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## Biological Science Section

### ELECTRONIC MULTIPLICATION

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#### ABSTRACT

Direct instantaneous multiplication of electrical voltages has been regarded as a difficult electronic problem not subject to direct simple solution. This is especially true when the two voltages each have arbitrary unrelated wave forms, contain D.C. components, or are non-recurrent.

By utilizing tubes whose characteristics are accurately parabolic in some region, a circuit has been devised which gives essentially a square-law response. With such a circuit the desired multiplication of voltages A and B can be carried out using only the simple electronic processes of addition, subtraction, and division by a constant:

$$(A + B)^2 = A^2 + 2AB + B^2,$$

$$(A - B)^2 = A^2 - 2AB + B^2;$$

$$(A + B)^2 - (A - B)^2 = 4AB.$$

A technique for determining accurately the parabolic portion of a tube characteristic has been developed. This and the actual apparatus for performing the multiplication will be described and possible applications discussed.

### ELEMENTARY MATHEMATICAL FUNCTIONS WHICH CAN REPRESENT THE NERVE ACTION POTENTIAL

JOHN LINSLEY AND OTTO H. SCHMITT

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#### ABSTRACT

A method of successive approximation functions has been devised which permits quite accurate representation of the complex nerve action potential form by usable analytic functions. The representation, while it is empirical, permits substituting analytical for graphical methods in calculations involving the action potential.

## ELECTRONIC COMPUTER MEASUREMENTS OF THE ELECTRIC ENERGY EXPENDED IN THE PROPAGATION OF THE NERVE ACTION POTENTIAL

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### ABSTRACT

A rough experimental model of an electronic computer has been constructed which can instantaneously calculate the electric energy released in the active nerve for propagation of the impulse. This instrument automatically determines the integral and derivative with respect to time of the incoming nerve signal, multiplies together the instantaneous algebraic values of these functions, and accumulates a running time integral of this product.

The resulting function, which is recorded from the cathode ray screen photographically, can be established theoretically to represent the nerve impulse energy on a quantitatively calibrated scale.

Comparison of preliminary results from the experimental computer with those obtained by laborious graphical analysis of the nerve potentials indicates satisfactory agreement and assures success of the more elaborate computer now under design.

Values of the nerve impulse energy obtained in these preliminary experiments will be compared with the total nerve energy expenditure values obtained by means of heat production and metabolism measurements.

1 1 1

## SCOTCH PINE SEED SOURCES FOR NORTHEASTERN MINNESOTA

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### ABSTRACT

Scotch pine (*Pinus sylvestris* L.), widely planted in early days, fell into general disrepute among foresters. However, there may be races suitable for planting in this country. One study involving 20 seed sources of Scotch pine and a comparison with red pine (*Pinus resinosa* Ait.) was made in northeastern Minnesota. The seed sources represented northern European, central European, and Asiatic types. They were obtained partly from American plantations and partly from stands in their native localities. At the end of 16 years in the field (18 years from seed) the planted trees of

the various seed origins varied considerably in survival, height development, diameter growth, basal area and volume per acre, form, vigor, and soundness. The trees of known or supposed central European origin were generally superior in quantity of wood produced, but those of known or supposed northern European origin were generally better in quality. Combining quantity and quality factors as cubic foot volume per acre of satisfactory trees, the best single source was from northern Europe, but the rest of the upper 25 percent were of central European type. The single Asiatic type was mediocre.

Compared with red pine, the Scotch pines were superior in survival, diameter growth, and volume; they were about the same in height development, but much more subject to injury; and they were much poorer in form, soundness and volume of satisfactory trees per acre.

Results at the end of 16 years indicate that the best source of Scotch pine for the inland portions of the Superior National Forest is from what was formerly called the province of Courland in Latvia; the best central European source is Bohemia; but more satisfactory results will be obtained if red pine of suitable seed origin is planted, especially as regards quality production.

1 1 1

## THE COILING OF CHROMOSOMES IN TRILLIUM

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### ABSTRACT

The problem of coiling of chromosomes in *Trillium* has been one of the major interests of cytologists and there have been conflicting opinions as to the presence of a minor coil in this material. The paper is based on a reinvestigation of the problem and the findings of the author.

1 1 1

## CONSIDERATION OF CERTAIN BIOLOGICAL ASPECTS OF ULTRASONICS

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### ABSTRACT

Interest in the biological aspects of ultrasonics has increased considerably during the last few years. According to recent German

literature favorable results have been obtained when treating certain cutaneous malignant conditions with ultrasonic vibrations having a frequency of 800,000 cycles per second. This frequency was considered the optimal one to use. Higher frequencies of say, 100,000 cycles per second were absorbed too highly by the surface tissues. Frequencies as low as 500,000 cycles per second proved to be too painful. The equipment which we are using in our studies is similar to that described by the German investigators. This equipment will be described. The technic of application will be given.

## THE ANATOMY OF A TWO-HEADED CALF

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### ABSTRACT

A two-headed calf fetus of about five months revealed the following interesting anatomy. Both heads were normal in size, but one was slightly deformed. There was a single common occipital bone which articulated with an expanded atlas. Each head possessed a normal brain except that a common medulla attached both brains to the spinal chord. One of the heads was, however, an appendage in most respects. The right head possessed a normal trachea and oesophagus while the mouth of the other ended abruptly at the lower end of the pharynx. Each head had a set of ears, but those on the left were displaced downward to the angle of the jaw and were not connected with the auditory canal. The blood supply to the right head was normal, but the left head received its supply from branches of the left carotid. Blood was returned by several vessels which connected with the left jugular vein. The single body possessed a single set of normal organs. The specimen was a female.

## THE FINER STRUCTURE OF THE BODY WALL AND PARENCHYMA OF THREE SPECIES OF DIGENETIC TREMATODES

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### ABSTRACT

The origin, nature, and function of the various components of the body wall and parenchyma of trematodes has long been the

subject of investigation by many workers. Four major items have been of particular interest. The first is the origin of the cuticula and the question whether it is a metamorphosed epithelium or a secretory product. The second deals with the nature and function of the subcuticular cells. The third item is concerned with the origin and structure of the hooks, spines, scales, and related defensive or protective structures of the cuticula, and their relationship to the subcuticular cells. The last item deals with the spaces in the parenchyma and with the question whether the lacunae are intracellular or intercellular.

Three species of distomes from frogs were used: *Loxogenes arcanum*, which occurs encysted on the duodenum and pyloric end of the stomach; *Gorgoderina attenuata*, found in the urinary bladder; and *Pneumonoeces medioplexus*, parasitic in the lungs. *Loxogenes arcanum* was obtained from frogs collected near Park Rapids, Minnesota; the other species of worms used were taken from frogs collected in the New York City area.

Of the three species examined, only *Loxogenes arcanum* possesses a true subcuticular layer of cells. *Pneumonoeces* also showed cells beneath the muscle bands but these cells were directly continuous with the general parenchyma of the body and there was no sharp demarcation between the two regions. In *Gorgoderina*, in addition to the lack of a pronounced subcuticular layer there was an almost complete lack of cells in the subcuticular area.

No evidence of ducts leading into the cuticula was observed in any of the three species studied.

Pratt (1909) has suggested the possibility that the physical nature of the cuticula is not the significant factor in the resistance of the parasite to its environment but that chemical secretions are of more importance. The three species studied were selected with the possibility in mind of discovering a relationship between the environment of the parasite and its cuticula. *Gorgoderina*, inhabiting the urinary bladder, might be expected to possess a heavy thick body covering, since it has the least favorable environment of the three worms, yet this form possessed the thinnest cuticula of the three. *Pneumonoeces*, parasitic in the lungs, and thus having a favorable environment from the standpoint of food and the absence of digestive enzymes, possessed the thickest cuticula of the three. *Loxogenes* was encysted, and apparently well-protected against mechanical injury and the action of enzymes, possessed a relatively thick cuticula. There appears to be no correlation between the physical nature of the cuticula and the environment.

A COMPARATIVE STUDY OF THE FOOD HABITS  
OF *Cottus bairdii* AND ASSOCIATED  
SPECIES OF *Salmonidae*

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ABSTRACT

The stomach contents of 328 trout and 1074 *Cottus bairdii* *bairdii* Girard (sculpin) were examined. 292 of the trout were *Salmo trutta fario* *Linnaeus* (brown trout) and 36 were *Salvelinus fontinalis fontinalis* *Mitchill* (common brook trout). The fish were collected from the Caribou River in Lake County and from the Main South Branch of the Root River in Fillmore County. Sixteen quadrates (each 18 inches square) of bottom fauna from these rivers were examined.

Salmonid eggs were eaten by the *Cottus* but the number of eggs was small and did not constitute a major food item of the *Cottus* examined in this study. A number of large trout were found to eat their own eggs in considerable numbers.

In general, the bottom fauna was consumed by both trout and *Cottus* in proportion to its availability. The feeding of *Cottus bairdii* was restricted to the bottom while the trout fed at all levels in the water. Both *Cottus* and trout were entirely carnivorous in food habits. The five major food items of *Cottus* were Gammarus, and the aquatic stages of *Trichoptera*, *Ephemera*, *Plecoptera* and *Diptera*. These were major food items also of the trout. Forage fishes largely *Cottus* were an additional major food item for the trout.

*Cottus bairdii* and trout were considered to be competitors for major food items, however, this competition was lessened by the fact that the food habits of trout were more varied, and *Cottus* were of value to the trout as a forage fish.

THE EFFECT OF DERRIS ROOT (ROTENONE) UPON  
PLANKTON AND BOTTOM FAUNA ORGANISMS  
OF A SMALL MINNESOTA LAKE \*

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During the summer of 1946, a quantitative investigation was

\* A part of the data presented in this paper was taken from a thesis submitted to the Graduate Faculty of the University of Minnesota, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.