on the open market in exchange for 'new national money' issued by the State, such money bearing no interest at all? If so, he has yet much to learn of human nature. W. H. COATES.

[No further correspondence on this subject can be accepted.—ED. NATURE.]

### Transmission of Excitation in Plants.

IN his letter in NATURE of October 23, Prof. N. G. Ball throws doubts upon the validity of my conclusions that in Mimosa (1) the transpiration-current has nothing to do with the conduction of the excitatory impulse, and (2) that the conduction is a phenomenon of propagation of protoplasmic excitation. I would refer Prof. Ball to my work "The Nervous Mechanism of Plants" (1926) for accounts of experimental demonstrations fully justifying the above conclusions. Limited space available allows me to refer here only to a few of the more important results.

The possibility of stimulating Mimosa by application of extracts of the stem to the basal end of a cut shoot has been adduced as evidence in support of the transpiration-current theory. This is by no means conclusive, as I have already pointed out in "The Nervous Mechanism of Plants," p. 17: "It is conceivable that certain vegetable extracts might act as stimulants; vegetable alkaloids of a poisonous nature, for example, produce excitation when applied in minute doses to the cut end of the stem. It would, however, be quite unreasonable to conclude from the result that an alkaloid is excreted from the plant under the action of a minimally effective stimulus." The following facts will be found to discredit the theory of transpiration-current.

1. The transpiration-current theory is based on the supposition that injury to wood caused by the wound, produces a stimulating substance which, being carried by the transpiration-current to the leaf, stimulates it to movement. It follows from this theory (*a*) that an intense wound-stimulus is essential for stimulation; (*b*) that the impulse should only travel upwards in the same direction as the ascent of sap; (*c*) that the velocity of the transpiration-current should be the same as that of the excitatory impulse; and (*d*) that in conditions where there can be no ascent of sap there should be no transmission of impulse.

I will take these points one by one. (*a*) I have shown that Mimosa can be excited by an electric shock one-tenth of the intensity of that which evokes human sensation. No wound is produced, yet the excitation produced by such an excessively feeble stimulus is transmitted to a considerable distance. (*b*) The excitation is found to be *simultaneously conducted both upwards and downwards*. It is also found that, under moderate unilateral stimulation, *the transmitted excitation ascends along one side of the stem to the apex and descends down the other*. The transpiration-current could not possibly have produced this result. (*c*) Accurate determinations of the velocities show that the rate of transmission of excitation is several hundred times quicker than that of the ascent of sap. (*d*) The tip of the uppermost leaf of Mimosa was stimulated by the application of a drop of hydrochloric acid: an impulse was generated which travelled to a considerable distance downwards against the direction of the normal ascent of sap. Subsequent chemical examination proved that the stimulant had not been transported, but had remained localised at the point of application.

These experimental results leave no doubt of the unfounded character of the transpiration-current theory. Nor can this theory be considered to have established its claim to acceptance until it has been demonstrated that excitation induced not by flame alone, but by stimulus of every kind—chemical, mechanical, electrical—is transmitted across the water-gap in the fundamental experiment upon which the theory has been built.

2. I next adduce positive evidence which proves that the transmission in the plant is one of protoplasmic excitation. This is demonstrated by the fact that the transmission is correspondingly modified by all conditions which modify the transmission of excitation in the animal nerve. The polar action of a constant electric current is identical in the two cases; when the current is feeble, stimulation occurs at cathode-make, the excitation being transmitted to a distance; with stronger current, excitation is produced at cathode-make and at anode-break. In both Mimosa and animal nerve, the velocity of transmission is increased within limits by a rise of temperature, and diminished by a fall. In both, transmission may be arrested temporarily or permanently by various physiological blocks. When the conducting tissue in the animal or plant is cooled, the speed of the impulse is slowed down, culminating in its arrest. The conducting power is temporarily arrested by a block produced by the passage of an electric current in a portion of the conducting tissue through which the impulse is being transmitted. This electrotonic block is removed on the stoppage of the current. Finally, poisonous solutions abolish the conducting power of both animal and plant.

These results offer conclusive proof that the conduction in the plant is a phenomenon of propagation of protoplasmic excitation, as in the nerve of the animal. J. C. BOSE.

Bose Institute, Calcutta,
Nov. 17.

### The Behaviour of Cultures of *Leishmania tropica*, *L. infantum*, and *L. braziliense* in the Sandfly, *Phlebotomus papatasii*.

EXPERIMENTS were carried out to determine the behaviour of *Leishmania braziliense* and *L. infantum* in *P. papatasii*. The sandflies were infected by feeding through a membrane of rabbit skin on emulsions of flagellates in inactivated rabbit serum or defibrinated rabbit blood, and control experiments were performed with *L. tropica* in sandflies similarly infected.

*L. tropica* from cultures introduced into the sandfly *P. papatasii* (irrespective of the age and source of the strain of *L. tropica*) behaved exactly as *L. tropica* ingested by the sandfly from oriental sores, *i.e.* infection was always present in the uppermost end of the cardia, and in two cases out of twenty, flagellates were also found in the pharynx. Further, in cases of light infections the flagellates were confined to the uppermost part of the cardia only and, in some cases, sandflies which had fed on an emulsion of 100·000 flagellates per c.mm. were found to contain no flagellates at all. Passage of *L. tropica* from cultures through *P. papatasii* appears to increase the pathogenicity for man of the organism, as the following experiment shows.

A subculture made on August 27 from a culture taken directly on July 7 from an experimental human lesion was used for the experiment. September 15, Sandfly No. 172 (hatched in laboratory, September 15) *P. papatasii* ♀ fed on emulsion of culture (100·000 per c.mm.) September 26: Sandfly died and was dissected. Numerous flagellates were found in the midgut, particularly in the uppermost part of the