The other differences between Mr. Briggs and myself are matters of opinion. But in considering them, one must not forget that the Esperantist has almost always approached the study of Esperanto with a considerable previous study of other languages, sufficient to render language study easy to him, and with an enthusiasm raised to a high pitch by repeated assurances that Esperanto is extremely easy. Professor R. A. Muttkowski develops this theme very effectively in *America* for December 30, 1922. But of these two factors, the former is not intrinsic in Esperanto, and the second is extraneously stimulated. Grant the same mental attitude toward Latin or toward any other language as that which has been developed toward Esperanto by its advocates, and the rate of progress would be enormously accelerated. But this is not normal. One may note that Professor Leskien, the great linguist and philologist of Leipzig, found it very difficult to gain a mastery of Esperanto, though he devoted several hours a day to it for three months, and he was a man who spoke a number of modern languages, including several Slavonic languages, which are reputed to be very hard to learn.

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SCIENTIFIC APPARATUS AND METHODS

ARTIFICIAL CULTIVATION OF FREE-LIVING NEMATODES

THE artificial propagation in pure culture of microscopic organisms, wherever it has been successfully applied, has opened the road to discoveries of the most important and most diversified kinds. The development of cultural methods for the study of bacteria by Pasteur will always stand as one of the important milestones in the progress of bacteriological science. Since Pasteur's time numerous refinements have been made in cultural methods, particularly the introduction of solid media by Koch, and great extensions have been made in the application of this method of study to organisms other than bacteria and fungi. Spirochetes, free-living protozoa, trypanosomes, Leishmaniae, intestinal flagellates and even malarial parasites have been successfully grown in culture, either pure or in conjunction with organisms on which they feed.

So far as I am aware the propagation in pure culture (pure as far as metazoan species are concerned) on artificial media of free-living nematodes has not previously been recorded. I recently made the discovery that certain species of free-living nematodes would thrive and multiply at an astounding rate on ordinary nutrient agar plates. A single isolated adult female of Rhabditis sp., placed on an agar plate with a drop or two of dirty water to supply a bacterial growth, in a period of five days produced hundreds of offspring which swarmed all over the plate. In ten days the offspring numbered many thousands—males, females, eggs and young in all stages of development. The majority of the individuals are found moving about on the surface of the agar, but some burrow into it also. The movements on the agar are sufficiently impeded so that they can be watched after the fashion of a slow-moving picture. The swallowing of bacteria and fungus spores, the excretion of waste matter from the anus, and every detail of locomotion can be observed under ideal conditions. I have succeeded in culturing at least two different species of Rhabditis, a Cephalobus and others which are not positively identified. A pure culture, *i.e.*, a culture containing only one nematode species, seems to develop more rapidly than a mixed culture.

Cultivation of free-living nematodes in this manner suggests a great range of possibilities in the way of study and experimentation, *e.g.*, on foods, effects of hydrogen ion concentrations and of chemical substances, resistance to desiccation, tropisms, effect of various modifications in environment on rate of reproduction and development, etc. In the case of beneficial or injurious species, it might lead to the discovery of methods for controlling or encouraging them. The extremely rapid rate of reproduction and ready inbreeding suggests great possibilities in the way of genetic experiments.

Cultivation on agar plates also furnishes a convenient method of obtaining large quantities of material for taxonomic study, in all stages of development. A drop or two of water washed over the surface of the plate and then placed on a slide with a little ether gives a large number of perfectly clean nematodes for microscopic examination.

For class demonstration the cultivation of the soil nematodes on agar plates is ideal. If a student places a small quantity of soil, especially manured soil, in a piece of gauze or in a fine sieve, and washes it in a beaker of water of about 100° F., for a few minutes, the majority of the nematodes present will fall to the bottom of the beaker. A drop or two of water from the bottom of the beaker is placed on the surface of the agar, the plate is covered and left at room temperature for a week or two and then examined under a microscope. I can guarantee from personal experience that the result will be startling.

Further investigation on the cultivation of these nematodes, especially its application to a larger number of species, had been planned before publishing the work, but an unexpected change in my plans makes it improbable that it can be continued for some

time to come. In order, therefore, that others who are interested in the study of free-living nematodes may pursue the matter further, this preliminary note is published in its present incomplete state.

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SPECIAL ARTICLES

ELECTRIC CONDUCTIVITY OF RED BLOOD CORPUSCLES USING HIGH FREQUENCY ALTERNATING CURRENTS[1]

RUDOLPH HOEBER determined the electric conductivity of suspensions of erythrocytes in isotonic sugar solutions by various substitution methods. He used damped alternating currents of radio frequency for the high frequency currents. Owing to the fact that high frequency apparatus has been very much improved, and it is now possible to obtain undamped alternating currents of any desired frequency, it seemed desirable to make some new determinations. During the past nine months I have spent much time in the attempt to observe a difference, if any exists, between the conductivity of erythrocytes as measured by continuous currents in contrast to that measured at about one thousand cycles per second. It was found that calomel electrodes of large size showed so little polarization during the passage of a small current for fifteen seconds that these could be used for running the current into and out of the erythrocytes. Apparatus was made which reversed the current every fifteen seconds and the final reading was verified during one fifteenth-second interval. The electrode vessels were separated from the erythrocytes by means of agar gel made up with saturated potassium chloride solution. After many methods were tried, a Wheatstone bridge method was finally used. No difference in conductivity with direct current and with a thousand cycles could be established with certainty. Attempts were next made to detect a difference between the conductivity at one thousand and one million cycles. The current of a thousand cycles was generated by a Vreeland oscillator and gave a pure sign wave as shown by the oscillogram. A million cycle current was produced by an electron tube oscillator. This frequency is too great to be studied by the oscillogram, but it is a general opinion of radio engineers that such currents show harmonics. No better source of current, however, was known at this frequency. Measurements made with a bridge whose known resistances were wound according to the Ayrton-Perry winding were very unsatisfactory at a million cycles, although this bridge gave very good results at fifty thousand cycles. Therefore, a very simple and symmetrical bridge was constructed in which the metallic resistances were straight wires and the detector was a crystal detector and sensitive galvanometer. No theoretical defect in this bridge was known, and since no more suitable arrangement has yet been used, the results are taken to be provisionally correct. It was found that the specific conductivity of a sediment of ox-erythrocytes containing a small percentage of serum was 0.001 reciprocal ohms at one thousand cycles per second, and was 0.0014 reciprocal ohms at a million cycles per second.

Hugo Fricke has made some measurements of the capacity reactance of living cells. In order to interpret his data as capacity reactance, certain assumptions had to be made. If it is really true that the conductivity is greater at high frequency and that the cells show capacity reactance, a simple and time-honored picture of a cell which would show these phenomena is one in which the cell interior is a moderately good conductor of electricity but the cell surface acts as a dielectric and insulator. When a direct (continuous) current is passed through a sediment of the cells, the current passes through the film of medium separating the cells and does not pass through the cells themselves to any large extent but when a high frequency alternating current is passed, it passes through the medium as well as before and in addition to that it passes directly through the cells, the insulating surface of each cell acting as the dielectric of a condenser.

These preliminary measurements are published owing to the fact that the work will have to be interrupted during the summer.

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STINGING CRYSTALS IN PLANTS

STINGING crystals are widely distributed throughout the vegetable kingdom. They are in the form of raphides, composed of calcium oxalate, and their action is generally regarded as mechanical. As a matter of fact, however, the mechanical effect of such crystals is not the sole cause of the irritation, though this is a contributing factor. Calcium oxalate in the form of raphides is common particularly in the Monocotyledons, but by no means always do they have stinging properties. Some other factor must be looked for. For the purpose of this investigation the Cabo Negro palm (*Arenga pinnata* Merr.), the dumayaka (*Arenga tremula* Becc.) and the pungapung (*Amorphophallus campanulatus* Blume) were used. In the first two the crystals occur in the fruit in a layer of cells on the inner side of the endocarp;