basis for comparison, which Weiner *et al.* acknowledge. A modern rat tail and a seventeenth century book cover do not provide a varied series, though the authors use them as comparative materials to the scroll samples. An adequate sample basis must be developed on a wider range of material both ancient and modern; this could be accomplished by application of the tests on samples which have a known documentation between the first and sixteenth centuries AD which would include changes in parchment preparation both in Europe and the Near East^{3,4}.

When considering the condition of materials found in the Qumran caves, it may be of interest that most scholars, given the methods of examination at the time, believed the two scrolls offered to the British Museum in the 1880's by M.W. Schapira to be forgeries based partly on the fact that their condition was throughout so superlative compared to known fragments⁵. There is now little doubt that the Schapira Scrolls came from the Dead Sea caves⁶.

It is unfortunate that Weiner *et al.* did not examine the agents of deterioration of vellum to gelatin by controlled testing, and then subject their samples to the collagen/gelatin and D/L testing. Such testing of modern and ancient samples (combined with accelerated aging tests) would

give information of a positive and precise nature on the causes of the variations found on Dead Sea Scroll samples (some on the same fragments) which undermine their study. As the authors note, we know damage has occurred, but its cause, and when it occurred are unknown. Plenderleith⁷ found during the unrolling of Dead Sea Scroll fragments of cave 1 that certain fragments were permeated with a black bituminous substance which he identified as a decomposition product of the skin. During the unrolling he found it necessary to dampen the Scrolls which caused this substance to become sticky. This black substance apparently was gelatin. This incident brings up a very important topic, that of the interventions made necessary by the fragile and rolled nature of the scrolls. Careful identification of the location from which each sample was taken should have been presented by Weiner *et al.* This information could have been correlated with published data on the condition of the fragments as they were found and treated. Both Plenderleith⁷ and Cross⁸ report extensive treatments with moisture and oils to remove clay and/or relax the skins⁹. The materials used in the treatments and the originally adherent substance could have altered analytic results.

This consideration of the condition of each fragment and their individual histories, including methods of skin preparation of which Stambolov¹⁰ has prepared a thorough survey and Poole and Reed³ a precise analysis, is of great importance. Some of the skins were found in the same cave, some scattered on the surface, others buried and some appear to have been discovered several centuries ago and been exposed to quite varied climatic conditions¹¹⁻¹³.

Others were preserved for longer periods as whole scrolls rolled in linen and placed in jars encased in tar. Varied histories of the fragments should be listed and referred to when discussing the results of testing. Rapid deterioration can occur in organic material transferred from one environment to another. Fragments taken from the dry conditions in the caves to a humid environment or one with rapid or frequent variation could cause severe and immediate damage. It is of interest to note that the authors are continuing their research with specific attention to the climatic effects of the transition of collagen to gelatin (S. Weiner, personal communication).

Given the problems with amino acid dating, especially the variation with regard to radiometric methods¹⁵⁻¹⁷, examination of rates of decay from amino acid D/L values should be considered very relative, especially with regard to natural and human interventions. Nevertheless, its use as a source of approximate time

during which collagen has changed to gelatin may prove to be of great value.

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WEINER *et al.* reply—In our study, we reported the development of a new method for assessing the extent to which collagen has transformed to gelatin in ancient parchments and we tried to estimate the approximate time that elapsed since the transformation took place. We applied these methods to the analysis of some 40 parchment fragments from the Dead Sea Scrolls. We agree with Kahle and Caldaro that a thorough study, which includes more background information on the pieces analysed as well as controlled studies of parchments of different ages, prepared in various ways and subjected to a range of temperature and humidity conditions, would be the most helpful. Incidentally, some of the background information can be ascertained from the literature using the information supplied in our Table 1. We took care to emphasize in our original publication that the transformation of collagen to gelatin may be only one of several different degradative processes that occur in ancient parchments. Thus caution must be exercised when correlations between some parchment property and collagen:gelatin proportions and/or D/L ratios are made, as Kahle and Caldaro are suggesting. We also noted that the