Under life societies, the author takes up first the life of the ponds and pools that occur in moors. The algae, protozoa, rotifers and crustacea of the open waters are considered as well as the bottom fauna. The population is made up of ubiquitous forms and of those that are rather closely restricted to habitats of this character.

The moss turf usually holds a great deal of water which is well populated with a great variety of characteristic forms of algae, rhizopods, Turbellaria, rotifers and nematodes. In high moors the population is much smaller and the variety of organisms is rather limited. There is also a characteristic air-breathing fauna which shows considerable variation in composition in the different kinds of moors.

A bibliography of 178 titles is given.

C. JUDAY

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

Icones Plantarum Sinicarum. By H. H. HU and W. Y. CHUN. Fasc. 2, pp. 1–50, pl. 51–100. The Commercial Press, Shanghai, 1929.

THIS folio work prepared under the auspices of the Science Society of China and the department of botany, National Central University, Nanking, reflects distinct credit on both the authors and the publishers. Detailed descriptions in both English and Chinese of fifty indigenous species, together with important synonyms, geographic distribution, etc., are given. The figures, drawn natural size with enlarged details of the essential parts, are well executed and graphically represent the several species, many of which are here figured for the first time. The work is one that should be consulted by all botanists interested in the Chinese flora and in the preparation of monographic treatises.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

CHART ILLUSTRATING THE HISTORY OF BIOCHEMISTRY AND PHYSIOLOGY

MAY I be permitted to call the attention of the readers of SCIENCE to a recently published chart dealing with the history of the twin sciences of physiology and biochemistry?

This chart, which has been reproduced from the original by a lithographic process, gives a two-dimensional account of the historical development of these and cognate sciences. The arrangement is that of a graph, the vertical scale being in years and running from 1450 to 1900 with ten-year intervals marked off by horizontal lines. The lives of individual investigators are represented by continuous vertical lines beginning at the date of birth and ending at the date of death. Beside each such line is the name of the investigator in capital letters, with special signs indicating the university in which he was professor or the town where he worked. The vertical divisions group the investigators into anatomists, physiologists, biochemists, chemists, zoologists and philosophers. Diagonal wavy or dotted lines indicate relationships, controversies and succession in professorial chairs, and in this way also the main streams of intellectual influence are shown. At the date of publication of an important book or memoir, a thin horizontal line leaves the life-line of the investigator in question and leads to the title followed by a short description of the book. In addition to these descriptions there are quotations and notes interspersed throughout. In order to give an idea of contemporary events, the lives of men not biologists are shown in a separate column, *e.g.*, Galileo, Cervantes, Montaigne, Erasmus, Browne. Certain wars are also represented by vertical lines; the founding of associations such as the Royal Society is marked, and the beginnings of scientific journals noted. Before 1450 there is no regular time-scale, but the achievements of classical antiquity, the Hellenistic age and the dark ages are briefly referred to. The chart may be said to give a wide and detailed survey of the history of biochemistry and physiology, but its interest for biologists in general is considerable, as before 1800 the fields of study were not clearly differentiated, and until then the chart is practically a history of biology as a whole.

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FIXING THIN BLOOD SMEARS FOR STAINING WITH IRON HEMOTOXYLIN AND WITH GIEMSA'S STAIN

THE writer was unable to make satisfactory iron-hematoxylin preparations of blood smears that were fixed by the methods commonly in use because the erythrocytes retained this stain very tenaciously and, when they were finally destained, the chromatin of intracellular blood parasites was found to be likewise destained. The following modifications of well-known methods have, however, been made with success. Thin smears were dried in the same way as for Giemsa's preparations and fixation was completed by immersion in Schaudinn's alcoholic sublimate solution without acetic acid. The erythrocytes did not then take the hematoxylin, whereas the intracellular blood parasites stained well. In slides thus treated the cytological details of *Babesia bigemina* were brought out very clearly. Good results with iron-hematoxylin have also been obtained following wet fixation by formaldehyde. For this purpose the thin smears were dropped into a coplin staining jar that contained about 3 cc of 40 per cent. formalin and were then treated with alcoholic sublimate as for dried smears. The erythrocytes took the stain but were destained easily. It has been found difficult to make good dried smears of the blood of anemic cattle. This was especially the case when a high relative humidity retarded drying. The erythrocytes of such smears appeared full of air bubbles when examined under oil immersion. This difficulty has been overcome by the use of the wet formaldehyde fixation described above. Blood and blood parasites thus fixed stain well in Giemsa's.

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SPECIAL ARTICLES

A NEW BASIS FOR FERTILIZER EXPERIMENTS

EARLY in this century, Mitscherlich, the German experimenter of Königsberg, had discovered that the equation expressing the relation between yield of a crop and increase in the amount of a growth factor made available to the crop has the form

$$y = A(1-e^{-kx}) \quad (1)$$

in which y is yield per acre, x is the quantity of the growth factor available, A is the maximum yield obtainable by the use of any amount of the factor and k is a constant.

Some years later, the writer, without knowledge of Mitscherlich's work—I was not then interested in this field of research—discovered that this law has the form

$$y = A(1-R^x) \quad (2)$$

in which y, A and x have the same significance as in (1), while R is the ratio of a decreasing geometric series the terms of which are the increments of y corresponding to successive equal increments in x. I was also able to show that the e^{-k} of the Mitscherlich formula has the same significance as the R of my formula.

The German mathematician Baule pointed out, and Mitscherlich confirmed the same experimentally, that when two or more growth factors are varied simultaneously, this equation assumes the form

$$y = A(1-R_1^{x_1})(1-R_2^{x_2})(1-R_3^{x_3}) \quad (3)$$

in which x_1 represents the quantity of the first growth factor, R_1 the ratio of the series of increments in yield due to increases in this factor; x_2 and R_2 have a similar relation to the second growth factor; x_3 and R_3 to the third, and so on.

Equation (3) applies to plants grown in water or sand cultures, in which the only amounts of the first, second, etc., factors available are those supplied by the experimenter, and which are therefore measurable directly. The purpose of the present preliminary note is to point out that in field experiments, on a soil containing n, p and k available units per acre of nitrogen, phosphoric acid and potash respectively, the above formula takes the form

$$y = A(1-R_1^{n+x_1})(1-R_2^{p+x_2})(1-R_3^{k+x_3}), \quad (4)$$

and, further, to show how, with results from three fertilized plots, with suitable check plots, with sufficient replication to make the results reliable and with sufficient repetition from year to year to eliminate seasonal variations in yield, it is easily possible to calculate the values of the four constants A, n, p and k (the constants R_1, R_2 and R_3 are known from Mitscherlich's work) in equation (4), and then to use this equation for calculating the yield to be expected from the application of any quantities whatever of the three fertilizer ingredients, nitrogen, phosphoric acid and potash. The addition of other growth factors to the list requires only the addition of a single experimental plot for each factor, and, of course, the determination of the value of R for that factor. Mitscherlich has shown that the value of R is the same for all crops and all soils for a given growth factor when the unit of the growth factor is properly chosen.

The fertilizer treatment necessary on the four plots (three fertilized and one check plot) is shown in the following tabular statement:

	Units of fertilizer per acre			
	N	P_2O_5	K_2O	Yields
Plot 1.	a	0	0	y_1
" 2.	0	b	0	y_2
" 3.	0	0	c	y_3
" 4. (Check)	0	0	0	y_4

in which a, b and c are the respective amounts of nitrogen, phosphoric acid and potash, in units of 100 lbs. per acre, applied in fertilizer on the plots. The values of a, b and c should be such as to give considerable effect on yield so as to lessen the percentage