transfer of its antiquarian collections commonly known as its Museum, to the Government upon the conditions—

a. That the arrangement of the Museum, as well as the purchase of additions, shall continue to be conducted by the Academy; and that adequate provision shall be made for the continued acquisition of Irish antiquities which may hereafter be discovered or offered for sale.

b. That the Museum of the Academy, together with such other Irish antiquities as may be added to it, shall be for ever kept apart from other collections, and be permanently maintained as a Museum of our National Antiquities, no portion of its contents being ever removed from the City of Dublin, unless by permission given under the seal of the Academy.

c. That the Academy shall be accountable, as at present, to her Majesty's Treasury, through the Irish Government, for all sums voted by Parliament, and shall not be subject, in the conduct of its affairs or the expenditure of its grants, to any control on the part of the Science and Art Department, or any of its officers.

2. That, considering the position which the Academy has long held, and will continue to hold, as the first scientific, literary, and antiquarian Society of the country, the proportional representation proposed to be given to it on the Board of Visitors (sect. 12 of Lord Sandon's letter), is altogether inadequate; and the Academy further think that no paid official of the Science and Art Department should be eligible to act as a representative on the Board.

3. That there should be provided in the yearly estimates, as laid before Parliament, instead of the several sums now annually voted, a sum at least equal to what is at present voted, to enable the Academy to discharge more completely its functions as a scientific, literary, and antiquarian body, by making grants in aid of original research, by publishing the results of such research, by maintaining a library specially adapted to assist learned investigation, and by editing and printing ancient Irish texts, &c.

SCIENTIFIC INSTRUCTION AND THE ADVANCEMENT OF SCIENCE.

ON Wednesday and Thursday last week two separate deputations from the Council of the British Association waited respectively on Mr. Cross and the Lord President of the Council, the Duke of Richmond and Gordon, both introduced by Dr. Lyon Playfair, and headed by the president of the Association, Sir John Hawkshaw. The object of the deputations was to induce the Government to adopt certain recommendations of the Royal Commission on Scientific Instruction and the Advancement of Science.

Dr. Playfair said there were three points in the Reports of the Science Commission to which they desire to direct attention—namely, the recommendations as (1) the study of science in elementary and endowed schools, (2) the endowment of research, (3) the administration by a Minister of Science and Art.

Sir John Hawkshaw said that the matters which they that day desired to mention were chiefly treated in the Fifth and Eighth Reports. He read a memorandum on these points approved by those he represented. This document set forth that the Government possessed, through the elementary schools and through the authorities charged with framing schemes for endowed schools, the machinery for insuring scientific teaching. The public schools will follow the Universities; the Universities in England and Scotland are about to be the subjects of inquiry by Commissions, and science ought to be adequately represented on these Commissions. University College and King's College, London, Owens College, Manchester, and Trinity, Dublin, would require special consideration, and if further pecuniary assistance were granted them by Government, guarantees should be taken for the further encouragement of scientific teaching. Direct endowments of research must be approached with caution. There would be no objection to the course of liberally endowing professorships in the several Universities, combining the duty of original research with a moderate amount of teaching to be attached to the professorship; an extension of the principle involved in the grant to the Royal Society might be advantageously resorted to, and the grant might be gradually increased. The Lord President of the Council was practically entrusted with the functions of a Minister of Education, responsible to Parliament; and it therefore seemed to follow that he should be made the responsible administrative head of the business connected with scientific institutions which receive their support from public grants, with the allocation of funds for scientific purposes, as well as of the business relating to the promotion of scientific instruction, as these matters all form an essential part of public education in science. Sir John Hawkshaw would only add to the document that it would be of great advantage if the State would establish, say, a laboratory for chemical science, and an observatory for physical investigations.

Prof. A. W. Williamson, Prof. Roscoe, Mr. Spottiswoode, Dr. De La Rue, and others spoke in support of the deputation's object, with which Mr. Cross said he sympathised very much indeed.

The Duke of Richmond and Gordon said the Government were well aware of the great importance of scientific education. With regard to the Reports of the Science Commission, he thought Lord Salisbury was now acting upon the Third Report, in respect to Oxford and Cambridge. It seemed to him that the endowment of professorships had not been altogether satisfactory so far as it had been tried. With regard to the Government grant to the Royal Society, that was a grant, not an endowment for those who work, but, as he understood it, a provision of apparatus. The sum of money was so expended. It was not an endowment of research. With regard to establishing physical observatories, the Government had taken action in the work connected with astronomical physics which Mr. Norman Lockyer was now carrying on, or beginning to carry on at South Kensington. With regard to the laboratories for chemistry and physics which Mr. De La Rue alluded to, it seemed to him they could not very well do more in that direction till they had the report of the Commission which was to inquire into the Universities' scheme proposed by Lord Salisbury. He concluded by assuring the deputation that the Government were quite alive to the great importance of the subject.

PHYSICAL SCIENCE IN SCHOOLS

I CONFESS I did not understand Dr. Watts's letter quite as Prof. Roscoe has done. But that is of little importance. Prof. Roscoe has opened wider questions as regards the position of Physical Science at Schools, and I should be glad of the opportunity, if you can spare me the space, of writing a little more at length on this matter, and, if possible, of thereby arriving at a distinct understanding what it is that the thorough-going advocates of science, like Prof. Roscoe, want. His letter is a good hearty grumble at things in general, and a good grumble from him wakes people up, and does us all good; but we want to know what specific changes he wants, and who is to make them. "Regulations" and "Examinations" and the "position accorded to science in schools," and the "discouragement to the teaching of science," want of "efficient means of teaching science," "difficulty of obtaining masters," are all in turn mentioned as obstacles. Some of these arise from one cause, some from another, and before any improvement can be effected, we must analyse the position of science at schools, see what

the circumstances are which affect it, and understand where pressure can effectively be brought to bear.

The position of science at schools is dependent on—

1. The Public Schools' Commission.
2. The Statutes and Regulations of each School; *i.e.*, the Governing Bodies.
3. The Indirect Influence of the Universities and other Examining Bodies.
4. Head-Masters.
5. Parents.

1. The Public Schools' Commission enforce the teaching of science by requiring (Reg. 3) that "In any examination of a boy (not being one of the senior boys) in the school, or in any report of a general examination, the proportion of marks to be assigned to Natural Science shall be not less than one-tenth nor more than one-fourth, as the Governing Body shall think fit." Also that (Reg. 6) "There shall be one Mathematical Master, at the least, for every 100 boys in the school, and one Science Master, at the least, for every 200 boys learning Natural Science in the school." Also that (Reg. 7) "Every boy shall learn Natural Science continuously from his entrance into the upper middle form, Div. II., until he become one of the senior boys in the school." Further, that (Reg. 8) Senior boys may pursue special subjects of study and discontinue other subjects for that purpose: and that (Reg. 11) "Any boy in the school who may evince an aptitude for Natural Science shall have facilities for that study." Also (Reg. 10), "Any boy entering the school shall have the opportunity of showing acquaintance with Botany, Physical Geography, or some other branch of Natural Science."

It is evident that the all-important question here is, who are senior boys? Regulation 5 says "the Governing Body shall from time to time determine the point in the school list above which the boys shall be reckoned as senior boys for the purposes of these regulations."

These regulations are dated Aug. 4, 1874.

I do not think any reasonable fault can be found with these regulations from Prof. Roscoe's point of view, unless he finds fault with Regulation 7, which does not give natural science equality "as regards range," with classics and mathematics. To this I shall recur again.

2. The Statutes of Rugby School order that three Major Exhibitioners shall each year be elected—to pursue their studies elsewhere—for general proficiency in the studies of the school; and that four Minor Exhibitioners shall be elected, for proficiency in Classics, Mathematics, Natural Science, and Modern Languages respectively. The Regulations (37) order that "Natural Science shall be obligatory on every boy in the middle school, and either Natural Science or German on every boy above the middle school." Also (40) that "two Major and three Minor Scholarships shall be given for proficiency in Classics; one Major and one Minor for proficiency in Mathematics; one Minor for proficiency in French, and one in Natural Science." These are open to all boys between twelve and fifteen years of age.

I think it cannot but be felt that Natural Science has not been ignored in these regulations; it is not indeed put on an *educational equality* with Classics, but it is respectfully treated.

3. The Universities and other examining bodies affect us greatly. We at Rugby are principally influenced by Oxford and Cambridge, and it is of their influence only that I proceed to say a few words. It is plain that at the Universities some subjects must be universal, and some optional. The compulsory subjects are Latin, Greek, Mathematics, and Scripture Knowledge; optional subjects are numerous enough. Science ranks there with Law, History, Moral Science, Medicine, &c. Does Prof. Roscoe think that this is wrong? I really wish to know whether any thoughtful man who has considered the subject will say that science ought to be a *sine quâ non* for admission or for a degree at the Universities? *I* certainly think that science has its right position among the optional subjects. The point in this system that is more doubtful is the position of Greek, whether it might not be ranked with the optional subjects, and so give fair play to those schools and portions of schools which teach Science instead of Greek, and which are practically relegated to the rank of middle class schools (whatever they are called), because they have no outlet into the Universities. This is a change that has been already discussed more than once, and the opinions are, I believe, so nearly balanced, that the existence of a few more such schools, and a little pressure from without, will probably soon cause the change to be made. There is no doubt that the ready sympathy between the Universities and the educational needs of the country will be shown in this as in other things.

This is a digression, however. To return. Such being their system, the Universities are asked to examine schools and award leaving-certificates. I have reason for thinking that it was felt that this was not a time for fettering schools, or preventing educational experiments; they therefore declined to lay down *any* universal subject of education. They grant certificates without requiring a knowledge of even Latin and arithmetic. Every school may select its own studies. They will not, however, grant a certificate without a certain variety of attainment: four subjects must be taken, speaking generally, from three groups. Language, Mathematics, Literature, and Science form the groups.

It seems to me, therefore, not fair, not a statement of facts, to charge the University examination for certificates with "placing the science subjects in a distinctly inferior position to the older studies." The position is exactly identical. As a *leaving* examination nothing can be fairer.

What I pointed out in my first letter (Feb. 24) was that the *leaving* examination from school was in fact, to our boys, an *entrance* examination to the Universities; and in it they select, of course, the compulsory subjects of the Universities, for otherwise the certificate has no value. Science is not one of these compulsory subjects, and therefore the indirect action of these examinations is adverse to science. But I do not see how it can, or ought to be, otherwise; only I wish that their examination in science was a little more carefully arranged, with a view of forming at schools a sound method of teaching science.

The Universities of course affect us greatly by their scholarships in Natural Science, which do more to guide the teaching than anything else, and by their training masters. The influence of men like Maxwell and Clifton in inspiring teachers of Physical Science is very great; and when this influence is wanting in any subject at the Universities, the schools are the bodies which suffer. The Professors of Chemistry and Physics at the Universities are masters of the situation.

4. Head-masters have, of course, the chief power at schools of making science teaching effective or the reverse. This is a delicate matter for an assistant-master to speak of; and I have no right to discuss in this place—nor indeed elsewhere—how far the Regulations of the Commission and Governing Body are carried out in letter or in spirit, here or elsewhere.

But I may point out that, except in rare instances, head-masters follow, and do not lead, public opinion on educational points. The competition between schools is close; their prosperity depends on their meeting the demands of the public; and few men are bold and clear-sighted enough to make with success a move in anticipation of a demand from the public. At present a Balliol Scholarship, or other University Scholarship, are the grand advertisements; got at whatever cost to boy or school, they *pay*. And head-masters, being but men, are influenced by this. To get one such scholarship, except

in cases of rare genius in a boy, costs the school a good deal, not in money, but in efficiency. To get one you must spoil several. First-rate proficiency in a subject, it is believed, can only be got when many are working together in it. Competition is stimulated by numbers. The success is less brilliant when the racers are few. A form is somewhat disorganised, it is urged, if some boys drop Greek, and others drop verses, or composition altogether; and thereupon many are kept to swell the triumph of the few. The possible disorganisation is an imaginary evil, I believe, but a real argument none the less, and science suffers much at schools from a want of freedom given to boys to drop some other subjects and pursue it as a principal study.

Then there is the inevitable silent disparagement of non-appreciation. Some men have genuine sympathy with learning of all kinds, and can make others feel that they respect a learning they themselves do not possess. But such men are rare. It is too often made plain to boys who "take to science," that they are regarded as failures—as we hear of some "ne'er-do-weel" that he has "taken to" sheep-farming in Australia. It is the entire and transparent honesty of this opinion that makes it so effective, and this adverse influence, which is deeper than words, and often in flat contradiction to them, will only be eliminated by the general growth of public estimation of science, and by the fruits that education in science can show. For this we must wait.

5. The last influence is that of parents and the public generally. From them, as far as I can judge, there is no trace of a demand for a revolution in education. The only subjects on which there seems to me to be a strong and tolerably united opinion, are the postponement of Greek in the education of young boys, and a desire for greater weight to be given to arithmetic, good writing, and geography. The teaching of science is desired, principally on grounds of utility, not of training; and choice of the time of introduction of it, the order of the subjects, &c., the stratification of science, in a word, has not been considered, except by very few.

Prof. Roscoe thinks science ought to have "educational equality both in range and time with classics and mathematics." Here I distinctly differ. I maintain, after trial, that it is unwise, and unscientific from an educational point of view, to attempt to teach science at school to boys till they have attained a certain standard of knowledge in arithmetic, and a certain power of reasoning and language, as shown by their attainments in geometry and Latin. Let science be held before them as a thing to be enjoyed when they are older and more advanced. It is spoiled for them, and they are spoiled for it, by its being taught them too soon. The dicta of men like Faraday and Sir John Lubbock, and Roscoe are misleading opinion on this point, and I wish to record my protest against them. Do Sir John and the Professor know, have they the slightest idea what the standard of arithmetic is in the lower forms and among the new boys of a public school? I will tell them. This was the entrance paper I set in Arithmetic last January. By the Regulations, "No boy shall be admitted who cannot work sums in Fractions and the Rule of Three."

"RUGBY SCHOOL, JANUARY, 1876.

"*Entrance Examination.—Arithmetic.*

"You are required to satisfy the Examiners in this paper.

1. Subtract one hundred and seven pounds, nineteen shillings and sixpence three farthings from two thousand seven hundred and three pounds, and threepence halfpenny.

Multiply the result by seventeen.

2. Write out the table of square measure, and find the number of ounces in a ton.

3. If 49 tons 15 cwt. 1 qr. 13 lbs. of coal are distributed among 23 persons, how much will each receive?

4. Multiply 11*l.* 3*s.* $6\frac{5}{6}$*d.* by $3\frac{2}{7}$.

5. Simplify $2\frac{3}{4} \div 1\frac{5}{6}$ and $\dfrac{2\frac{1}{2} - 1\frac{1}{4}}{7 \div 5\frac{1}{4}}$.

6. If a man walk 4 miles, 1 furlong, 40 yards in one hour and 13 minutes, how far will he walk in two hours?

7. Multiply .105 by 3.027 and .105 by 3.027.

8. Find the cost of 3,653 articles at 7*l.* 13*s.* $6\frac{1}{2}$*d.* each."

The plucking on this paper happily did not rest finally with me. But it may affect Prof. Roscoe's opinions if I tell him that if every boy had been required to answer one of the first three questions, and either 4 or 5, and 6, —[1] per cent. would have failed: and the average age of these boys cannot have been under fourteen. This is a stubborn fact. No doubt boys *ought* to know more. But they *don't.*

What, therefore, we insist on is that boys, when once in the school, shall not begin science till they know something of fractions, decimals, and square measure, and half the first book of Euclid. Does the Professor think our standard too high?

To sum up, therefore, what has been said. The commission and governing body secure fair play to science; the Universities do the same, though the new examination is, indirectly, rather adverse to it. Head-masters follow, and do not lead the public; and the public has no very decided opinions just at present.

If, therefore, I were asked what I think ought to be the programme of those who are interested in the progress of physical science and of sound education generally, in schools, I should reply that our great aim ought to be *the postponement of Greek in all schools, and its removal from the compulsory subjects in the examination for certificates that carry a University value;* that meantime we ought to use the certificate examination, and improve it; and to demonstrate, if possible, to unbelievers, the advantage it would be to some boys to drop Greek and composition for the purpose of scientific study, and that such a liberty would not injure the efficiency of schools in classics. It will be well also to watch with care the progress of schools in which Greek is not taught at all. No index to public opinion can be more valuable.

"The History of Education," Henry Sidgwick says,[2] "is the battle-ground and burial-ground of impracticable theories; and one who studies it is soon taught to abate his constructive self-confidence, and to endeavour humbly to learn the lessons, and harmonise the results of experience."

It is in this spirit—and I trust it is mine—that anything must be written that will now, in the present stage of the discussion, be a valuable contribution to the formation of opinion on this interesting and important question.

Rugby, March 6 JAMES M. WILSON

I should feel obliged if you would permit me to say that my views with regard to this question agree in the main with those of Mr. Hutchinson and Mr. Wilson.

The regulations of the Oxford and Cambridge Schools Examination Board were amended after the first examination in 1874, and the paper together with the practical work set last year was, in my opinion, sufficient in point of difficulty. Several of the candidates from Clifton, and doubtless from other schools, were quite prepared to work a much more difficult paper. That, however, is not the question which is to determine what shall be required of the average boy when he leaves school.

In Clifton College the Modern Side receives instruction in science at the rate of two lectures a week on chemistry and two on physics. Latin gets only three hours a week. A large number of boys (over fifty) attend voluntarily in the laboratory and thus have three or more hours a week of practical work, whilst a few of the more advanced receive two lessons in theoretical chemistry, besides doing a considerable amount of reading out of school. The subject is rewarded by marks at the same rate per hour as Latin, and also gets a fair share of prizes. In short, science at Clifton occupies a prominent and

[1] In the revise I have struck out this number. Its publication might be regarded as a breach of confidence. And it is almost incredible.

[2] "Essays on a Liberal Education." Macmillan, 1867.

honourable position in our curriculum. At other schools, as, for example, the Manchester Grammar School, I am told that even a larger proportion of the time of the boys is given to work of this kind; and on the whole I am inclined to think that, notwithstanding the reluctance of some of the old foundations to admit the interloper, yet that the prospects of science in connection with general education are exceedingly satisfactory and encouraging.

It would be a mistake to attempt to *displace* classical studies, as some people seem to wish, in favour of science or any other subject. It cannot be expected that all boys should have the same tastes or capabilities. It would be as much an error to compel a boy, who has shown no aptitude for science, to devote any large proportion of his time to that subject, when he might be getting on with his classics, as it would be to doom another to Latin prose when his heart was all the time in the laboratory. The true system I believe to be this. After passing through a junior school, in which all should be equally instructed in some branch of natural history or experimental science, boys should then be drafted off into one of three departments. There should be (1) a classical school, in which Latin and Greek should be the staple, though not to the exclusion of a certain modicum of mathematics and science; (2) a modern school, in which mathematics are predominant; and (3) a science school, in which languages, though subordinate to science, should not be altogether extinguished. This is very nearly the system pursued at Clifton, and I can testify to its practical convenience and success.

As regards the choice of subjects, though I believe chemistry is pre-eminent in its capacity for developing certain of the mental powers, I consider that the fullest advantage is not derived from it, unless it is taught in a certain way. I hold that teachers of chemistry *in schools* are wrong when they set about teaching boys according to the methods commonly in use in the instruction of ordinary chemical students. The latter have to apply their knowledge to practical purposes, and this is not the prime object to be kept in view in determining the educational value of a given subject.

And this leads me back to the question of examination papers. I consider that examiners have as much to learn as teachers in connection with their respective functions. At present it is too frequently, "How do you make this?" or, "What are the properties of that?" a style of question which is good enough in its way, but to answer requires very little intellectual effort. The preparation for such an examination is little better than "cram," and is of proportionately small educational value.

If examiners, whether in school or university, would take more pains in framing their questions so as to extract not alone that which is in the memory of the candidate, but to get the product of his brain, I believe great and important service would be rendered to scientific education.

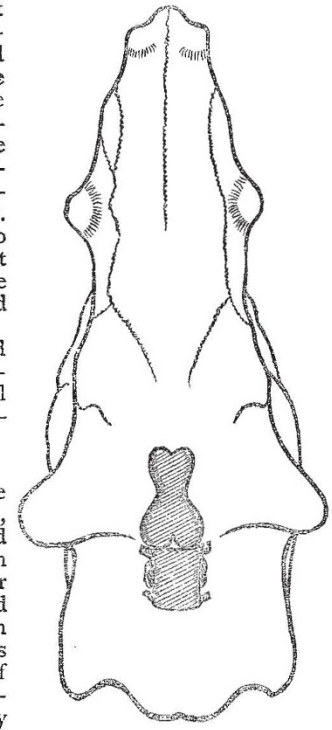
WILLIAM A. TILDEN

Clifton College, Bristol, March 6

PRINCIPAL CHARACTERS OF THE DINOCERATA

UNDER the above title, Prof. O. C. Marsh, of Yale College, has published several facts of great importance with reference to the structure of the huge Eocene Mammals of Wyoming, of which we have already given a short description (NATURE, vol. vii. p. 366) from the same author's memoirs.

We now learn that the brain as known from the inside of the skull was very remarkable, being proportionately smaller than in any other known mammal, the Spermaceti and some other whales alone excepted. In *Dinoceras mirabilis* the entire brain was not greater in any of its transverse dimensions than the spinal canal in the cervical region. Its relative size and position can be best estimated from the accompanying drawing, copied from one given by Prof. Marsh, the brain in it being shaded, with a portion of the spinal cord attached. From the figure it is also evident that the olfactory lobes are proportionately large, at the same time that the cerebral lobes are hardly bigger than in some reptiles. The cerebellum must also have been small, whilst the cranial as well as the spinal nerves and the cord were immense.



The teeth are figured with their prominent V-shaped ridges, the dental formula being given as:—

$$i\,\frac{0}{3}\;c\,\frac{1}{1}\;p\,m\,\frac{3}{3}\;m\,\frac{3}{3}\times 2 = 34.$$

The upper canines were very long and pointed, and peculiar expanded descending processes on either side of the lower jaw seem to have acted as guards to protect them whilst the mouth was closed. The condyles of the lower jaw were transverse, and therefore only allowed of an up-and-down movement. The molars were peculiarly small for the size of the animal and of the skull. The creature must have been carnivorous, as mastication could only have been slight, and the food therefore nutritious.

The feet are figured. They were very elephantine, there being five digits on each; these, with the carpus and tarsus, being short and compressed from above downwards. The terminal phalanges were well developed. The other bones much resembled those of the elephant in size as well as contour. Prof. Marsh tells us that the head could evidently reach the ground, and that there is no evidence of a proboscis.

These characters all point to the fact that in Eocene times there lived an order of animals which have no representatives at the present day, and that they were highly specialised in some points of their structure, whilst in others they were equally ill-developed.

NOTES

WE learn that a scheme is on foot for a memorial of the late Prof. Rankine. Students of Thermodynamics, Engineering, &c., will be doubly delighted to hear that the memorial is to take the form of an edition, in two handsome quarto volumes, of his valuable papers contributed to the various scientific societies and magazines.

A SERIES of lectures upon zoological subjects will be delivered after Easter in the Zoological Society's Gardens, in Regent's Park, on Thursdays, at 5 P.M. The following are the titles, together with the days on which they will be delivered by the respective lecturers:—April 27, Mr. P. L. Sclater, F.R.S., on the Society's Gardens and their inhabitants; May 4, Prof. Flower, F.R.S., Rhinoceroses and Tapirs; May 11, Prof. Flower, Horses and Zebras; May 18, Dr. J. Murie, the Manatee; May 25, Prof. Garrod, On Birds; June 1, Prof. Mivart, On Bats; June 8, Mr. Tegetmeier, On Homing Pigeons;