biana zoologiae professor, qui saltationes illas *karyokinesis* nomine nuncupatas descripsit, quas ovorum in cellulis dividendis nucleorum fragmenta certatim exercent. In insectis autem nonnullis, docente doctore nostro novo, determinatur sexus, prout nucleorum fragmentum unum aut adest aut abest. Genus femininum tot fragmenta efficiunt; fragmenta uno tantum minora masculinum. Videtis, Academici, discrimine quam tenui genus masculinum a genere feminino separetur, ne dicam superetur.

CHARLES RENÉ ZEILLER, PROFESSOR OF PALÆOBOTANY IN PARIS.—E tot doctoribus supremus adest Francogallorum Instituti celeberrimi socius, palaeobotanicae professor praeclarus Parisiensis, qui iam per annos triginta plantas fossiles (ut aiunt) accuratissime examinavit; Africae, Americae, Indiae, Asiae Minoris flores extinctos non sine summo iudicio, non sine summo ingenio, investigavit. Viri huius auxilio, Florae antiquae e monumentis non iam unum alterumve capitulum perbreve, non iam paginae cuiusque lineae paucissimae, sed novae paginae plurimae, orbis terrarum quasi vitae perpetuae ad catenam continuam anulos novos addiderunt.

> "Sic unumquicquid paulatim protrahit aetas
> in medium, ratioque in luminis erigit oras.
> namque alid ex alio clarescere et ordine debet
> *omnibus*, ad summum donec venere cacumen."[1]

Rerum naturae seriem aeternam claudit *Homo sapiens*: honorum nostrorum seriem hodiernam claudit vir in Flora antiqua sapientissimus, Carolus Renatus Zeiller.

A NEW ANALYTICAL ENGINE.

THE April number of the Scientific Proceedings of the Royal Dublin Society contains an interesting and very original paper by Mr. Percy E. Ludgate on a proposed analytical machine. Of all calculating machines, the analytical machine or engine is the most comprehensive in its powers. Cash till reckoners and adding machines merely add or add and print results. Arithmometers are used for multiplying and dividing, which they really only accomplish by rapidly repeated addition or subtraction, with the exception alone, perhaps, of the arithmometer of Bollée, which, in a way, works by means of a mechanical multiplication table. Difference engines originated by Babbage produce and print tables of figures of almost any variety, but the process is one of addition of successive differences. The analytical engine proposed by Babbage was intended to have powers of calculation so extensive as to seem a long way outside the capacity of mere mechanism, but this was to be brought about by the use of operation cards supplied by the director or user, which, like the cards determining the pattern in a Jacquard loom, should direct the successive operations of the machine, much as the timing cam of an automatic lathe directs the successive movements of the different tools and feeding and chucking devices. However elaborate the mechanism of Babbage, if completed, might have been, the individual elements of operation would, so far as the writer has been able to understand it, have been actually operations of addition or subtraction only, and, with the exception of the method of multiplication created by Bollée, the writer does not recall any case in which mechanism has been used to compute numerical results except by the use of the processes of addition or subtraction, simple or cumulative. Of course, harmonic analysers and other instruments depending on geometry are not included in the category of machines which operate on numbers.

The simplicity of the logarithmic method of multiplying must have made many inventors regret the inherent incommensurability of the function to any simple base, or, if commensurability is attained for any particular number and its powers by the use of an incommensurable base, the incommensurability of the corresponding logarithms of numbers prime to those first selected. On this account the writer has always imagined that the logarithmic method was unsuited to mechanism, or, if applied at all, could only be so applied at the expense of complication, which would more than compensate for the directness of the process of logarithmic multiplication.

Mr. Ludgate, however, in effect, uses for each of the prime numbers below ten a logarithmic system with a different incommensurable base, which as a fact never appears, and is able to take advantage of the additive principle, or, rather, it is so applied that the machine may use it. These mixed or Irish logarithms, or index numbers, as the author calls them, are very surprising at first, but, if the index numbers of zero be excepted, it is not difficult to follow the mode by which they have been selected. The index numbers of the ten digits are as follows:—

Digit	...	...	0	1	2	3	4	5	6	7	8	9
Index number.			50	0	1	7	2	23	8	33	3	14

When two numbers are to be multiplied, the index numbers of the several digits are mechanically added to the index numbers of each of the digits of the other, and, the process of carrying the tens being carried on simultaneously, the time required is very small. For instance, the author gives as an example the multiplication of two numbers of 20 digits each, which will require 40 of these additions, which he shows will require $9\frac{1}{2}$ time units if a time unit is one-tenth of the time of revolution of a figure wheel.

Unfortunately, while the principle on which the proposed machine is to work is described, only the barest idea of the mechanical construction is given, so that it is difficult to judge of the practicability of the intended construction. Whatever this may be, the originality of the method of mixed commensurable logarithms to incommensurable bases seems to the writer so great and the conception so bold as to be worthy of special attention.

Division has hitherto always been effected by the process of rapid but repeated subtraction, following in this respect the method practised with pencil and paper. Having discovered how to harness the logarithm to mechanism, Mr. Ludgate would, it would be expected, have managed to effect division by a logarithmic method, and possibly he could have done so, but here again he has left the beaten track, and by his ingenuity has made division a direct, and not, as hitherto, an indirect or trial-and-error process. Starting with a table of reciprocals of all numbers from 100 to 999, which in a mechanical form is intended to be stored in the machine, he imagines both numerator and denominator of the required fraction p/q to be multiplied by the reciprocal A of the first three digits of q so as to become Ap/Aq. Aq must, then, in every case begin with the digits 100, and it may be written $1+x$, where x is a small fraction. Then $p/q = Ap(1-x)(1+x^2)(1+x^6)(1+x^8)\ldots$ a highly convergent series of which five terms will give a result correct to twenty figures at least, and so division is intended to be effected by a process of direct multiplication.

Until more detail as to the proposed construction and drawings are available it is not possible to form any opinion as to the practicability or utility of the machine as a whole, but it is to be hoped that if the author receives, as he deserves, encouragement to proceed with his task, he will not allow himself to become swamped in the complexity which must be necessary if he aims at the wide generality of a complete analytical engine. If he will, in the first instance, produce his design for a machine of restricted

[1] Lucretius, v. *ad finem.*

capacity, even if it does no more than an arithmometer, he will, by demonstrating its practicability and advantages, be more likely to be enabled to proceed step by step to the more perfect instrument than he will if, as Babbage did, he imagines his whole machine at once. In the writer's opinion, the ingenuity required to arrange a complete analytical engine is really in great part misplaced. Such a machine can only be used and kept in order by someone who really understands it, and it would seem to the writer of this notice more practicable to allow the user's attention to replace the action of operation cards, and leave to the machine the more direct numerical evaluations.

C. V. BOYS.

PROF. D. J. CUNNINGHAM, F.R.S.

THE death of this eminent anatomist occurred on Wednesday of last week, June 23. It was known that Prof. Cunningham had been ill for several months, but the fatal nature of the illness was not at first recognised, and the news of his untimely death in the full vigour of his powers will have come as a shock to many of his friends, and their name is legion.

Daniel John Cunningham was born in April, 1850, at Crieff, where his distinguished father, who was later to become principal of St. Andrew's University, was then the minister. His school days were passed at Crieff Academy. At the age of seventeen he was sent to Edinburgh University, and began the study of medicine. Here he had a brilliant career as a student, and in 1874 took his M.B. degree with first-class honours. In 1876 he proceeded to the M.D. degree, the subject of his thesis being "The Anatomy of the Cetacea"; for this he was awarded a gold medal. His work on this subject was performed in the anatomical department of the university, where he was acting as assistant demonstrator to Prof. Turner; the influence of the master is apparent in the work of the pupil.

In 1876 Cunningham became principal demonstrator of anatomy, a position of much responsibility, as well as of great advantage to the holder from the experience in anatomical work and in teaching which it offers. Of this experience he took full advantage, and his high qualifications were recognised when he was appointed in 1882 to the chair of anatomy in the Royal College of Surgeons in Dublin. This appointment was not long held by him, for in the following year his services were transferred to the much more important chair of anatomy in Trinity College. Here he remained until 1903, when, on the retirement of Sir William Turner from the professorship of anatomy in the University of Edinburgh, it was felt that there was only one man worthy to succeed him, and the invitation which was tendered to him by the Curators of Patronage was, not without some hesitancy, accepted by him.

The hesitancy—even in view of the higher emolument and larger sphere of usefulness which the appointment to his Alma Mater involved—is not difficult to understand. For Cunningham had endeared himself to Dublin by many close ties; he was the centre of a large circle of intimate friends, and his influence and interests were in no way confined within the walls of the university, but extended to all circles of society. For several years he acted as secretary, and for some time as president, to the Royal Zoological Society of Ireland, and the effect of his work is apparent in the splendid condition of their menagerie, which is, for its size, probably the most successful in Europe. He was a constant attendant at the famous Saturday morning breakfasts of the council, and on leaving Dublin for Edinburgh was the recipient of a silver bowl engraved with the signatures of his fellow-members, a testimonial which he prized with pleasurable pride. During four years he was honorary secretary to the Royal Dublin Society. He was frequently consulted on scientific questions by the Viceregal Government, who in 1900 appointed him a member of the commission to inquiry into the condition of the inland fisheries of Ireland. In the same year he was sent out to South Africa as a member of the Royal Commission to inquire into the care of the sick and wounded in the war. He also served on a War Office committee to report on the physical standards required for candidates for commissions and recruits.

But the performance of these public duties was not allowed to interfere with his scientific work. Both before and after his appointment to Dublin his communications on anatomical subjects were numerous and important. His text-books on "Practical Anatomy" and on "Systematic Anatomy"—the latter edited and in part written by himself—have a large circulation. His "Memoir on Cornelius McGrath, the Irish Giant," which was published by the Royal Irish Academy in 1891, is a model of exact anatomical description, and was influential in pointing to the analogies between the conditions of gigantism and those met with in acromegaly, a disease to which attention had shortly before been directed by Marie, who was the first to associate it with tumour of the pituitary body. No less important is his "Memoir on the Surface Anatomy of the Cerebral Hemispheres," which was published in 1892. In 1902 he delivered the Huxley memorial lecture before the Anthropological Institute, the subject of the lecture being "Right-handedness and Left-brainedness."

On his transference to Edinburgh in 1903, Cunningham's activities were in no way diminished, and his influence was immediately felt both in the university and in scientific and medical circles of the city. His genial personality at once won the hearts of the students, who were no less attracted by his powers of exposition. The confidence of his colleagues was manifested by his early election to fill the position of dean of the faculty of medicine. This confidence proved well-merited, for, under his auspices, the scheme of reform of the medical curriculum which had been for years in a condition of suspended animation was re-invigorated, and before long passed through all its stages, which in a Scotch university are more complex and difficult than those of a Bill in Parliament. As a member of the council and as secretary of the meetings, he took an active part in the work of the Royal Society of Edinburgh, and was instrumental in improving the form and character of its published Proceedings. He effected a similar change in the *Journal of Anatomy and Physiology*, of which he became acting editor, and to which he had always, either personally or through his pupils, been in the habit of contributing articles. He continued to take a keen interest in the public services, and was prominent in the movement for the establishment of a medical equipment of the Territorial Force in the East of Scotland.

Cunningham's eminence in science has been recognised on many occasions. He was elected in 1891 to the Fellowship of the Royal Society, and in 1898 served on its council. The Universities of Dublin, Oxford, St. Andrews, and Glasgow conferred upon him their honorary degrees. He was president of the Anatomical Society and of the anthropological section of the British Association, and at various times was examiner in most of the universities of the United Kingdom.

Of Cunningham's personal character it is impossible