

## AN X-RAY STUDY OF SOME LEATHERS

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## Plate I

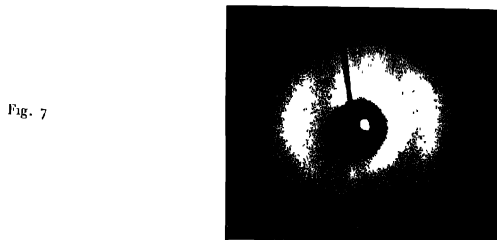
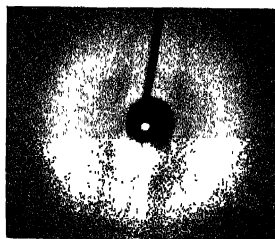
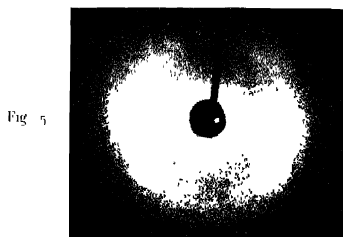
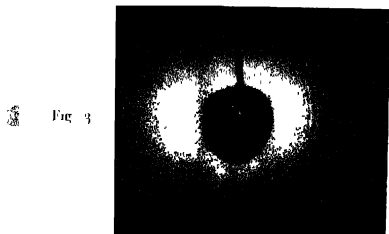
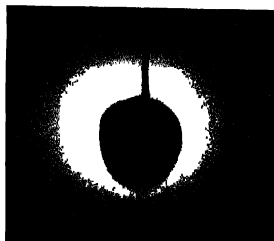
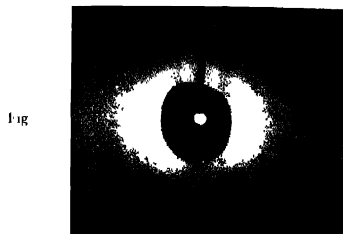
**ABSTRACT** The spacings of the diffuse intense band of some leather samples were measured. It was observed that the spacings were varying from sample to sample. The variations are explained on the basis of Pauling's model of collagen-gelatin structure.

## INTRODUCTION

The outstanding works on leathers and skins which are classified under collagen-gelatin protein group were mainly confined to the measurement of meridional and equatorial reflections and the interpretation of such reflections. It was pointed out by Bear (1944) that the principal meridional arc was varying from  $2.82 \text{ \AA}$  to  $2.90 \text{ \AA}$ , and the principal equatorial reflection between  $10.4 \text{ \AA}$  to  $15.5 \text{ \AA}$ . The variation of the equatorial reflection was accounted for but the variation of spacings of meridional reflection has never been seriously looked into. Pauling (1951), however, proposed a model of the polypeptide chains in collagen-gelatin protein with special reference to dried tendon for which he accepted the value of the principal equatorial reflection as  $10.4 \text{ \AA}$  and the meridional reflection as  $2.86 \text{ \AA}$  and set up a satisfactory structure by assuming alternation of two cis groups and a trans group in polypeptide chain and three such polypeptide chains coiled into helix, the binding between the chains being achieved by intramolecular hydrogen bonds. The coiling of the chains were achieved at the  $\alpha$ -carbon atom. The important features of such structure are (1) the dihedral angle at these carbon atoms is  $97^\circ$ , (2) the helix formed by a single chain of collagen molecule has nearly a 9-fold screw axis of symmetry and (3) the value for C-N-C in polypeptide chain is  $123^\circ$ . A set of co-ordinates were derived for different atoms on the above considerations and the derivation of the form factor  $F$  led to the calculated intensity and spacings of certain bands. The important diffuse intense band of some considerable intensity was calculated to be  $4.72 \text{ \AA}$ .

## EXPERIMENTAL OBSERVATION

The verification of the structure requires an accurate measurement of the band spacing particularly that of the calculated intense band at  $4.72 \text{ \AA}$ . For dried tendon only the observed spacing of such band was reported as  $4.4 \text{ \AA}$  by



X-ray photographs of leather samples

Astbury (1940) and  $4.37\text{\AA}$  by Pauling and Corey (1951). In the present investigation we have concentrated our attention on the measurement of the diffuse band in different samples of leather with the idea of correlating the observed and calculated spacings. Each leather or skin specimen was cut into thin strip and mounted on a frame. This frame was in turn mounted on a goniometer head of X-ray camera and pictures were taken in  $\text{CuK}\alpha$  and  $\text{CoK}\alpha$  radiations which showed bands and in several cases faint lines of chemicals like NaCl used during tanning. Using the observed 200 reflection of NaCl as the internal standard in some cases, the spacing of the diffuse band was calculated and some of the results were verified by taking photometric records. For accurate measurement some of the pictures were taken in cobalt radiation instead of copper radiation. The results are tabulated in Table I and the pictures are shown separately in Plate I.

TABLE I

Samples	Camera radius	Radiation used	Spacing of the diffuse intense band
Sample I	3 cms.	Copper	4.32 $\text{\AA}$
Sample II	3 cms.	Copper	4.47 $\text{\AA}$
Sample III	3 cms.	Copper	4.33 $\text{\AA}$
Sample IV	4.13 cms.	Copper	4.49 $\text{\AA}$
Sample V	4.55 cms.	Copper	4.32 $\text{\AA}$
Sample VI	4.55 cms.	Cobalt	4.44 $\text{\AA}$
Sample VII	4.13 cms.	Cobalt	4.74 $\text{\AA}$

## DISCUSSION OF THE RESULT

It is difficult to find out a systematic correlation between the observed values and calculated value  $4.72\text{\AA}$ . In samples II, IV, VI and VII the observed results are nearer to the calculated value, but in others the observed values are too low. To account for the low values we have assumed certain distortions and deviations in the structure already proposed. Although we are unable to establish our views from the pictures obtained by us, we predict that it is possible to obtain the calculated band spacing lower than  $4.72\text{\AA}$  for a particular value of meridional reflection ranging between  $2.82\text{\AA}$ — $2.90\text{\AA}$ , but other than the value of  $2.86\text{\AA}$ . bearing, of course, in mind the variations of meridional reflection reported by Bear (1944). Proportionally the C-N-C angle must be changed slightly to account for (1) the helix formed by a single individual chain of collagen molecule to retain a 9-fold screw axis and (2) the intramolecular bonds binding the three

polypeptide chains. The other structural features will remain similar to that proposed in Pauling's structure.

#### ACKNOWLEDGMENTS

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Bear, R. S., 1944, *Jour. Am. Chem. Soc.*, **66**, 1207.  
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