been constructed entirely of glass, in which the motion of the piston is actuated by electromagnetic forces.

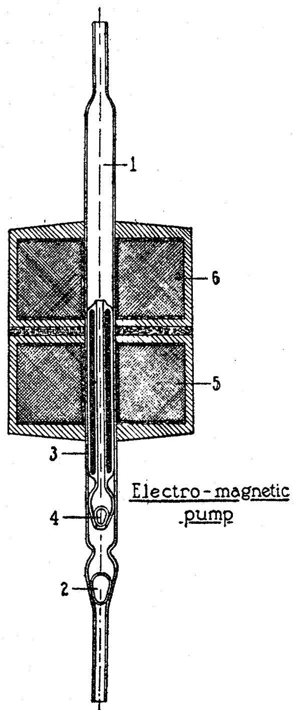

FIG. 1

The diagram shows the pump in cross section. The pump cylinder (1) is a glass tube which has a carefully ground valve (2) at its lower end. The piston (3) consists of two tubes with a soft iron core fused between them. The lower end of the piston has a valve (4) which is identically the same as the cylinder valve (2). Both valves close by gravity. The pump cylinder is surrounded by a lower solenoid (5) and an upper solenoid (6). Both solenoids are hooked up in separate circuits. By means of a three-pole, automatic, mercury switch actuated by a rocking device, the electric current flows through the solenoids periodically in such a way that they are switched on and off, one after the other, with an intermediate state in which both solenoids are magnetized for a short time. Thus, a magnetic field is created inside the solenoids. The center of this field travels up and down periodically.

The iron core inside of the piston is attracted into the center of the magnetic field. The piston moves up and down continually, like the plunger of any pump. The up-stroke of the piston opens the cylinder valve (2) and closes the piston valve (4), while the down-stroke closes the cylinder valve and opens the piston valve. By this means, any fluid can be circulated or transferred.

The pump has many practical applications, especially where it is necessary to maintain sterility. It can also be employed for blood, and for strong acids, alkalis or other dangerous fluids.

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## A METHOD OF SECURING MARINE INVERTEBRATES

WHEN instructor in charge of Bryozoa in the course in marine invertebrates at the Marine Biological Laboratory at Woods Hole, Massachusetts, in 1918, Dr. C. L. Parmenter introduced the expedient of suspending microscope slides in racks from floats so as to be held below tide level and clear of the bottom near shore in the Eel Pond and outside in the harbor at the docks of the laboratory to become inoculated with Bryozoa colonies.

This method of securing young colonies of encrusting and stolonate Bryozoa, otherwise very difficult to study undisturbed or even to secure in any other way, has been continued and modified as occasion demanded by his successors in charge of this group. The writer, who is the present incumbent, learned of it from Professor D. B. Young when first succeeding to the group in 1926. During the past three summers the method has been used in securing young clean tunicate colonies and some solitary tunicates for class study. In addition young and very transparent Anomia individuals of varying sizes have been obtained in such condition that the heart-beat and other rhythmical activities may be very accurately observed and timed. Some study has been begun on the relation of these rhythms to varying temperatures and oxygen content of the sea water in finger-bowls in the laboratory. Some investigations have also been made on the early development of some of the encrusting Bryozoa so obtained. The transparent substratum is ideal for such studies. Material for class studies so obtained is more than satisfactory, but the uncertainty as to just what will turn up on the slides on a given day for study prevents its exclusive use as the basis for study of definite forms.

Among the animal species so obtained at different times and in some abundance were the following: Barentsia sp., Bowerbankia sp., *Bugula flabellata, B. turrita,* Schizoporella sp., Lepralia sp., Membranipora sp., Folliculina, Botryllus, Ciona, Hydroids, Microciona, Halicondria, Balanus sp. and Corophium, on the slides; and *Asterias forbesi* and *Arbacia punctulata* between them and inside the racks.

The following description applies to the racks now used and their methods of suspension.

Two pieces of wood 34.5 cm × 2.7 cm × 1.5 cm and two pieces 7 cm × 2.7 cm × 1.5 cm are fastened together to make a rectangular frame of 34.5 × 10 × 2.7 cm external and 31.5 × 7 × 2.7 cm internal dimensions. In the long sides of the rectangle so formed, in the interior face of each, and directly opposite each other, twenty saw-cuts are made to receive the glass microscope slides of ordinary size (3″ × 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 pseudohexagonal 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.