The pamphlet also contains a paper by Professor Ch. Richet on the physiological schedule, and reprints from this JOURNAL Dr. H. H. Field's article on the catalogue.

PROFESSOR ROWLAND'S table of solar spectrum wave-lengths originally printed in the *Astrophysical Journal* has been reprinted in a single volume containing 225 pages, and is offered for sale by the Press Division of the University of Chicago. The table gives the wave-lengths of nearly 20,000 lines measured from photographs made with the concave grating of the Johns Hopkins University.

BOOKS RECEIVED.

*Descriptive General Chemistry.* S. E. TILLMAN. New York, John Wiley & Sons; London, Chapman & Hall, Ltd. 1899. Pp. x + 429.

*Elementary Studies in Chemistry.* JOSEPH TORREY, JR. New York, Henry Holt & Co. 1899. Pp. viii + 487.

*Insects; Their Structure and Life: A Primer of Entomology.* London, J. M. Dent & Co. Pp. xi + 494.

## *SCIENTIFIC JOURNALS AND ARTICLES.*

THE *American Naturalist* for August opens with an article by Vernon L. Kellog on 'The Hopkins Seaside Laboratory,' calculated to make Eastern naturalists envious of the advantages enjoyed by their friends on the Pacific coast. J. A. Allen discusses 'The North American Arboreal Squirrels,' in view of Mr. E. W. Nelson's recent revision of the Southern species of the group. William Trelease gives a brief biographical sketch of 'Alvin Wentworth Chapman,' and Thomas H. Montgomery, Jr., continues the 'Synopsis of North American Invertebrates,' with a short account of, and key to, the Gordiaceæ. An interesting account of 'An Abnormal Wave in Lake Erie' is given by Howard S. Reed. There is an unusually large number of reviews of zoological publications, and in the correspondence Dr. Alex Hrdlicka considers 'The Needs of American Anthropologists,' the greatest of which he believes to be the establishment of an Anthropological Institute to form a common, independent center.

*The American Journal of Science* for Septemtember contains the following articles:

Gas Thermometer at High Temperatures, by L. Holborn and A. L. Day.

Flicker Photometer, by O. N. Rood.

Quantitative Investigation of the Coherer, by A. Trowbridge.

Double Ammonium Phosphates of Beryllium, Zinc, and Cadmium in Analysis, by M. Austin.

Separation of Iron from Chromium, Zircomium and Beryllium by the Action of Gaseous Hydrochloric Acid on the Oxides, by F. S. Havens and A. F. Way.

Albertite-like Asphalt in the Choctaw Nation, Indian Territory, by J. A. Taff.

Notice of a New Meteorite from Murphy, Cherokee Co., N. C., hy H. L. Ward.

Separation of Alumina from Molten Magmas, and the Formation of Corundum, by J. H. Pratt.

IT will be remembered that a department of agriculture for the British West Indian Islands was created last year with Dr. Morris, of Kew Gardens, as Director. We also called attention at the time to the agricultural conference held at Barbados in January. A further step in advance has now been taken by the establishment of a *West Indian Bulletin*, containing a number of articles on the agricultural problems of the islands. Like our agricultural bulletins, it is sent without charge to residents.

## *DISCUSSION AND CORRESPONDENCE.*

### DARK LIGHTNING.

TO THE EDITOR OF SCIENCE: I have been greatly interested by some photographs showing the rare phenomena of dark lightning, which have recently been sent to me. So far as I know, the only explanation that has ever been offered to account for them is photographic reversal, due to extreme brilliancy. This appears to me to be wholly out of the question for two reasons. In the first place, a dark line on the picture, resulting from over-exposure of a very brilliant line, would be surrounded by bright edges, due to the lesser photographic action in the halation region. This is never present, so far as I know, the dark flashes being minute dark lines ramifying from or in the neighborhood of the main discharge. Secondly, from what evidence I can gather, the dark parts of the flash are not those which appear most brilliant to the observer. Mr. Jennings, of Philadelphia, who in 1890 secured a remarkable picture, reproduced in *Photographic Times Annual* for 1891, showing a very brilliant flash with

countless dark flashes covering the sky around it, tells me that the appearance to the eye was a brilliant white discharge, with fainter rose-colored ramifications, the latter developing in the negative, or rather positive, as dark flashes. Some years ago it occurred to me that a dark flash might be produced by a preponderance of infra-red radiations, which, as Abney has shown, undo the work of ordinary light on the plate. If we had a form of discharge capable of giving off very little actinic light, and an abundance of infra-red light, it might come out dark on a feebly illuminated background. This is, of course, a very wild guess, with nothing to substantiate it, but the dark flash appears to be a reality, and a poor hypothesis is perhaps better than none at all.

I have recently thought that the phenomenon might perhaps be explained in another way. We have a flash which appears darker than the sky behind it. It is inconceivable that the discharge could render the air in its path opaque in the ordinary sense to white light But the light which illuminates the sky in the case of these pictures is not daylight, but light coming from another flash, that is made up of wave-lengths corresponding to the periods of vibration of the dissociated matter in the path of the discharge. Now, may it not be possible that in the dark flash we have a discharge, weak or nearly wanting in actinic light which, however, renders the air in its path capable of absorbing to some extent the radiations of the wave-lengths which come from the bright flash. Such a flash might possibly appear dark on a blackground feebly illuminated by light exclusively of these wave-lengths.

In other words, may we not have in the path of the dark flash, dissociated molecules, radiating but feebly, and capable of taking up vibrations of periods similar to their own, coming originally from a simultaneous brighter discharge?

It might not be impossible to reproduce the phenomenon by photographing a spark in front of a white background in an absolutely dark room. Sparks are almost always taken against a dark background, which would account for the absence of dark flashes in pictures of artificial discharges. A heavy main spark with lateral branches would seem the most suitable kind to employ.

The best method, however, of attacking the problem experimentally, it seems to me, would be a search for selective absorption in a partially exhausted tube. If the source of light were continuous any absorption would be unnoticeable unless it persisted for some time after the discharge (which is unlikely), for the time between successive discharges is very great in comparison to the actual duration of one of them. Even in the case of so-called continuous discharges produced by high potential storage batteries the discharge is often, and may always be, intermittent in character. The source of light should then be of no longer duration than the discharge occurring in the gas, the absorption of which is to be examined.

I can think of no way of producing a white or continuous spectrum source of as short duration as, and contemporaneous with, the discharge in the tube, but by employing two tubes differently excited, the one as a light source, the other as an absorption tube, some results might be obtained. Professor Trowbridge found that an argon tube emitted a blue light or red light, according to whether it was illuminated by means of an oscillatory or non-oscillatory discharge. By using the blue tube as the source and the red tube as the absorption tube, the two being arranged so as to be illuminated simultaneously, it might be found that the red tube had the power of absorbing to some extent the blue radiations from the other. I hardly think results would be obtained, but the experiment seems worth trying.

A picture taken by Mr. H. B. Lefroy, of Toronto, sent to me by Mr. Lumsden, Secretary of the Astronomical and Physical Society of Toronto, has some very curious appearances. There is an exceedingly brilliant flash running down the center of the plate, illuminating the sky quite brilliantly in its neighborhood. In its immediate vicinity, though not joined to it in any way, are innumerable dark, thread-like markings, which in places seem to cross each other, forming meshes.

Mr. Lumsden assures me that the testimony of all photographic experts who have seen the plate is to the effect that markings of that description could only be produced in the exposure; that is, they are not due to faults in the

film or the results of imperfect development. The fact that they are found only in the immediate vicinity of the bright flash is additional testimony in the same direction. These markings are wholly different from any that I have seen, not having the form of branched flashes. Something in their resemblance to photographs of sound-waves started by a spark, which I have recently made (see *Phil. Mag.* for August) suggested to me that they might possibly be due to the illumination of the sound-wave due to a powerful discharge by a second discharge. Under ordinary conditions, that is with a uniformly illuminated background, such waves would, of course, be invisible, but conditions might possibly arise, due to the proximity of black clouds, under which they might show—a sort of 'Schlieren Methode' on a large scale. I have not attempted yet to plan an arrangement of clouds, which, by acting as screens to light coming from certain directions, might render visible a region of the air, in which the optical density underwent a rapid change. In Mr. Lumsden's picture there are many dark clouds close to the flash. The idea of a photograph of a thunder-wave is a pleasing fancy at all events.

It seems to me that it will be impossible to formulate even a reasonable guess as to the cause of these dark flashes until a good many pictures are gotten together for comparison, and as much testimony as possible secured as to the appearance of the flashes to the eye. Personally, I have seen very few of the pictures and never the original negative.

My intention in writing this letter is not so much to advance theories accounting for the phenomenon of the dark-flash as to re-awaken an interest in the subject and bring out ideas from persons better qualified than I to treat the matter.

R. W. WOOD.

MADISON, WIS.

## A REPLY.

EDITOR OF SCIENCE: The review of my 'Elements of Practical Astronomy' by G. C. C., in SCIENCE for June 16th, criticises adversely some eight or ten small points. In so far as the article expresses the reviewer's individual opinions, there is no call for a reply, since that is the prerogative in which a critic should be protected. But I venture to say that the reviewer's zeal has led him unconsciously to make several erroneous statements.

In answer to the reviewer's remark: "Throughout his entire work the author appears to have ignored the advantage offered by addition and subtraction logarithms," I respectfully refer him to page 50, where both addition and subtraction logarithms are employed, and to the statement, p. 243: "If two quantities are given by their logarithms, and the logarithm of their sum or difference is required, it should be found by means of addition and subtraction logarithms." This covers the whole case.

The reviewer regrets that the book gives up '4% to diurnal parallax as affected by the earth's compression.' Such is not the case. Less than 2% is devoted to this subject, and in reality only about 1%, if we deduct the space demanded for the substitute treatment of the earth regarded as a sphere. Besides, the inclusion of this subject is imperative, unless, indeed, we exclude observations of meteors, the moon and any other near-at-hand bodies. Is G. C. C. willing to send out students of Practical Astronomy ignorant of the fact that there can be a parallax in azimuth? His criticism means just that.

The formula expressing the rate of a chronometer, p. 160, criticised in all seriousness by G. C. C., will meet his requirements if we replace the missing exponent 2 over the parenthesis—the only omission of the slightest consequence yet brought to my notice in the more than 400 equations. This formula is as fundamental in dealing with a chronometer as $\sin^2 + \cos^2 = 1$ is in Trigonometry, and should give a reviewer no trouble.

The reviewer refers to a well-known method of computing the azimuth, p. 199, and curiously enough misses the whole point of the method. He suggests another method—also well known—which in practical use is actually longer, with the added disadvantage of requiring two kinds of logarithms in the same solution. It is true that one solution by the first method requires 21 entries on the computation sheet (all the quantities being recorded), whereas the substitute