If, then, for any reason, summation is required for transneuronal conduction and temporal summation at the individual synapse does not occur while spatial summation occurs from many axonal terminations upon one cell but not in the reverse direction, transneuronal conduction can only occur in the direction in which it does occur in the reflex arc.

In brief, even though there be no irreciprocal property of the individual synapse, there may still be irreciprocity of transneuronal conduction.

Three characteristics of such conduction have in times past been commonly explained by attributing special properties to synapses. Lorente de Nó has demonstrated that the prolonged period of temporal summation in such conduction depends upon delay paths (Forbes) and reverberating chains of internuncial neurons and not on any protraction of the period of latent addition at the synapse itself. Gasser has already accounted for the inhibition in reciprocal innervation in terms of threshold changes in necessary internuncial neurons, instead of in terms of inhibitory synapses. Thus the explanation here offered for the irreversibility of conduction in the reflex arc, without the assumption of irreciprocity of the synapse itself, renders it now unnecessary to attribute to any individual synapse any property except that of a region of decrement.

W. S. McCulloch

DARWIN AND EARLY DISCOVERIES IN CONNECTION WITH PLANT HORMONES

In the November 19 issue of Science (p. 468) Professor N. Cholodny calls attention to the point that Charles Darwin first set forth the basic idea of the present hormone theory of tropisms, and that the subject is incorrectly treated in P. Boysen Jensen's "Die Wuchsstofftheorie" (G. Fisher, Jena, 1935), as well as in our English translation and revision of the book.[1]

Reference to the original text (p. 1) shows Darwin's name the first to be treated in the historical discussion of the subject, and Darwin (p. 405)[2] is quoted: "Wir müssen daher folgern, dass, wenn Sämlinge einem seitlichen Lichte frei ausgesetzt sind, ein gewisser Einfluss vom oberen Teil nach dem unteren hingeleitet wird, welcher die Ursache ist, dass sicht der letztere biegt." Similarly, on page 3 of the translation it is stated that Darwin (p. 474)[3] concluded "when seedlings are freely exposed to a lateral light, some influence is transmitted from the upper to the lower part, causing the latter to bend," and on page 4 in the pictorial treatment of the "historical outline of the early discoveries concerning plant growth hormones," Darwin's classic experiment is illustrated, together with those of other early workers. Cholodny cites Darwin as concluding that "these results seem to imply the presence of some matter in the upper part which is acted on by light, and which transmits its effects to the lower part." Boysen Jensen in 1910–11 supplied the *evidence* which enabled him to establish as a fact the opinion which Darwin expressed thirty years earlier; this evidence permitted the definite conclusion that the influence transmitted in tropic curvatures consists of a "substance or of ions."

If we erred or inadequately treated the work of Darwin or any other contributor to this field, it was entirely unintentional. We felt that Professor Boysen Jensen had, as a matter of fact, done a real service in calling attention to Darwin's work. No important mention of it has been found in English reviews published before the translation.

We had hoped that the pictorial treatment referred to above might be perfectly just to all workers, and at the same time illustrate the point so aptly brought out by Professor W. J. Robbins[4] in his reference to the history of growth substance discoveries: "This history, brief and fragmentary as it is, demonstrates that scientific knowledge accumulates slowly; that it does not spring full-formed from the mind of any one individual, but is the result of the contributions of many."

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[1] P. Boysen Jensen, "Growth Hormones in Plants." Translated and revised by Avery, Burkholder, Creighton and Scheer. McGraw-Hill. New York, 1936.

[2] C. and F. Darwin, "The Power of Movement in Plants." London, 1880.

[3] C. and F. Darwin, "The Power of Movement in Plants." D. Appleton-Century Co., New York. 1881.

[4] W. J. Robbins, *School Science and Mathematics*, 158–167, February, 1937.

NITROGEN IN THE NUTRITION OF TERMITES

The rôle of the symbiotic protozoa found in the hind-gut of certain species of wood-eating termites has been the subject of numerous investigations and is still a debatable question. Cleveland (1925)[1] cultivated reproductive colonies of termites for more than 18 months on a diet of filter paper and concluded that the termites could live indefinitely on a diet of pure cellulose, although he was at a loss to account for the source of nitrogen required for their forty-fold increase in weight. He concluded that "they must be able in some way to fix atmospheric nitrogen which

[1] L. R. Cleveland, "The Ability of Termites to Live Perhaps Indefinitely on a Diet of Pure Cellulose," *Biol. Bul.*, 48: 289–293, 1925.

they use in manufacturing proteins; or else, contrary to the current opinion, they must be able to transform carbohydrates into proteins." He was unable to demonstrate fixation of atmospheric nitrogen, and, as the other alternative is obviously impossible, the question of the source of nitrogen was left unanswered. Cook and Scott (1933)[2] have questioned the ability of termites to survive on a diet of cellulose, and presented data to show that termites require a diet including carbohydrates, proteins, salts and vitamins A, B, D and G. These authors used as criteria viability and group weight of non-reproductive colonies over a relatively short period of time, and also placed considerable weight on the presence or absence of cannibalism. These criteria are subject to some criticism because, as pointed out by Hendee (1935),[3] cannibalism often occurs in normal colonies on a natural diet of rotten wood. This might account for a decrease in weight and numbers during the first few months which could not be attributed to a deficient diet. Even though the termites may not be able to survive indefinitely on a diet of pure cellulose, as claimed by Cleveland, his data indicate that the colony lived and thrived for a surprisingly long time on a diet of pure cellulose.

Although the writers have never worked with termites they have been interested in the general subject of symbiosis between insects and microorganisms. While reviewing the work on termites and protozoa there occurred to them a possible explanation of the apparent ability of termites to thrive on a nitrogen-deficient diet. Because the writers probably will never have an opportunity of testing the hypothesis experimentally it is presented here for what value it may have.

The hypothesis is based on a possible nitrogen cycle within the termite colony. The symbiotic microorganisms, including protozoa, bacteria and spirochetes, are localized in an enlargement of the hind-gut *behind* the point where the Malpighian tubules enter the intestinal tract. The urates and other nitrogenous waste products excreted by the Malpighian tubules are probably utilized as food by the microorganisms and elaborated into protoplasm. Since anal feeding (the feeding on excreta of other individuals) is common among termites, the bacteria and protozoa or their dead bodies obviously are consumed by some individuals of the colony. Refaunation has been considered the principal function of anal feeding. It may also play a part in the nitrogen economy within the termite colony. The synthesis of protoplasm from urates by the protozoa and the utilization of the dead protozoa as food by the termites would permit the same nitrogen supply to be used over and over. In this way the metabolic processes of the termite colony could continue indefinitely as long as carbohydrates are available. The maximum size of the colony would of course be limited by the amount of nitrogen originally available in the bodies of the founders of the colony. Within this limit such a nitrogen cycle within the termite colony would permit the colony to live for a very long time on a diet apparently consisting of cellulose only.

It is also possible that some nitrogenous matter derived from dead protozoa within the digestive canal is absorbed directly through the anterior region of the hind-gut, especially since one of the functions of the ileum is absorption. If this occurs the nitrogen would be used over and over by a single individual, increasing still more the efficiency of the insect's nitrogen economy.

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QUOTATIONS

JUBILEE MEETING OF THE INDIAN SCIENCE CONGRESS

THIS week, the twenty-fifth meeting of the Indian Science Congress Association opens in Calcutta, the jubilee being marked by the attendance of a strong delegation from the British Association; Lord Rutherford was to have presided at the meeting, but fate decided otherwise, and the association has been fortunate enough to persuade Sir James Jeans to take his place. It may be hoped that this meeting will confirm the growing appreciation in India of the value of modern science.

In the address prepared for the meeting by Lord Rutherford before his death, he pointed out that prior to the first decade of this century scientific research in India was, with a few notable exceptions, confined to the great scientific services, initiated and maintained on a generous scale by the government, such as the Survey of India, the Geological Survey, the Botanical Survey, the Departments of Agriculture and Meteorology, and others. To the work of members of the Trigonometrical Survey we owe the principle of isostasy, while the development of the mineral resources of the country has been due largely to the activities of the Geological Survey. In forestry, the fine research institute at Dehra Dun is a monument

[2] S. F. Cook and K. G. Scott, "The Nutritional Requirements of *Zootermopsis* (*Termopsis*) *angusticollis*," *Jour. Cellular and Comp. Physiol.*, 4: 95–110, 1933.

[3] Esther C. Hendee, "The Rôle of Fungi in the Diet of the Common Damp-wood Termite, *Zootermopsis angusticollis*," *Hilgardia*, 9: 499–525, 1935.