

sequences in the two continents has recently been emphasised by Profs. Jongmans and Gothan². Many European species belonging to all the more important Carboniferous genera occur in Pennsylvania, West Virginia and Kansas in substantially the same sequence as that found in Europe; so close is the agreement that a fairly detailed correlation is proposed.

It may be possible to account for these facts by hypotheses other than that of continental drift, but I would suggest that they are of real importance in any discussion of the problem.

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June 3.

¹ NATURE, 135, 900, June 1, 1935.

² W. J. Jongmans and W. Gothan, "Florenfolge und vergleichende Stratigraphie des Karbons der Östlichen Staaten Nord-Amerika's. Vergleich mit West-Europa". Geol. Bureau Heerlen, Jaarverslag over 1933, pp. 17-44; 1934.

PROF. TRUEMAN, who has specially studied Carboniferous stratigraphy, makes an important addition to my brief article. Following Wegener, I merely mentioned that the theory of continental drift might explain the observed distribution of Carboniferous land and fresh-water life in the northern hemisphere. Prof. Trueman rightly emphasises the significance of the identity of succession of this life in widely separated areas. There can, indeed, be no doubt that identity in succession of whole faunas and floras in two distant regions is much more satisfactory proof of former connexion than the apparent identity of single groups to which I chiefly referred.

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Statistical Aspect of the Production of Primary Lesions by Plant Viruses

MR. BALD points out in NATURE of June 15 (p. 996) that an attempt to fit the equation $y = N(1 - e^{-ax})$ to data obtained by Samuel and Bald¹ meets with poor success, especially at high dilutions. Samuel and Bald plotted the logarithms of their counts against the logarithms of the dilutions and found that at high dilutions the points lay on a straight line with a slope of 0.6. It may be easily shown that the equation predicts a slope of unity. Data published recently by Price², Chester³, Caldwell⁴ and Beale⁵, give experimental curves with approximately unit slope. This suggests that the discrepancies between Samuel and Bald's experimental counts and values calculated from the equation may in a large part be due to the fact that their data are at variance with other measurements in the literature.

It is true that the equation gives low values at high dilutions, and this was pointed out and a possible explanation offered. It is also true that in this range more plants have to be used to obtain accurate results, since the error is a function of the total number of lesions. The use of log paper for plotting results exaggerates the weight of measurements at high dilutions.

Finally, the sixteen dilution curves fitted to this equation give no indication that its application, at least over a considerable range of dilution, is limited to highly purified virus preparations. Contrary to the idea that only certain cases were chosen, an attempt was made to include all published dilution

curves giving data at high enough concentrations to establish the nature of the curve. The lack of concordance between the dilution data reproduced in Mr. Bald's letter and the curves obtained by other workers indicates that Samuel and Bald's data cannot be used to condemn the validity of the equation.

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¹ Ann. App. Biol., 20, 70-99; 1933.

² Contrib. Boyce Thompson Inst., 4, 359-403; 1932.

³ Phytopath., 24, 1180-1202; 1934.

⁴ Ann. App. Biol., 20, 100-116; 1933.

⁵ Contrib. Boyce Thompson Inst., 7, 37-53; 1935.

Coagulation of the Blood as a Chain-Reaction

IN studies on the mechanism of the coagulation of blood, I have found that an active principle of coagulation is formed in the process of coagulation—a principle which can be transferred indefinitely into new plasma without decrease in its activity. In one experiment, 30 γ of an active phosphatide¹ was added to a certain amount of chick plasma. About one minute before coagulation took place, another similar portion of plasma was 'inoculated' with 0.03 c.c. of the first plasma, which was still liquid. Before coagulation of the second plasma took place a third portion of plasma was inoculated; then the coagulation time of the second plasma was recorded. Then a fourth portion of plasma was inoculated from the third, and the coagulation time of the third plasma was recorded. Inoculation of a series of plasmas was continued in this way successively until the original amount of active phosphatide added was diluted to $5 \times 10^{-10} \gamma$, and the experiment was discontinued. The clotting time was practically constant through all the passages.

Further experiments showed that the coagulation-active substance formed during the clotting process of blood plasma increases and disappears almost instantaneously at the very moment of coagulation. The formation of the active principle in the plasma occurs shortly after the 'inoculation' rather slowly, but it increases very rapidly until it reaches an explosion-like rate just before the plasma clots. As soon as the coagulation has taken place, the activity of the principle disappears almost completely. The curve plotted for the formation of active substance during the coagulation process has an exponential form.

A theory of blood coagulation as a chain-reaction finds support in our experimental facts. It is still an open question, on which work is proceeding, whether free radicals are produced during this process. As in chain reactions, we have here an initial reaction and a chain-interrupting reaction. The latter is indicated by the sudden decrease in activity when the substrate is used up. In our case the chain-reaction velocity is exponential, and should belong to such a type as foreseen by Christiansen and Kramers² and proved experimentally by Hinshelwood and Grant³ for the hydrogen-oxygen system. In this kind of chain-reaction more than one active molecule or free radical of the kind which started the reaction may be set free by any of the elementary reactions.

ALBERT FISCHER.

Carlsberg Foundation,
Copenhagen. May 15.

¹ Fischer, A., and Hecht, E., *Biochem. Z.*, 269, 115; 1934.

² Christiansen, J. A., and Kramers, Z. *phys. Chem.*, 104, 451; 1923.

³ Hinshelwood, C. N., and Grant, G. H., *Proc. Roy. Soc., A*, 141, 29; 1933.