herst has long been known as the trainer of very many applied entomologists of high rank. Once, in an address, I discussed the subject of the education of the entomologists in the federal service and I found that many of the best of them had studied under the Fernalds. And so when the first edition of this book was published in 1921 I greeted it with great interest, knowing that from it I should find out something of the way in which these good men had been taught.

This last edition, just published, contains much new matter, and much of the rest has been rewritten since the second edition was published in 1926, and the last ten years have been especially noticeable for advances in the fight against insects as well as in the new problems that have confronted the rapidly increasing army of workers.

The dedication of this edition appeals to me especially. It reads: "To the Memory of my Father, Professor Charles H. Fernald; one of the first teachers of Economic Entomology to College Students in this Country." I knew the elder Fernald well. He was a truly great teacher and he will be remembered for many years. Henry, the author of the present volume, had greater educational advantages than his father (I remember that he studied at Johns Hopkins fifty or more years ago under W. K. Brooks and his colleagues) and greatly profited by these advantages as well as by inherited aptitude and constant association with his father. His whole career was spent at the college, and he constantly mixed with the leaders in the federal and state services and was at one time the president of the big association of economic entomologists.

This new edition is admirable. I marvel at its scope and thoroughness, and I marvel at the wonderful way in which the author has concisely put such a mass of information. No one, with the least tendency to ramble, could have told the stories of the cotton-boll weevil, the San Jose scale, the gypsy-moth and the other great pests as Fernald has done, competently, concisely and readably. And the book could not have been done until to-day. On examining it, old-timers, like myself, must say to themselves, "Oh, if I could only have had a book like this when I was young!" But there could have been no such book then. The good old times were not so good after all in many ways. Of course we old fellows after such a thought as that shrug our shoulders and grumble, "Well, they were not so bad either in many other ways."

But to the book: There are four chapters on the place of insects among other animals and on their structure and development; one on nature's control methods; four on man's method of control; one on the relationships of insects; 23 on the different orders, and a final chapter on the animals, not insects, with which the entomologist is expected to deal—a necessary chapter, since it includes ticks and mites, eel worms, millipedes and so on.

The 23 chapters on the different orders contain accurate, condensed, but sufficient information upon the different injurious species with a statement as to remedial treatment in each specific case; and all these can be readily traced from the very competent index.

The make-up of the book is excellent. It is of convenient size and is fully and admirably illustrated. Think of 384 illustrations to 384 text pages! Many of these illustrations are original and the others are borrowed from other good books. The selection of the latter has been very careful and shows a very wide reading on the part of the author.

For some years now, Dr. Fernald, having retired from teaching, has been living for most of the time at Orlando, Fla., which has now become rather a center for entomologists. There he has worked away almost uninterruptedly on his rewriting of much of the second edition in constant touch with W. W. Yothers, W. V. King and other well-known workers whose advice and help he acknowledges in his readable preface.

I congratulate Dr. Fernald very heartily. I can see that this book will be of great value not only to teachers and students, but to every one who even temporarily wishes to know the answer to some question about injurious or beneficial insects. I shall give the book to the library of the old country club in the Catskills where I am writing this, since many of the families have beautiful gardens and there are many children growing up with most inquiring minds. I predict that it will be read and reread.

Its admirable composition and its thoroughness explains to me in a large part the high rank of the entomologists who have come from that laboratory of the Massachusetts Agricultural College.

L. O. HOWARD

SPECIAL ARTICLES

X-RAY REFLECTIONS OF LONG SPACING FROM TENDON

THE proteins which have given crystalline x-ray diffraction patterns fall into two groups. One—the soluble proteins that can be grown in recognizable crystalline forms—give the long spacings to be expected from true crystals composed of very large molecules. Pepsin,[1] hemoglobin[2] and insulin[3] belong to this class. Tendon and hair are examples of the second, insoluble, group of crystalline protein structures. They provide typical fiber diffraction patterns upon which no large spacing reflections have hitherto been found. From the apparent absence of such spacings it has often been suggested that these animal fibers do not consist of large molecules in typical crystalline array but rather of clusters of indefinitely prolonged polypeptid chains bearing side chains irregularly distributed along them. This type of structure and the x-ray evidence bearing on it have been extensively discussed by Meyer and Mark,[4] by Katz,[5] by Astbury[6] (especially for wool and hair), and by many others.

We have been interested in tendon and other forms of connective tissue as typical examples of these insoluble crystalline proteins and have made experiments to see whether they really differ from the soluble proteins in giving only short spacings. For the photographs about to be described raw tail tendon of the kangaroo has been used because it yields especially well-oriented fiber patterns.[7]

By employing a camera of sufficient radius in conjunction with a slit system composed of small pinholes, spacings greater than the previous maximum of ca 11A can be photographed. A tracing of such reflections of chromium radiation recorded in an 11.4 cm radius camera is reproduced in Fig. 1. The observed spacings, as yet only approximately determined, are listed in Table I.

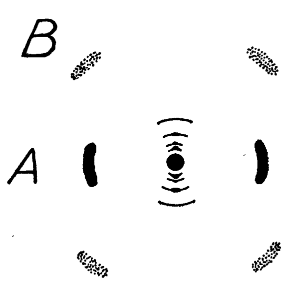

FIG. 1. A tracing of the inner reflection pattern of tendon. Letters refer to spots recorded in Table I.

TABLE I
LONG SPACINGS OBSERVED IN KANGAROO TENDON

Spot	Intensity	Spacing
B (Fig. 1)	f	7.33A
A "	ss	10.83
Fiber axis spot	ff	21.7
"	m	33.6
"	f	53.1
"	s	68.9

Note: If these four spots on the fiber axis are different orders of the same reflection, as is conceivable, they are the 5th, 6th, 10th and 15th orders of a fundamental spacing of ca 330A. Patterns of other forms of connective tissue also show a horizontal reflection (inside of A) with a spacing of ca 23A.

There is every reason to expect that still longer spacings will be found with bigger cameras and finer slits. It is obvious that detailed knowledge of the structure of tendon must await a thorough exploration of this region of large spacings. The mere existence of long spacings, however, makes it certain that tendon cannot consist of parallel polypeptid chains bound together by irregularly repeated cross linkages. Instead, there is at present no sound reason for considering tendon, and undoubtedly other forms of connective tissue as well, as having anything but a typical crystalline array with all the regularity of atomic arrangement this implies. Two possibilities then remain. According to one a tendon, like a crystal of a soluble protein, consists of a regular assemblage of very large molecules, all of equal size. On the other hand, it might be built of indefinitely extended polypeptid chains along which different amino-acid residues were regularly repeated with a master period of a hundred or more Angstrom units. Such a model, which is an elaboration of that often assumed for cellulose, is not a grouping of like molecules: the molecule is identical with the crystal fragment. A choice between these structure types can undoubtedly be made when more data are available. In the meantime the existence of large spacings from tendon makes desirable a careful search for similar spacings from cellulose and other macromolecular fibrous substances.

SUMMARY

A series of large spacings has been observed in diffraction photographs from tendon. The significance of this observation for the structure of this and other fibrous macromolecular substances is briefly discussed.

RALPH W. G. WYCKOFF
ROBERT B. COREY
J. BISCOE
ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, NEW YORK, N. Y.

1 J. D. Bernal and D. Crowfoot, *Nature,* 133: 794, 1934.
2 R. W. G. Wyckoff and R. B. Corey, SCIENCE, 81, 365, 1935.
3 D. Crowfoot, *Nature,* 135: 591, 1935.
4 K. H. Meyer and H. Mark, "Der Aufbau der hochpolymeren organischen Naturstoffe," Leipzig, 1930.
5 J. R. Katz, "Die Röntgenspektrographie als Untersuchungsmethode," Berlin, 1934.
6 W. T. Astbury, "Fundamentals of Fiber Structure," London, 1933.
7 We are indebted to Dr. Ralph O. Clock of Davis and Geck, Inc., for supplying us with this material.