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.

ASA C. CHANDLER

BIOLOGICAL LABORATORY,
RICE INSTITUTE

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.

J. F. MCCLENDON

LABORATORY OF PHYSIOLOGIC CHEMISTRY,
UNIVERSITY OF MINNESOTA

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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;

in the pungapung the crystals occur in the stems and leaves.

Application of the crystals to the skin produces a violent irritation which continues for a considerable period of time. This property is made use of in the Philippines for the protection of fish ponds against robbers. The crushed fruits of Cabo negro are scattered along the edges of the ponds, and make a very effective barrier against bare-footed intruders.

Many of these plants containing stinging crystals are used for food purposes. Prolonged boiling renders them harmless, and microscopic examination shows that the crystals have been destroyed. The irritation produced by the fresh material is very similar to that produced by the latex of the unripe papaya (*Carica papaya* L.), in which the active agent is the proteolytic enzyme papain. This affords a hint as to the reasons why irritation is produced by some plants with raphides, and not with others.

Four possibilities may be taken into account: (1) Irritation may be due to the mechanical action of the crystals; (2) It may be due to organic acids; (3) It may be due to an enzyme; or (4) It may be due to a combination of (1) and (2) or (1) and (3) or a combination of all three.

A strong infusion of the crushed tissue was filtered over a suction pump. The filtrate, though devoid of crystals, was found to produce irritation when left in contact with the skin, but its action was not nearly as violent as when the crystals were present. Scratching of the skin followed by application of the filtrate produced much more comparable results. The conclusion, therefore, is that the crystals are essential to the production of the full amount of irritation, but that the active agent which produces the effect after the first mechanical action of the raphides (which may be reproduced experimentally by pin pricking) is some substance associated with them. This is not an acid, as the liquid is slightly alkaline in the case of the palms and neutral in *Amorphophallus*. In *Laportea* and *Urtica* (*Urticaceae*) it has been shown that the irritation is due to formic acid, injected after the skin has been pierced by the siliceous trichomes. The mechanism in the cases of stinging hairs may, therefore, be compared to that of stinging crystals. Mechanical piercing is followed by the further action of an irritant. Bearing in mind the similarity in sensation produced by these crystals with that produced by the latex of the papaya, some confirmatory experiments were carried out with the result that conclusive proof was produced that the irritant was a proteolytic enzyme. Within little more than an hour cubes of hard-boiled white of egg were appreciably corroded when immersed in the juice. Ammonia and metallic salts (such as mercuric chloride) acting as enzyme inhibitors when added to the juice destroyed its irritating properties for the most part, though the annoying prickling of the raphides could still be felt.

The custom of boiling the tissues of plants containing stinging crystals before using them for food has two objects. First, heating with water dissolves the crystals, and second, the heat destroys the enzyme.

SUMMARY

The results go to show that in the case of plants with stinging crystals, the action consists of two distinct stages: (1) The mechanical action of the raphides in piercing the skin; (2) The entrance through the minute wounds of a proteolytic enzyme which is the cause of the greater part of the effect.

The removal of the crystals by filtration or the destruction of the enzyme will not eliminate all the irritating properties, but the two actions together are sufficient, and so the action must be regarded as being produced by combination of the two factors.

D. A. HERBERT

COLLEGE OF AGRICULTURE,
UNIVERSITY OF THE PHILIPPINES,
LOS BANOS, P. I.

THE WESTERN SOCIETY OF SOIL MANAGEMENT AND PLANT NUTRITION

THE Western Society of Soil Management and Plant Nutrition held its third annual meeting on June 24 and 25, commencing one day in advance of the regular session of the Pacific Division of the A. A. A. S. Twenty-five members attended and participated freely in the discussion of the papers.

Four half-day sessions and a business meeting were held and the following program was presented:

SOIL ALKALI AND SOIL ACIDITY

Replaceable bases in relation to soil acidity and the theory of replaceable bases: W. P. KELLEY.

The relation of certain alkali salts to the growth of plants: A. R. DAVIS and D. R. HOAGLAND.

Tolerance studies for alkali soils in Idaho: R. E. NEIDIG and H. P. MAGNUSON.

The injurious after-effects of sorghum: J. F. BREAZEALE.

THE SOIL SOLUTION

Nature and promise of the soil solution: J. S. BURD.

Secular and seasonal changes in the soil solution: J. S. BURD and J. C. MARTIN.

Some physiological aspects of soil solution investigations: D. R. HOAGLAND.

Soil structure and the soil solution: M. D. THOMAS.

Replaceable bases in relation to the soil solution: W. P. KELLEY.

PLANT NUTRITION

The stimulation effect of NaCl upon respiration and growth of wheat: A. R. DAVIS and L. J. TEAKLE.