shorter, and in some cases of a slighter character; for example, the excerpts from the technical journals on various questions of electrical practice; but the reader who wishes to follow Lord Kelvin in his more abstract speculations will find plenty of occupation in this volume also. There are his papers on molecular and crystalline theory, which are heroic attempts to find mechanical explanations of such things as the pyroelectricity and piezoelectricity of crystals, and the known chemical and physical properties of gases, liquids, and solid crystalline substances.

That one man should have attacked with so much success so many subjects of transcendent difficulty is a great marvel. But our wonder is mingled with regret that his mind should have been distracted so much as it was from the great themes with which it was pre-eminently fitted to deal. The turning from one thing to another probably, however, did not result in so much dissipation of its energy as might be supposed. He obtained mental refreshment by change of the objects of thought, and often when he returned to the consideration of difficulties obtained their solution with unexpected facility.

The work of editing has been excellently performed by Sir Joseph Larmor. He has appended notes here and there, but with a reverent frugality, and in their substance they are short and to the point.

A. G.

THE NUCLEI OF THE PROTISTA.

Die Konstitution der Protistenkerne, und ihre Bedeutung für die Zellenlehre. By Prof. Max Hartmann. Pp. v+54. (Jena: Gustav Fischer, 1911.) Price 1.60 marks.

THIS paper is an extended version of a lecture delivered by Dr. Hartmann at the International Zoological Congress in 1910. It is an attempt to obtain a simple interpretation of the many complex nuclear conditions recorded in the Protista.

By "constitution" Dr. Hartmann means "morphogenetic constitution," and it appears from his paper that "Protista" means—as is so usual—chiefly the Protozoa.

Dr. Hartmann's views are not easily given or criticised in a short space, for they contain much that is purely hypothetical and highly controvertible. He insists, in the first place, upon the universal occurrence of a centriole in all protists—a contention that is not likely to find universal acceptance. The cyclical changes (centrifugal and centripetal streaming) undergone by this body are also insisted upon.

Nuclei are classified as "monoenergid" and "polyenergid"—"energid" being used in a sense different from that of its inventor, Sachs. Monoenergid or univalent nuclei (e.g. in *limax* amœbæ) consist of two components—idio-generative (chromosomes) and locomotor-generative (centrioles, polar caps, &c.). The power of polar division is an important attribute of the locomotor component. Polyenergid nuclei (e.g. those of Radiolaria) are those which are really not simple, but multivalent, containing many individual-

ised univalent nuclei inside them. These are the "chromosomes" (e.g. in Aulacantha), which are really not chromosomes but nuclei.

Mitosis in the Protozoa is accordingly univalent or multivalent, according as the nucleus is monoenergid or polyenergid. From which it follows that the nuclei and their mitoses are not homologous throughout the Protista. There is no true amitosis in any protist—the process now so called being designated "promitosis."

We are glad to see that Dr. Hartmann now rejects the "box within box" trophokinetic binuclearity hypothesis which he formerly advocated so strongly, and now regards binuclearity—formerly of universal occurrence—as exceptional in the Protista. "Generative chromidia" he regards as monoenergid nuclei which have escaped from a polyenergid nucleus. The formation of new nuclei from chromidia is therefore "explained"—the nuclei are really there all the time, but at last become visible. There are also numerous other curious interpretations of protozoan nuclei resulting from Dr. Hartmann's hypothetical considerations. Thus, the mitotic figure of *Acanthocystis* is really not an ordinary mitotic figure, but a composite figure composed of two nuclei which simulate one. It may be noted, however, that the interpretation of monoenergid nuclei as consisting of two components is, in reality, merely a variant of Dr. Hartmann's former binuclearity hypothesis, become more complex by the introduction of polyenergid nuclei.

The relation of protozoan nuclei to metazoan nuclei and the constitution of the latter, is only briefly and hesitatingly considered. Dr. Hartmann thinks that all the chromosomes of a univalent protozoan nucleus are homologous with only one chromosome in a metazoan nucleus. Chromosomes in the former correspond with chromioles in the latter. Metazoan nuclei are, for the most part, polyenergid—the chromosomes being nuclei (or energids in Hartmann's sense). "Only the simple monoenergid atypical amœbæ and similar forms can be considered as elementary organisms in the sense of the cell theory." The union of the ovum and spermatozoon in Metazoa is not homologous with the conjugation of two protozoan gametes: for the latter are monoenergid, the former polyenergid.

Dr. Hartmann's ideas are discussed at some length in numerous special cases in the Protozoa, with the aid of figures copied from other works. There are several misprints in the text, and I may point out that "Herr Newin" referred to on page 18 is my friend and former pupil Mr. K. R. Lewin. His conclusions are at present indefinite, and do not warrant what Dr. Hartmann says of them.

Whether Dr. Hartmann's speculations will turn out to be well-founded or not, future work will determine. For our own part, we by no means agree with all his interpretations. But they will, no doubt, give rise to further discussion and analysis of a difficult problem, and thereby perhaps lead eventually to a better understanding of the nuclei of the Protista.

C. CLIFFORD DOBELL.