second. The other ciliates studied obviously have a much lower speed of coordinating impulse. These values are so far below the velocities of true neural impulses that it is not possible to consider a "neuromotor" factor in the coordination of these Protozoa.

Further investigations are in progress along the lines indicated here and will be reported in detail.

The writer is indebted to Dr. W. M. Barrows for suggesting the use of the stroboscope in the study of the Protozoa.

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DARKFIELD MICROMANIPULATION WITH AN ULTROPAQUE ILLUMINATOR

RECENTLY I had been studying the surface precipitation reaction[1] in the ameba. The experimental work consisted in tearing *Amoeba proteus* and *A. dubia* with a microneedle in various salts solutions. This technique is essentially similar to that used by Chambers and Reznikoff.[2] If an ameba is carefully torn in a solution containing an appropriate concentration of Ca- or Sr-ions, a new plasmalemma will be formed at the zone of tearing. Before the new plasmalemma is formed, some of the protoplasm will exude into the surrounding medium in the form of granules, crystals and unorganized matter. This more or less rapid disintegration of protoplasm will continue until the new plasmalemma is formed. The time at which this new plasmalemma is produced may be more easily determined if the ameba is studied under darkfield illumination.

Although special darkfield condensers are available for micrurgical technique, their use is somewhat limited. A specially designed moist chamber is needed. The regular substage condenser must be removed before the darkfield condenser can be installed. Brightfield illumination as furnished by the substage condenser is indispensable for making preliminary adjustments of the microneedles. In order to use both brightfield and darkfield illumination it is necessary to interchange these condensers. This procedure complicates the micrurgical technique and frequently the original adjustments of the microneedles are disturbed.

An ideal arrangement should furnish either brightfield or darkfield illumination without involving an interchange of condensers. Also this arrangement should permit the use of any style or height of moist chamber. The Ultropaque illuminator[3] adequately fulfils these requirements.

This instrument is a vertical illuminator permitting the use of a large series of objectives. The light source, consisting of a low voltage Mignon lamp, is an integral part. Color, neutral or heat-resisting filters may be conveniently used. The entire unit is mounted on the microscope in place of the revolving nosepiece. The substage condenser need not be removed. Each objective is furnished with a ring condenser. A slight rotation of this condenser will produce varying degrees of illumination ranging from brightfield to darkfield without disturbing those adjustments previously made either with the microscope or with the micromanipulator.

I use the following procedure. The amebas are mounted in a shallow hanging drop on a coverslip which is then placed on the moist chamber. The ring condenser is adjusted to give darkfield illumination. The preliminary adjustments of the microneedles are made in a brightfield furnished by the substage lamp and condenser. Two toggle switches conveniently placed near the micromanipulator are used to control the two sources of light. At any time, during or after the ameba is torn, the substage lamp may be quickly turned off and the Ultropaque turned on. Thus the effect produced by the microneedles on the protoplasm may be immediately studied with an excellent darkfield illumination.

Some of the intermediate degrees of illumination are exceedingly useful. In a semi-darkfield the *plasmalemma/medium* interface may be seen very distinctly. A semi-brightfield is useful in studying the nucleus; while the minute granules within the ectoplasm may be made visible if extreme darkfield is used. In transmitted light these ectoplasmic granules are not evident. Thus any change in the size, aggregation or number of granules can be readily detected. In a darkfield the tips of the microneedles when in focus appear as very bright luminous points.

The use of darkfield illumination makes possible a closer check on the condition of the cytoplasm. The importance of being able to detect various changes in the cytoplasm (Brownian movement, streaming, etc.) while micrurgical experiments are being conducted has also been pointed out by Plowe.[4]

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[1] L. V. Heilbrunn, *Arch. f. exp. Zellf.*, 4: 246, 1927.
[2] *Jour. Gen. Physiol.*, 8: 369, 1926.
[3] Made by E. Leitz.
[4] *Protoplasma*, 12: 196, 1931.

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