due to the portion of the electric field of the charges constituting the current which depends upon their acceleration. In the case of the open circuit under discussion the electromotive force along the central wire can not be calculated in any simple manner from Faraday's law, but it can be obtained at once from the series for the simultaneous electric field of a point charge given on page 40 of the writer's "Introduction to Electrodynamics." The necessary integration can be carried out without difficulty if we assume that the inner wire has a length small compared to that of the outer cylinder and is placed at the center of the latter. In this case the electric intensity along the axis is found to be

$$E = -\left\{\log\frac{1+\cos\vartheta}{1-\cos\vartheta} - \cos\vartheta\right\}\frac{di}{dt}$$

where both E and i are expressed in electromagnetic units and ϑ is half the angle subtended at the center of the tube by a diameter at either end. The current has been assumed to be uniform along the length of the tube, which would not be the case in the illustration previously mentioned. The electromotive force along the inner wire is obtained by multiplying this expression by the length of the wire. As the length of the outer conductor is increased $\cos\vartheta$ approaches unity and E becomes great without limit.

The electromotive force is the same as if the current were concentrated in a generating line of the hollow cylinder instead of being spread over its surface. Therefore we can check the formula given above by considering the former inner conductor to be one side of a rectangular circuit lying in the plane of the two conductors just considered and extending to infinity on the side away from the generating line. If we calculate the electromotive force along the long sides of the rectangle by the method employed above we get an expression per unit width of the circuit equal to the second term in the formula above, but opposite in sign. As the electromotive force in the distant short side of the rectangle is negligible, the total electromotive force around the entire circuit is given by the first term of the formula, for a rectangle of unit width. But if we calculate the magnetic flux through the rectangle and then compute the electromotive force from Faraday's law we are led to the same expression.

LEIGH PAGE

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SIR JAGADIS CHUNDER BOSE AND HIS LATEST BOOK

THE delicacy of the political situation in India, the prominence of the Bose family, the unusual taste for biology possessed by one of its members, the strain of mysticism in the minds of all the East Indians with whom we come into contact—these factors and their sequelae have produced a singular situation in the scientific world. As a result biologists, or at least botanists, may be divided, without serum-diagnosis, as Bosephile or Bosephobe: and to have a neutral reaction is taken to indicate either a degree of ignorance or a feebleness of backbone quite deplorable.

In the first place, there is no question that Sir Jagadis Chunder Bose is the most distinguished biologist in India. The wealth of his family has secured for him freedom from economic anxiety, has built and supported for him the Bose Institute in Calcutta, where, under his directorship, the study of reactions to stimuli in the living and the lifeless is carried on in accordance with his tastes and methods.

Bose's recent book, "Plant Autographs and their Revelations," is the address of an enthusiast to an audience conscious of ignorance and desirous of enlightenment. From its dedication to his wife, "who has stood by me in all my struggles," to the last paragraph, "Not in matter but in thought, not in possession nor even in attainments, but in ideals, is to be found the seat of immortality," one sees the idealist, the mystic, dealing with facts too few in number, too incompletely understood, too imperfectly apprehended in their relations, quite too inaccurately measured and recorded, to justify conclusions put forward as knowledge. The conclusions are interesting, suggestive though not new, and are entirely legitimate if correctly labeled: but they are not science, they are not knowledge; they are belief, they are a philosophy of life, a guide and interpretation of conduct.

The trouble with Bose, as I see it with my occidental eyes and my American mind, is that while his curiosity is directed to biological phenomena, his mind is inadequately equipped with the information and the habits necessary for accurate study, and his reflections are addressed to philosophical problems. He is practical minded to the extent of using self-recording apparatus in his laboratory and social institutions in his human relations, but his ambitions exceed his capacities, his critical faculties are not applied to his methods and their results, his vocabulary outruns his findings. This may be illustrated by a quotation, typical of the whole book in spirit and defects: pp. 183–185. "Autographic Record of Assimilation:" "Water plants obtain their carbon from the carbonic acid dissolved in water. When sunlight falls upon these plants, carbonic gas is broken up, the carbon becomes fixed in the form of organic compounds known as carbohydrates, and an equal volume of oxygen is evolved which rises as a stream of bubbles from the plant. The rate of evolution of oxygen indicates the rate of assimilation. Numerous difficulties were encountered in making this method practical; they have been overcome by my automatic recorder. A piece of a water plant, *e.g., Hydrilla verticillata,* is placed in a bottle completely filled with tank-water containing sufficient CO_2 in solution, the open end of which is closed by a special bubbling-apparatus, the bubbler, for measuring the oxygen evolved. The bubbler consists of a U-tube, the further end of which is closed by a drop of mercury acting as a valve. The oxygen evolved by the plant, entering the U-tube, produces an increasing pressure, which eventually lifts the mercury valve and allows the escape of a bubble of gas. The valve then immediately closes until it is lifted once more for the escape of another equal volume of gas. The movement of the mercury completes an electrical circuit, which either rings a bell or makes an electro-magnetic writer inscribe successive dots on a revolving drum (fig. 102). The automatic method eliminates all personal errors of observation; it is so extremely sensitive that it is possible to measure a deposit of carbohydrate as minute as a millionth of a gram. In illustration of the practical working of the apparatus I will give the following example. The plant with the apparatus is so placed as to face the northern light; the bell rings each time it has evolved a certain amount of oxygen representing an equal volume of absorbed CO_2. If a person now stands obstructing the light, the assimilation is slowed down and the bell now strikes at longer intervals. When strong sunlight is thrown on the plant, the successive strokes on the bell become greatly quickened. The plant is such a sensitive detector of light that it may be employed as a photometer for indicating the slightest variations in the intensity of the light of the sky."

I need not point out to the initiated the many individual faults, even errors, in this plausible and very interesting exposition, but certain comments may be made by the way. 1. Whatever may be the usage in India, or elsewhere in the English-speaking world, discussion has demonstrated that *carbon fixation* is a better term than *assimilation,* and that *photosynthesis* is still better because self-descriptive. 2. Water plants probably obtain as much carbon from carbonates and bicarbonates, where they are present, as from carbon dioxide which, in solution in water, may be *called* "carbonic acid." 3. "When sunlight falls upon these plants" much more happens than merely that "carbonic acid is broken up," for—to mention only one thing—the temperature rises, producing purely physical effects in the water, in the plant cells and tissues, and bubbles arise which are not wholly, and may not be even mainly, oxygen. Hence any apparatus devised to demonstrate photosynthesis and depending upon evolution of gas in water of unknown composition, of undetermined temperature, in unmeasured light, should be used for demonstration, graphic representation, but never for one moment considered as *measuring* "a deposit of carbohydrate." This has been recognized for so long in botanical laboratories in this country that the method is employed only on the lecture table, or in elementary laboratory experimentation.

I do not need to multiply quotations. "Resonant recorder," "acuity of perception," "the plant biophytum is found to be eight times more sensitive than a European and four times more so than a Hindu"—these also are fair samples of vocabulary, of deduction, and of aviation. It is a book as dangerous as it is fascinating. Would that it might be followed by a book of equal charm, but exhibiting the respect for the truth which keeps the occidental scientific man from mixing poetry, mysticism and grandiose generalization with his descriptions of the facts of nature! Nature is indeed more wonderful, more beautiful, more impressive than the products of man's imaginings, reflections and theorizings.

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WHEN IS MID-WINTER?

I HAVE long intended to answer the communication by Charles H. Briggs in SCIENCE for April 29, regarding the date of midwinter, but have delayed until I could speak from observational data. I have never before heard the shortest day called the middle of winter. One should hardly expect the coldest weather to fall then, for though it is the day when the hemisphere receives least sunshine, yet the general run of weather should continue to grow colder so long as the solar energy received per day is insufficient to replace the heat radiated to space. For this reason the curve of temperature shows a lag in phase as against that of sunshine.

Our texts of descriptive astronomy and most almanacs tacitly accept the amount of this lag as a month and a half, making the four seasons coextensive with the four quadrants of the sun's apparent motion, thus calling the shortest day the *beginning* of winter. This is an easy way of defining the seasons and one entirely independent of local conditions. Perhaps this last fact is one cause of its apparently wide acceptance.

In addition to the astronomical definition, Webster and other lexicographers give as the "popular" definition of the seasons, groups of three months each, beginning (for the U. S. A.) on March 1, June 1, September 1 and December 1, thereby antedating the astronomical seasons by three weeks. This has the