scope slides of ordinary size (3″ x 1″). The two open faces of the racks are then covered with zinc wire screen of about 0.8 cm mesh fastened along both sides of one and one side of the other by staples which, in the latter case, act as hinges and enable the rack to be opened for insertion and removal of the glass slides. These slides are inserted in the racks while clean, and the racks are then strung in pairs about three feet apart on tarred fish-net cord and a brick or stone sinker attached about five feet from one rack of the pair. The cord is so wound around the racks as to keep them closed, when suspended, and retain the slides in place. These are then suspended one above the other from the under-side of the floats, used as docks for small boats, in such a manner that the lower rack of each pair does not touch bottom even at low tide.

Somewhat similar methods have recently been reported as used for obtaining preparations of Protozoa and Algae by Butcher,[1] Lloyd[2] and Nauman[3] in Europe, and the method appears to be of wide applicability.

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SPECIAL ARTICLES

DETERMINATION OF POLYMERIZATION OF SOME POLYMER FORMALDEHYDES BY X-RAY METHODS[1]

IN attempts to determine the molecular size of highly polymerized bodies (mostly assumed to be in the form of very long chains) by X-ray methods, only relatively small unit cells could be found. However, it was pointed out that this would not necessarily justify the assumption that the molecules were small, since a periodicity in a very long chain or the presence of molecules of varying chain length in one crystal could give similar experimental results. Thus, the controversy in regard to the constitution of polymers could not be settled in a definite fashion by X-ray analysis.

The experiences made in the study of polymerized formaldehyde (polyoxymethylenes) were of similar nature. Staudinger, Mie and Hengstenberg[2] and Hengstenberg[3] came to the conclusion that the molecular size of polyoxymethylenes could not be determined from X-ray methods. The absence of "inner" lines in the Debye-Scherrer diagrams made them assume that the structure could be represented as a lattice built up of CH_2O-groups exclusively and in a chain-like fashion. The residual groups which can be present and terminate the individual molecules are distributed at random throughout the crystal (different chain lengths) and do not cause any X-ray effects. If no residual groups are present the chain is extended throughout the crystal length. It must be emphasized, however, that no real proof for the existence of such chains is available from the X-ray standpoint. This interpretation of the X-ray results represents merely an adaptation to Staudinger's chemical conclusion.

Contrary to these results the author found the presence of "inner" lines.[4] In the first experiments only one such line was observed, which when considered as first order gave a degree of polymerization of 4.

The repetition of the experiments some months ago proved beyond doubt the presence of "inner" lines, only fortunately enough several orders could be observed, giving thus a means to determine for the first time the true length of the molecules of a highly polymerized body.

The preliminary results obtained are as follows:

δ-Polyoxymethylene: The following orders of the basis were measured: fourth, fifth, sixth, seventh, eighth, ninth, twenty-fourth and forty-eighth. The structure is closely hexagonal, the c-axes or length of the molecule is 45.1 Å.U. Neglecting the residual groups, the number of formaldehyde groups in the chain becomes 24 as calculated from the density. The length of one CH_2O-group then becomes 1.88 Å.U., which is in perfect agreement with the approximate value of 1.9 Å.U. of Hengstenberg which was determined from a series of acetyl derivatives of polymer formaldehyde. As to be expected, the twenty-fourth and forty-eighth orders have considerable intensities.

γ-Polyoxymethylene, sublimed: The eleventh, thirteenth, fifteenth, seventeenth and sixtieth orders were measured. The structure is more distinctly pseudo-hexagonal only. The length of the molecule is 113.4 Å.U. There are 60 CH_2O-groups in the chain (again neglecting the residual groups). The length of one formaldehyde residue is 1.89 Å.U., which again is a perfect agreement. The sixtieth order has the expected strong intensity.

Paraformaldehyde (Eastman Kodak organic chem-

[1] Contribution from the Department of Chemistry of the Johns Hopkins University; preliminary report.

[2] *Z. f. phys. Chem.*, 126: 425, 1927.

[3] *Ann. d. Physik* (4), 84: 245, 1927.

[1] R. W. Butcher, *Nature*, 125 (3147): 276, 1930.

[2] Ll. Lloyd, *Nature*, 125 (3142): 91, 1930.

[3] Nauman, *Ber. Deutsch. Bot. Ges.*, 37: 76–78, 1919.

[4] Emil Ott, *Helv.*, 11: 300, 1928; compare also G. Mie and J. Hengstenberg, *Helv.*, 11: 1047, 1928; Emil Ott, *Helv.*, 12: 330, 1929.

icals): The sixth, seventh, eighth, ninth and thirty-second orders are measured. Again the structure is pseudohexagonal only. The molecular length is 60.6 Å.U., containing 32 CH_2O-groups. The CH_2O-group again possesses the length of 1.89 Å.U. The thirty-second order is intense. The three X-ray patterns show also distinct differences in regard to the "outer" lines.

The δ-product was examined with Fe-radiation, for γ- and para-formaldehyde Cr-radiation was used. Additional orders are indicated in all cases. α-Polyoxymethylene and ordinary γ-polyoxymethylene also show a series of "inner" rings, which, however, could not be measured thus far. These lines are more diffuse, indicating a less uniform composition of the products. Additional investigations are under way. A full account will be published shortly.

These results give a definite proof for Staudinger's view of the constitution of polymer formaldehyde. It is proved that in highly polymerized bodies molecules of identical length may crystallize together. The molecule of such polymerized bodies may be determined by X-ray research, which is highly important since no other physical methods give such definite results.

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TURNING OF THE SPERM IN THE ACRIDIAN FOLLICLE

IN describing the spermiogenesis of a gryllid,[1] the author found in one species of cricket, *Nemobius fasciatus,* that first the nucleus and later the head are turned while elongating toward the open end of the follicles. The other species of crickets turn the head first toward the blind end of the follicle. Later these sperm turn in the follicle and enter the vasa efferentia, swimming with the head first. This phenomenon had not previously been described.

An examination of the literature revealed the fact that practically all the illustrations show the sperm forming with the head end toward the blind end of the follicle. This was particularly evident among the Acrididae, in which so many studies of spermatogenesis have been made.[2] The author therefore expressed the surmise that the sperm of grasshoppers turn in the follicle after they are formed.

This surmise he has confirmed by the study of many slides of fixed material. As the spermatids begin to elongate in the cysts all the nuclei move to the outer wall. In this stage the spermatids radiate out from the center. Later, as elongation continues, some of the heads move so that all point toward the blind end of the follicle. The elongation now continues until the head, and especially the tail, are very long. It is hardly thinkable that sperm could move any great distance with long flagella-like tails leading the way, and so the surmise was made that they turn in the follicle before leaving it. The following observations are believed to give evidence for this suggestion.

(1) In several specimens such elongated cysts contain clusters of heads which are still oval in shape. These are turned toward the blind end. Further toward the open end in the same cysts in a row beside the cyst wall are several heads all turned toward the open end. These were interpreted as having turned and being on the way to the open end of the cyst.

(2) In some very long follicles groups of heads lying around the periphery near the open end are headed in that direction. These are the sperm of a cyst which have completed the turning. In many cases these sperm are beside or in among degenerating cells—larger or smaller masses of mostly uniformly staining protoplasm. I suspect that these have to do with the nourishment of the sperm. The origin of these cells was not determined.

(3) Many of the much elongated cysts show, somewhere between the forming sperm and the open end, many tails which are plainly "looped." Sometimes these loops lie in the section. Others are cut in the curve part. In a few cases the heads are in this looped condition. Here is the point at which the turning or reversing is taking place. The number of tails (or heads) in the loops varies greatly in different specimens.

Some of the unturned heads have reached the elongated thread stage. Other sperm seem to turn while the head is still oval.

The details of the time, place and manner of the turning and relative phenomena are being investigated and will be reported on later.

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[1] W. J. Baumgartner, *Zeit. f. Zellforsch. u. micr. Anat.*, Bd. 9: 41, 1929.

[2] H. S. Davis, *Bull. Mus. Comp. Zool. Harvard Coll.*, 53: 59, 1908.

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