Paucker went to the college at Mitau, Struve obtained the degree of doctor of philosophy there and was soon made 'Observator' at Dorpat, where he remained a quarter of a century as professor. During his professorship at Dorpat he prepared lectures on the transit instrument, which were translated into French by a pupil, Lieut. Schyanoff, and are still an admirable textbook. Struve's ability attracted the attention of Tsar Nicholas I., and in obedience to his orders, Struve built and furnished the great central observatory at Pulkova, a suburban village near St. Petersburg. For the instruments he consulted the best mechanicians in Europe, especially the firm of Repsold of Hamburg. The observations at Pulkova were of the highest possible accuracy and were continued till Struve himself had retired from active service and had been succeeded by his son, Otto Struve, one of his most faithful students and an admirable observer. He died in 1864, and left the reputation of a scientific man, who had accomplished great results for the geography of his adopted country, and was one of the most practical astronomers of the present century.

George Biddell Airy, born in 1801, and surviving till 1892, was chiefly remarkable for the business-like routine which he introduced into the royal observatory at Greenwich, and for the example which was then set to less able astronomers of the manner in which they might conduct extensive operations connected with the vast study of the universe.

The writer considers himself not mistaken in assigning the position of astronomical science during the first half of the nineteenth century to the four philosophers mentioned in this brief paper, viz.: Gauss, Bessel, W. Struve and Airy.

TRUMAN HENRY SAFFORD.

WILLIAMS COLLEGE.

THE ELECTRIC FISH OF THE NILE.*

THE lecture dealt almost exclusively with the formidable fish found in the rivers of North and West Africa, *Malapterurus electricus*.

Photographs were shown of the drawings upon the interior of the tomb of Ti, showing that the fish was recognized as remarkable by the Egyptians five thousand years before the Christian era. Living specimens of the fish were also displayed, these having been given to the lecturer, for the purpose of illustrating the lecture, by the authorities of the Liverpool Corporation Museum.

The structure of the electrical organ was then described. It is situated in the skin enclosing the whole body of the fish, and has a beautiful and characteristic appearance when seen in microscopic sections. Each organ consists of rows of compartments, and each compartment has slung athwart it a peculiar protoplasmic disc shaped like a peltate leaf, with a projecting stalk on its caudal side. Nerves enter each compartment, and end, according to the recent work of Ballowitz, in the stalk of each disc. By these nerves nervous impulses can reach the organ; the arrival of such impulses at the nerve terminations evokes a state of activity which is associated with the development of electromotive charges of considerable intensity constituting the organ shock. The shock is an intense current traversing the whole organ from head to tail and returning through the surroundings; it stuns small fish in the neighborhood and can be felt by man when the hand is placed near the fish, as a smart shock reaching up the arms to the shoulders.

Recent investigations made by the lecturer at Oxford in conjunction with Mr. G. J. Burch were next described. These comprised a large series of photographic records of the displacement of the mercury of a

* Abstract of a lecture before the Royal Institution of Great Britain.

capillary electrometer in consequence of the electrical disturbance in the organ which is 'the organ shock.' A number of these records were exhibited; they showed the time relations, mode of commencement and manner of subsidence of the shock, and demonstrated its similarity to the electrical changes known to exist in nervous tissue during the passage of a nervous impulse. A remarkable feature of the organ shock as distinct from the phenomena of nerve was then brought forward. The shock even when evoked by a single stimulus was shown to be rarely if ever a single one. Each effect consists of a rhythmical series of electrical changes occurring one after another in a perfectly regular manner at intervals of $\frac{1}{100}''$ to $\frac{1}{300}''$, the rate depending upon the temperature. By special experiments it was shown that this rhythmical series is due to self-excitation, each change producing an electrical current of sufficient intensity to excite the nerves of the tissue in which it was generated. It follows that only the initial member of the series need be evoked by nervous impulses descending the nerves, since the others must then ensue. The potency of the organ as a weapon to be wielded by the fish is thus enormously increased by its resemblance to a self-loading and self-discharging automatic gun. The total electromotive-force of the whole organ in a fish only eight inches long can reach the surprising maximum of 200 volts, at any rate in the case of the initial shock. The attainment of this maximum is due to the simultaneous development of perfectly similar electromotive changes in each of the two million discs of which the organ is composed. In a single disc the maximal electromotive force only amounts to from .04 to .05 volt, and since in a small nerve an electrical change of .03 to .04 volt has been observed, the large total effect is not due to any extraordinarily intense electrical disturbance in each tissue element, but to the tissue elements being so arranged that the effect in one augments those simultaneously produced in its neighbors.

Finally, the remarkable characters of the nervous connections of the organ were described. Each lateral half of the organ, although it has a million plates receiving nerve branches, is innervated by one single nerve fiber and this is the offshoot of a single giant nerve-cell situated at the cephalic end of the spinal cord. The structure of this nerve-cell was displayed by means of microscopic sections and by wax models made by G. Mann, of Oxford. As regards the nervous impulses which the fish can discharge through this nerve-cell, experimental results were described which show that the fish is incapable of sending a second nervous impulse after a preceding one until a period of $\frac{1}{10}$ second has elapsed, and that this interval is rapidly lengthened by fatigue to as much as several seconds. The inability of the central nervous system to repeat the activity of the organ obviously presents disadvantages to the use of the shock as a weapon for attack or defence, but such disadvantage is more than counterbalanced by the property of the organ alluded to in the earlier part of the lecture, viz., that of self-excitation, since a whole series of shocks continue to occur automatically in rapid succession provided that an initial one has been started by the arrival of the organ of a nervous impulse sent out from the central nerve-cell.

FRANCIS GOTCH.

SCIENTIFIC BOOKS.

The Elements of Alternating Currents. By W. S. FRANKLIN and J. WILLIAMSON. New York, The Macmillan Company. 212 pages.

This book gives an exposition, or rather introduction into the engineering methods of investigation, that is, those methods which are used in practice to investigate the phenomena taking place in alternating circuits, and to design alternating apparatus.