urally, cracks in the crust will follow the sags of the ground surface. This automatic register of the movement of the earth-wave indicates a course at right angles to the directions given, namely, N.E. to S.W.

The direction of these crust cracks has been verified, since the above was written, by observations made by lumbermen 40 miles inland from Gaspé.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD OF DEMONSTRATING ACIDITY OF FOOD VACUOLES IN PARAMECIUM

WHILE searching for certain intravitem stains the present writers observed that acidity in the food vacuoles of Paramecium caudatum could very easily be demonstrated in the following manner:

Common red cabbage leaves with the stems cut out were boiled in a minimum of water. There thus was obtained a very dark reddish purple solution which became red in the presence of acids and green in the presence of alkalies. This solution was filtered and a few drops added to a small culture of the infusorian. Within ten minutes the animals had taken enough of the colored fluid and the small particles therein into their bodies to make their food vacuoles very distinct. Under these conditions the food vacuoles appeared distinctly red in color, thus showing the presence of acid in the vacuoles.

This appealed to us as a good simple method for classroom or laboratory demonstration.

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MICRO SLIDE RINGS

MICRO slide rings of any size desired can be cut from sheet celluloid by means of hollow punches. These rings are affixed to slides by dipping them in liquid nitrocellulose made by dissolving celluloid in amyl acetate and pressing them down on the slides by means of forceps. When dry, they are permanently attached to the slides, are not soluble in xylol and are excellent for mounting thick objects such as tapeworm proglottids in balsam. Ringing with gold size completes the mount.

Those who have found glass rings unsuitable, who have experienced difficulty in securing fiber or hard rubber rings and who have known the annoyance caused by the hard rubber rings breaking after the mounts are made, will find that this method will solve their problems.

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SPECIAL ARTICLES

THE EFFECT OF POLARIZED LIGHT ON THE GROWTH OF LUMINOUS BACTERIA

THAT polarized light does have a marked effect on biological phenomena was pointed out for the first time by Miss E. S. Semmens.[1] Shortly after her paper was published, E. G. Bryant,[2] working in South Africa, published a paper on the biochemical effect of polarized light and its relation to some of the superstitions of the natives of his part of the country. Although the presence of sufficient polarized light in moonlight to have any effect on the majority of biological processes is at present disputed by some workers in this field (*cf.* H. M. Fox, Proc. Roy. Soc., B, 95, 523, 1923), Mr. Bryant found that pieces of fish which had been placed in bright moonlight became highly putrid during the course of a night's exposure, while control pieces of the same fish kept in the dark remained comparatively fresh over the same period of time. He offers no explanation for this phenomenon, pointing out merely that the taboo against eating fish which had been exposed to moonlight had a fairly sound basis.

During the course of some work on luminous bacteria, it occurred to me to study the effect of polarized light on the growth and luminescence of these forms. The type used was Photobacterium phosphorescens, isolated from fish obtained at the Princeton fish market in the fall of 1923, and used in this laboratory for various experiments.

Two Petri dishes were planted with these bacteria and one was placed under light which had passed through a Nicol prism, while the other was kept in the dark. At the end of eight hours it was found that the one which had been in the polarized light had reached its maximum intensity, but the one in the dark was just beginning to glow. Likewise, it was found that the first plate had become almost dark at the end of fourteen hours, while the second had just reached its maximum intensity. The normal length of time for a culture to reach its maximum of luminescence and decrease again is about twenty-four hours, and the second plate followed this natural growth rate.

Later experiments were carried out in a more rigorous manner. A Petri dish of agar was inoculated with as uniform a culture of bacteria as it was possible to obtain over the surface of the plate. Two rings of sterile ebonite were then pushed into the agar and the cover of the dish brought down tightly upon them. On top of the plate were placed two ebonite rings of the same diameter as those inside of the dish and directly above them, and the rest of

[1] Semmens, E. S., *Nature*, Vol. III, 49, 1923.

[2] Baly, E. C. C., and Semmens, E. S., Proc. Roy. Soc., pp. 681, 1923.

the plate covered with black paper. In the top of one of these tubes was placed a Nicol prism, while over the opening of the other was laid a piece of cardboard containing a hole of the same dimensions as the prism, in order that the area of the plate which was affected by the ordinary light would be of the same size as that struck by the polarized light. Also over the top of the tube through which the ordinary light was to pass was placed a "neutral wedge" and by means of this the intensity of the light which struck the plate under this tube was brought to the same value as that which impinged upon the plate under the Nicol prism since this latter absorbed an appreciable amount of the incident rays. These two intensities were measured by means of a Macbeth illuminometer. The source of light was a 150 watt bulb of the ordinary gas-filled type, and between it and the plate was placed a bottle through which running water was passing and which acted as a screen to remove the heat radiations from the light.

On a Petri dish which had been prepared in this manner it was possible to have the three conditions under which an experiment was to be carried out all on the same plate; the temperature was uniform over the surface of the plate, and side by side were the areas to be exposed to polarized light, ordinary light and the portions which were to be kept in the dark.

It was found in these latter experiments, as in the case of the former ones, that there was a marked increase in the brightness of that area which had been exposed to polarized light as compared with the rest of the plate. That this was due to an increased rate of growth was determined by the fact that the bacteria had utilized the medium throughout that section of the plate which had been affected by the polarized light, bringing about a diminution of the light over that area even before the other portions of the plate had reached their maximum intensity of luminescence. Inasmuch as there is no method of measuring the intensity of the light of growing bacteria, no quantitative results could be obtained in these experiments, but a conservative estimate of the time required for such a portion of the plate to reach its maximum intensity was one third that of the other parts, whether exposed to ordinary light of the same intensity as that of the polarized light or whether kept in the dark.

During the course of this work some eighteen experiments were performed, of which number fifteen gave positive results, the other three giving results which, while *not* negative, were not of a sufficiently positive nature to warrant them being grouped with the others.

The question arose: Was there any effect of the polarized light on the medium itself? In order to answer this, plates of medium were exposed for about eight hours to light which had passed through a Nicol prism and were then planted with bacteria. Control plates of agar were also made and sown at the same time, but no difference in luminescence could be noted between the two plates.

In view of the fact that there has been practically no work done on the processes which take place inside of a cell upon exposure to polarized light, the cause for this increased growth is a matter of conjecture. However, Miss Semmens's work, which has very recently appeared in a more detailed form,[3] points to an increased rate of the hydrolysis of the starches in the plant. Although there is no starch in the bacterial cell, there are undoubtedly other carbohydrates which may be acted upon in the same manner in which the plant starches are by some of the enzymes present in the cell.

I wish to thank Dr. E. N. Harvey, professor of physiology at Princeton University, for his kind suggestions and interest in this work.

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THE NON-NUCLEATED CELLULAR ELEMENTS OF THE BLOOD[1]

IN a comparative hematological survey probably no one feature is so striking as the contrast between mammals and all other vertebrates with reference to the occurrence of non-nucleated elements in the blood. In lower vertebrates the blood cells are all nucleated; ascending the phylogenetic scale to mammals, we find that by far the major bulk of the circulating cellular elements has been replaced by non-nucleated structures or plastids, as they may be conveniently designated. That the formation, function, quantitative regulation and fate of this predominant mass of non-nucleated material in both health and disease is of fundamental importance can not be questioned.

The history and present status of our conceptions as to the occurrence, nature and origin of these structures may be summarized as follows:

First: That in consequence of the apparently exclusive occurrence of these elements in the mammalian organism, a sharp line of demarkation or hematological discontinuity has been drawn between mammals and all other vertebrates. Indeed, in 1875 Gulliver classified vertebrates into two great groups—the pyrenaemata, in which it was stated that "the blood cells of every animal without any known exception were nucleated," and

[3] Baly, E. C. C., and Semmens, E. S. Proc. Roy. Soc. B, *97*, 250–253, 1924.

[1] Abstract of a paper presented in a symposium on the blood at the fortieth annual session of the American Association of Anatomists, Buffalo, N. Y., 1924.