thinning out, rearranging, and adding fresh supplies, relays of young oysters in their first year may occupy the ambulances for eight months, although an individual oyster may only be in for a month or so.

Eventually all the oysters not sold to éleveurs get transferred from the ambulances to the open rectangular areas, like little fields, which make up the rest of the parc. The low banks bounding these areas are formed of two parallel rows of close-set vertical bunches of the local heath, *Erica scoparia*, with the space between, a foot or more wide, filled in with masses of a tenacious clay obtained from the Ile des Oiseaux. Planks of wood and stakes, to strengthen the boundary, are also used in places, and at one corner a sluice is formed, so that the water at low tide may either be retained to a depth of 6 or 8 inches, or allowed to run off as required. About one million oysters can be accommodated in each little field, which is about at the rate of 125 to the square metre. Going thoroughly over a parc, partly in a boat and partly by wading, gives one an excellent idea of the extensive and profitable system of aquiculture practised at Arcachon.

Between neighbouring oyster parcs, and surrounding the "concessions" of the various proprietors, run lanes of water about 4 metres wide. These give ready access to the parcs, and can be traversed by the long gondola-like boats of the parqueurs. The lanes are bordered by rows of tall saplings with bunches of twigs left on. These are called "pignons." They keep waving in any slight breeze, and give a characteristic appearance to the scene. The oyster men declare that they are of use in frightening away fish, and especially the voracious ray *Myliobatis*, which might otherwise do great damage in the preserves. Possible depredations of another kind are guarded against by the "pontons," or large barges, moored at the corners of the parcs in which the "gardes des pêches" live.

Great numbers of the oysters bred and reared through their early stages at Arcachon are sent to Marennes and La Tremblade, in the flat district on both sides of the estuary of the Seudre, to be fattened in a *parc d'élevage*, and "greened" by feeding upon the diatom *Navicula fusiformis*, var. *ostrearia*. Wide canals from the estuary lead the sea-water inland, and supply the numerous "claires," which are merely shallow artificial ponds excavated in the clay and marly soil. In spring and early summer the muddy floor of the claire undergoes a good deal of preparation by digging, cleaning, draining, and exposure to sun and air, in order that later on, when sea-water is re-admitted, at first in small quantity, it may be in what has been found by experience the most favourable condition for the growth of the desired kinds of lower algæ. These soon cover the floor with a dense green growth, which the éleveurs recognise as being of great importance to the nutrition of the oysters. Samples of the growth which I collected from the bottoms of several claires consisted of *Cladophora flavescens* and *C. expansa*, along with *Spirulina tenuissima* and a *Lyngbya* and little tufts of *Calothrix*, while a more detailed examination with the microscope shows that these plants are teeming with small animals and other forms of life, and nearly everything is covered with innumerable diatoms. Probably the larger green algæ, thought so much of by the éleveurs, are only of importance in oyster culture in providing points of attachment and shelter or favourable environment for the microscopic forms of life, and especially for the diatoms. It is well known that diatoms form a most important constituent of the food of oysters, and that the greenish blue tint of the celebrated Marennes oysters is due to the presence in the claires of enormous quantities of *Navicula fusiformis*, var. *ostrearia*, upon which the oysters feed. This form is found in our own fishery district in the estuary of the Dee (and probably elsewhere), although not abundantly; but it is probable that there are various other allied diatoms that would do equally well for rearing and fattening oysters on, and as a matter of fact the examination of the contents of an oyster's stomach shows that the food consists of a number of different kinds of diatoms as well as other minute organisms.

Altogether, all the evidence I was able to collect shows, I think, that the bottom of a claire is teeming with microscopic life, and that it is probably this rich feeding *alone* which is necessary in order to bring the oysters, in a very short period—a few weeks usually, sometimes ten days or a fortnight is sufficient—to the desired condition of fatness and flavour. The autumn and early winter months are said to be the best for fattening and greening.

I shall have to omit all reference to the industries at Pointe le Chapus, at the Island of Oléron, at La Rochelle, at Les Sables d'Olonne, and at Le Croisic—except a brief explanation of the basins of "dégorgement" seen at Le Chapus and elsewhere. These are shallow tanks, high up on the beach, with smooth bricked or tiled floors, so that they can be kept clean and free from mud. Their purpose is to enable the oysters taken fresh from the parcs and claires, and which naturally have some fine mud and food-matters of a decomposable nature clinging to them, both externally and internally, to lie for a few days in clean water, and so get rid of their impure mud and excreta before being packed up and sent off on a journey. The oysters also become accustomed in these basins, which can be emptied and filled with water periodically, to close their shells and stand prolonged exposure to air.

I do not see that the French shores are, in any important respects better fitted for shell-fish culture than some parts of our own Lancashire and Cheshire coast.[1] The deposits, both littoral and submarine, are, on the whole, much the same, the fauna, both macroscopic and microscopic, is scarcely appreciably richer, and although the temperature of the water is decidedly higher in the south—probably on the average about 10° F. higher in summer—I do not think that that is an essential condition, *so long as the winter temperature of our water does not get too low*. It would certainly be necessary, I think, to keep our oysters completely submerged during the winter months; but there are several places in the estuaries of the Dee and the Ribble, and in the Barrow Channel near Roe and Peil Islands, where "littoral" cultivation in summer might be combined with "bedding out" in winter—somewhat as is done at present with American oysters in the estuary of the Wyre, near Fleetwood. As to the other conditions—of bottom, of water, and of food, several places in the Barrow Channel and in the Dee estuary seem to me to be well fitted for oyster culture.

ENDOWMENT FOR SCIENTIFIC RESEARCH AND PUBLICATION.[2]

I.

TWENTY years ago Prof. Tyndall delivered in New York and in other cities of this country a series of lectures upon light. The last of the series was an impressive plea for a more thorough prosecution of original research in pure science; and incidentally, for the need of endowments to maintain it. I was fortunate in having the opportunity to listen to that remarkable course of lectures, and to that plea for science. Its impression has never left me. The impression was the deeper, because Tyndall set upon it the seal of self-denial. Some 30,000 dols., nearly the entire net proceeds of his lectures in the United States—money for which he undoubtedly had abundant use in his own affairs, or at least in the prosecution of researches in his own country, and which by all precedent and the example of other lecturers he would have taken with him—this he has given to the science of this country, endowing therewith, in 1885, three scholarships for the prosecution of original research in physics, one under the direction of Columbia College, one under Harvard, and a third at the University of Pennsylvania.

The truths uttered and the example set by this self-denying master have already many times borne fruit. The late President Barnard, of Columbia College, who was a warm supporter of Prof. Tyndall when here, bequeathed to Columbia upon his decease a few years since the sum of 10,000 dols. for the endowment of another fellowship for the encouragement of scientific research, upon substantially the same terms as those of the Tyndall scholarships. In other parts of the country there have been some other endowments for similar purposes. In the last year Columbia has also received 100,000 dols., the munificent bequest of Mr. Da Costa, for the establishment of the department of biology. Although this bequest is not primarily for the prosecution of original research, it is not restricted by hampering conditions, and will to some extent, it is hoped, admit of a direct and continuous support of the highest and most advanced studies.

The appeal made by Tyndall has been often renewed by

[1] This, being a report to the Lancashire Sea-Fisheries Committee, is only concerned with localities within the Fishery District.

[2] Address delivered by Mr. Addison Brown, at a meeting of the Scientific Alliance of New York. (Reprinted from Smithsonian Report, 1892.)

scientific men; by the heads of universities; by the presidents of scientific associations, here and abroad; and by none, perhaps, more eloquently than by Dr. Edwin Ray Lankester, in his address before the biological section of the British Association at Southport, in 1883.

What shall we say to the call and the examples of such men? Was the gift of Tyndall based only upon an idle fancy? Or was it the result of a clear perception of a profound truth, viz. America's need of that money as a stimulus and support to more scientific research; the call on him being felt to be the more imperious, because the need of it was so plain to him, while obscure to others; and making his act, therefore, a noble instance of self-renunciation in an unappreciated cause?

"To keep society as regards science in healthy play," he says, "three classes of workers are necessary:

"(1) The investigator of natural truth, whose vocation it is to pursue that truth and extend the field of discovery for truth's own sake, without reference to practical ends.

"(2) The teacher, to diffuse this knowledge. . . .

"(3) The applier of these principles and truths to make them available to the needs, the comforts, or the luxuries of life. . . .

"These three classes ought to coexist and interact. The popular notions of science . . . often relate, not to science strictly so-called, but to the application of science."

The great discoveries of scientific truth, he continues, are "not made by practical men, and they never will be made by them; because their minds are beset by ideas which, though of the highest value in one point of view, are not those which stimulate the original discoverer."

In a chance conversation, a few weeks since, I received a confirmation of these words, so direct and unexpected, that it may bear citation. I was talking with an electrical expert who had made several very interesting and important inventions. I asked him of how much importance he conceived that the scientific men of the closet, the original investigators, so-called, had been in working out the great inventions of electricity during the last fifty years—the telegraph cables, telephones, the electric lighting, and the electric motors; and whether these achievements were not in reality due, mainly, to the practical men, the inventors, who knew what they were after, rather than to the men of science, who rarely applied their work to practical use?

"Not at all," he said, "the scientific men are of the utmost importance; everything that has been done has proceeded upon the basis of what they have previously discovered, and upon the principles and laws which they have laid down. Now-a-days we never work at random. Look at that electric light! Of the energy expended in producing it, only 7 per cent. appears as light; the rest, 93 per cent. is wasted, mainly in heat. We are all now trying to prevent this enormous waste. I want to reverse that proportion; but if I can reduce the waste to only 33 per cent. a patent of my invention will be worth millions of dollars for its economy in production. In seeking this we do not work at random. I go to my laboratory; study the applications of the principles, facts, and laws which the great scientists like Faraday, Thompson, and Maxwell have worked out, and endeavour to find such devices as shall secure my aim."

This is but an expression, in another form, of what Tyndall said twenty years ago: "Behind all our practical applications there is a region of intellectual action to which practical men have rarely contributed, but from which they draw all their supplies. Cut them off from that region, and they become eventually helpless."

What is true in one department of natural science is, I apprehend, equally true in all. The practical men do not work at random, but upon the basis of what scientific research and publication have previously put within their grasp.

It is evident, therefore, that not only the advancement of knowledge itself, but all possibility of any continuous advance in those great improvements which are to mitigate the sorrows, and promote the health, the conveniences, and the comforts of men, is vitally dependent upon the progress of scientific research. In recent years how marvellous have these improvements been! Besides those that are most common and familiar to all, what miracles, almost, have been achieved through the photograph, the spectroscope, the microscope; by the discovery of the sources of fermentation and of putrefaction; by the discovery of anæsthetics and the application of antiseptic methods in surgery, and in the treatment of other lesions! These latter discoveries alone have ameliorated beyond expression the sufferings of man; they save more lives than war and pestilence destroy, surpassing even in that regard the safety lamp of Sir Humphrey Davy—an invention which at the time it was made, was said to have exceeded every previous discovery as a means of saving human life, except, possibly, inoculation for smallpox.

This vital relation between the advancement of knowledge and the welfare of man furnishes an all-sufficient reason for the continuous and never-ending prosecution of original research. Of necessity the original work of discovery must always lead; that must always precede the practical applications. The necessity for such research must therefore continue so long as science and human society endure. As there is no limit to the advance of knowledge, so there can be no limit to the benefactions it is capable of conferring upon mankind. The more rapid the advance, the more speedy the enjoyment of its fruits. In this relation alone the need of ample provision for scientific progress is one that addresses itself equally to the nation, to the State, to philanthropists, and to all who would advance the welfare of man on the broadest and most enduring lines.

How shall such research be maintained and extended? The investigator of pure science does not work for profit. His discoveries are not marketable. The law allows no patent upon a principle of nature or the discovery of a new truth. Newton could not patent the law of gravitation, nor Volta the galvanism of the voltaic pile; nor Ehrenberg and Schwann the discovery of the widespread influence of bacteria; nor Faraday, nor Henry, electro-magnetism; nor Joule, his correlation of forces; nor Jackson, his anæsthetics; nor Lister, his antiseptic treatment; nor Koch, nor Pasteur, their discoveries of the bacilli, the destruction of which may lead to the cure or amelioration of terrible diseases. To the practical men and to the inventors, on the other hand, who apply to the specific wants of men the truths and principles which the men of science have made known to them, the law, in the form of a patent, gives a monopoly of from fourteen to twenty-one years. They thus obtain, as a rule, a reasonable, and, in some cases, even an excessive, pecuniary reward. In this country alone nearly 500,000 patents have been issued; they are increasing at the rate of about 25,000 per year. In the extreme multiplication of patents affecting a large part of everything we use, the whole world, it might almost be said, is paying tribute to the inventors and practical men; while to the original discoverers, who have made so much of all this possible, there is no promise of pecuniary reward.

This is not said by way of complaint. In the nature of things it is scarcely avoidable. The aims, the motives, the methods, and the genius of the two classes of minds are and ever must be widely distinct. Original discoverers cannot be turned aside from their special work to become mechanics and inventors without infinite loss. Prof. Henry had one form of the electric telegraph in actual use some years before Morse conceived it.[1] But how great would have been the loss to science, without any corresponding gain, had Prof. Henry in 1830 turned away from pure science to do the subsequent work of Morse in adapting the telegraph to common and valuable use!

Research in pure science can never be made a self-supporting pursuit. It can never, therefore, be carried forward broadly, and continuously, and effectively, except through men sustained by some form of stipend or endowment. Occasionally, it is true, men of independent fortune, like Harvey, and Darwin, and Lyell, and Agassiz, have devoted themselves to original research upon their own means, and have accomplished most important results. But these instances are rare. Many other persons, too, with aptitudes and tastes for research, though not following a scientific career, have carried on private researches in the intervals of leisure stolen from the exacting demands of professional or business life; and these have, in the aggregate, added no small amount to the common stock of knowledge.

It is no disparagement, however, of these subordinate workers to say that nearly all the great discoveries, and nearly all the great advances along the lines of knowledge, have been achieved by men who in the main have devoted their lives to the work, and have been supported through institutions or endowments which made this devotion possible. Government appointments, professorial chairs, or salaried positions in scientific institutions of some kind, have been and must continue to be our chief dependence. And it is manifest that these can only be maintained by Government aid, or by the bounty of private in-

[1] "Smithsonian Report," 1878, pp. 159, 262

dividuals. The former is mainly the European system; the latter, in the main, is ours. There, universities are founded by the Government; here, chiefly by the people.

In Germany there are twenty-one universities maintained by the Government. In each of these, as Dr. Lankester states, there are five independent establishments in the department of biology alone, viz. in physiology, anatomy, pathology, zoology, and botany. At the head of each of these establishments there is a professor, with two paid assistants, making altogether about 300 for biological research in Germany; and he estimates about one-quarter of that number in the same department in England. In all the sciences, therefore, there would probably be found in Germany from 800 to 1000 persons of high scientific attainments, supported by the Government in the universities, who are regularly and systematically engaged in the discovery of new scientific truth. For it is there made both the object and the duty of the professors of natural science to carry on original investigations by work in the laboratory. Their positions are obtained through previous distinction in such investigations, and it is for this work that their small but fixed stipend is paid by the Government.

In the College de France, also maintained by the Government, there is the same requirement, though with a larger salary to the professors, and with the added duty imposed on them to deliver to the students about forty lectures yearly upon the subjects of the professors' researches; while in Germany the professors also receive from each student who attends their lectures, a moderate fee, which serves to increase their meagre stipend, as well as to stimulate their activity and usefulness. Under this system, Germany has become the greatest school of science, and the resort of the whole world.

In this country the opposite system prevails. The colleges and universities are mainly private foundations, dependent on private gifts and endowments. The colleges are unwisely multiplied. All are more or less cramped for money. This limits the number of professors and assistants appointed for instruction, and crowds them with routine work. The result is that in all but a few colleges, and in these until comparatively recently, the duties of instruction have left to the professors but little time or opportunity for the prosecution of original investigations; and these with but poor equipment and inadequate means.

In not one of all our colleges and universities, so far as I have been able to ascertain, is there a single professorship endowed or founded, even in part, for the avowed object of original scientific research. Instruction, not discovery, is the only avowed object. It is to the great credit of American professors and teachers that, with so much routine work on their hands, and so little leisure for research, they should have accomplished by purely voluntary studies so much as is shown in their contributions to our scientific publications.

To what is said above, perhaps a virtual exception should be made as respects our astronomical observatories, in which, the labours of instruction being less, original work has been perhaps expected, and has been accomplished with most signal success. To some extent this may possibly apply to our medical schools also. And in other departments, generally, wherever time and opportunity have been afforded, much original work has been done by our professors; some of it of the first class. This is attested, not to mention living instances, by the work of Prof. Henry at Princeton, Dr. Torrey at Columbia, Dr. Silliman at Yale, Dr. Gray at Harvard, and many others that might be named. In a number of the States, also, and at Washington, there have been maintained by the State or nation a number of scientific men, in connection with certain State or national interests, who have accomplished most important results; of these, Dr. James Hall, of this State, is a conspicuous instance. At Harvard and at other colleges some noble opportunities for special study have been also provided in their scientific schools and museums; notably in the zoological museum, the Jefferson Physical Laboratory, and the Peabody Museum of Archæology at Cambridge, and also in the department of hygiene at the University of Pennsylvania. But in most of these the great complaint is the lack of necessary endowments to make possible the active advanced work in original discovery for which those institutions are designed. In the Peabody Museum there was in 1891 a gift of 10,000 dols. by Mrs. Hemenway to establish a post-graduate fellowship; and also a gift of like amount by Mr. Wolcott, for the general support of the museum's work. New York also has within a few years past seen spring up almost as by magic, through the efforts of a single leading spirit, seconded by other public-spirited men and women, and by municipal aid, a museum of natural history that bids fair to stand in the front rank of scientific opportunities; but the endowments of fellowships and professors necessary to make its opportunities available in active research are as yet wanting.

England holds a position midway between the United States and Germany. Her scientific men lament her deficiencies. They are striving to increase their means for scientific work, and are doing so yearly.

If experience teaches anything, it is that no broad and general development of scientific work of the first class is possible, except either through independent establishments for special work, or else by the university system, in which professors in science and their assistants are first selected on account of their previous distinction in original research, and are then appointed to continue that work, and in the teaching of students, to transmit to them the zeal of discovery and the true methods of advance.

It matters little whether the support of the university or of special institutions for research comes from the Government or from private endowment, provided the provision is adequate and constant. The difficulty with us has been, and still is, that funds are insufficient, the means and equipment inadequate, and the time allowed to the professors for research insufficient. There has been too much of the schoolmaster, and too little of the real professor. Too great absorption of the professor's time in the work of instruction is injurious to both teacher and pupil. The most stimulating of teachers is he who by daily experiment is in vital touch with nature—he who brings from the fires of the laboratory the warmth, the illumination, and the inspiration of his own researches.

This is now well recognised; and so far as their means will permit, the leading colleges are by degrees relieving their professors of the work of elementary instruction, so that they may the better prosecute original researches, and at the same time become best qualified for the highest work of instruction. This system will doubtless demand watchfulness and discrimination. To prevent abuses, regulation and responsibility may have to be imposed. But it involves the appointment of additional instructors. It requires added means. And this is indispensable as a part of the transition of our leading colleges to the university system. It is indispensable, also, if we are to have in this country any considerable systematic prosecution of original research. We must use existing instrumentalities and existing institutions. And all experience shows that outside of the few Government positions, and in the absence of special institutions for research, the professorial chairs are best adapted to such investigations. No greater service could be done to science than to make such endowments as should insure systematic and continuous research by the professors as a part of the new university system.

Endowments for the same object, and operating in the same line, might also take a different form, viz. the endowment of several professorial fellowships, each, say, of 1000 dols. annual income; to be controlled and awarded by some independent scientific body (such as this alliance might afford) for distinction in active scientific investigations, either within the country or within the State. I know of no more quickening impulse to original scientific research than such as would be given to it by those means.

How backward we have been in this country, through the lack of proper endowments, in making use of the best existing opportunities for research, may be illustrated by a single instance. Some twenty years ago a school was established at Naples for the prosecution of marine biological research. It is most thoroughly equipped, and, being a general resort, is the most advantageous for study in the world. It is maintained by a charge of 500 dols. per year upon each table occupied, each occupant being entitled to all the advantages of the institution. Of these tables, the German States for several years have taken thirteen; Italy, eight; Austria, Russia, Spain, and England, each three; Switzerland, Belgium and Holland, each one; the United States, until 1891, none, except one table supported by Williams College for two years, and one by the University of Pennsylvania for one year. Prior to that time about fifteen other American students in all had obtained places at the tables taken and paid for by other nations. In 1890 this arrangement was prohibited by the administration of the institution;

and the right to a table in 1891, was secured to Americans, only through the private benefaction of Major Alex. Henry Davis, of Syracuse. For the year 1892 the use of a table has been secured through a subscription started by the American Association for the Advancement of Science, toward which the Association itself granted out of its scanty funds 100 dols. and was the means, I believe, of procuring the rest.[1]

We have not, however, been wholly without some such means of study in this country through the marine biological laboratories established some years ago at Newport and at Wood's Holl, by Prof. Alex. Agassiz. The former has been now enlarged so as to accommodate eight advanced students, besides the professor and his assistant.[2] The Johns Hopkins University also has supplied some opportunities of this kind by its summer school, formerly at Beaufort; later, at Jamaica; but at present, as I understand, it is without any permanent location.

Our neighbour, the Brooklyn Institute, has organised similar investigations, on a minor scale, during the summer months at different places on Long Island. But what is needed for the most effective work is suitable endowments for professors and advanced students, in connection with an adequate biological laboratory, such as the Newport one enlarged might afford, equal in means and equipment to that at Naples, or at least to that recently completed, largely through private enterprise, at Plymouth, England.[3]

(To be continued.)

SCIENTIFIC SERIALS.

Bulletin de l'Académie Royale de Belgique, Nos. 9 and 10.—On the conversion of black mercuric sulphide into red sulphide, and on the density and specific heat of these bodies, by W. Spring. As a general rule, if a body is capable of existing in two allotropic states with different densities, it is possible to convert the lighter into the heavier kind by compressing it to the higher density, the pressure depending upon its compressibility. Sometimes this conversion is only possible above a certain "critical temperature." In the case of the sulphide of mercury the conversion of the black into the red variety (vermilion) involves a compression of 9 per cent., and would require a pressure of 35.000 atmospheres, which is not at present attainable. But M. Spring has succeeded in obtaining a new form of black HgS which only requires 2500 atmospheres. It is obtained by sublimation of ordinary black HgS in an atmosphere of nitrogen or CO_2. Its density is 8·0395, while that of vermilion is 8·1587, and of ordinary black HgS 7·6242. A curious side result of the investigation is that the black sulphide hitherto known, after being made to expand by heat and then cooled, takes about a day to return to its original density.—Vapour tension and hygrometric state, by Dr. J. Verschaffelt. A new hygrometer may be based upon the fact that the hygrometric state of the atmosphere may be taken as the ratio of the vapour tension inside a solution to the highest possible vapour tension of water at the same temperature, if the tension inside the solution is equal to that in the atmosphere, *i.e.* when the solution does not evaporate or gather moisture from the air. The ratio mentioned is independent of the temperature, and hence the humidity is simply a function of the concentration of the solution. In practice, Dr. Verschaffelt moistens a weighed piece of blotting-paper with a weighed quantity of a solution of lithium chloride of known concentration, exposes it to the atmosphere, and weighs it again. From the last weight the "equilibrium concentration" may be calculated, and from this the humidity with the aid of Dieterici's data for this salt. The apparatus might be made self-registering.

[1] See *Proceedings American Association A. S.* 1891, vol. xl. p. 449-451.
[2] *Report Harvard College*, 1891, p. 182.
[3] In his address before the American Association for the Advancement of Science, in 1891, President Prescott, referring to this general subject, said: "To nurture investigation in science is the largest opportunity before the American people. Research, systematic and wisely directed, requires good organisation and strong support, the support of many powers. It must have the support of able and persistent men. It needs the conference of workers, and the dissemination of knowledge in societies like this. It wants the interest and the confidence of the public. It asks and will always obtain the constant, helpful use of the press. It requires distinct provision in colleges, and in the institutions of higher education. It ought to be sustained expressly by the Government, both in the several States and under the United States, and sustained on broad and permanent foundations. Still, it needs private benefactions. Research is the growth of years. Let it be the demand of all, and let this call find utterance everywhere."—*Proceedings American Association*, 1891, vol. xl. p. 440.

Bulletin of the American Mathematical Society, vol. i. No. 2. (New York, Macmillan, November, 1894.)—On the problem of the minimum sum of the distances of a point from given points, is the translation, by A. Ziwet, of a paper presented to the Society at its summer meeting (August 15), by Prof. V. Schlegel (pp. 33-52). This frequently discussed problem (see references given by Sturm, *Crelle's Journal*, vol. 97), is considered by the author to offer room for further treatment. He discusses the best method of investigating the question, and in the end treats it by means of the simplest methods of Grassmann's "Ausdehnungslehre." Prof. Cajori collects a number of authorities in confirmation of a statement in his "History of Mathematics" (p. 218), that it is *not* true that the binomial theorem is engraved on Newton's monument in Westminster Abbey. The latest additional authority for his statement is contained in a letter from the present Dean of Westminster, whom Prof. Cajori calls "Dr. Granville"!—The only other matters are the notes and new publications.

SOCIETIES AND ACADEMIES.

CAMBRIDGE.

Philosophical Society, November 26. — Prof. J. J. Thomson, President, in the chair.—On Benham's artificial spectrum, by Prof. G. D. Liveing. Prof. Liveing exhibited one of Benham's "artificial spectrum tops" (see NATURE, November 29, p. 113), and a variety of discs with figures in black disposed on a white ground, and with white figures on a black ground, which, when revolved in a bright light showed remarkable bands of colour of various shades of red, green, and blue. The general result of his observations of these discs was that if a succession of black and white objects were presented to the eye with moderate, but not too great, rapidity, then, when black was followed by white, an impression of a more or less red colour was perceived, while when white was succeeded by black a more or less blue colour was perceived. If the succession of black and white was very rapid the appearance presented to the eye was of a more or less neutral green or drab. The explanation offered by Prof. Liveing was based on the known facts that the impression produced on the retina by a bright object remained for an appreciable time after the light from the object had been cut off, and that the duration of that impression was different for different colours; and on a supposition, which he did not know to have been as yet verified experimentally, that the rapidity with which the eye perceives colours was greater for one end of the spectrum than for the other. From this point of view the explanation of the blue colour seen when white is followed by black would be that the impression of blue on the retina lasts a little longer than that of the other colours; while the red colour seen when white succeeds black is due to the greater rapidity with which the eye perceives red light than that with which it perceives blue. If, however, the alternations of white and black succeed each other with sufficient rapidity, the new impression of a white patch will be produced before that of its predecessor has vanished, and there will be an overlapping of impressions, and the sensation will be that of a mixture of colours, or of a more or less neutral tint. So far as he could test the theory by his own eyes it appeared to him that the residual impression, left when the light from a white object was suddenly cut off, was at first green and faded out through a more or less blue or slate colour.—On a simple test case of Maxwell's law of partition of energy, by Mr. G. H. Bryan.

PARIS.

Academy of Sciences, December 3.—M. Lœwy in the chair.—The reduction of alumina by carbon, by M. Henri Moissan. The author describes the reduction of pure corundum by means of his now well-known electric furnace. Liquid alumina is not reduced by carbon; the reduction only takes place when the vapours of these substances are carried to a very high temperature, metallic aluminium is then produced and partially combines with carbon.—Reply to M. Mayer-Aymar concerning his defence of *Saharien* as a name for the latest geological period, by M. A. Pomel.—A letter from Prof. R. Fresenius was read announcing the formation of a German committee in connection with the Lavoisier monument. The Academy appointed Prof. Fresenius delegate for this work. Prof. G. Hinrichs was similarly appointed delegate for the