

THURSDAY, AUGUST 14, 1873

THE ENDOWMENT OF RESEARCH

V.

ALTHOUGH it is not within the purpose of these articles to propose an elaborate scheme in which the Endowment of Research in all its branches may be completely provided for, yet it may be reasonably expected that some suggestions should be now put forward to serve as an answer to those who urge the hopeless impracticability of the attempt, and as a foundation upon which a definite plan may be constructed, by the help of criticism, from those who can speak with authority in their own particular subjects.

In the first place, it is above everything important that the need of a systematic organisation of a central character with entire freedom of action should be at once recognised. It is absurd to suppose that the lack of pecuniary means can be the main difficulty which has hitherto, in the richest country in the world, hindered original investigation in the Sciences. The natural harvest of scientific discoveries which England ought annually to reap has rather been checked by the irregularity with which the labourers have been rewarded, and the comparative indignity with which they have been treated. For a certain class of scientific investigations of a strikingly practical character the public will always be willing to sanction large parliamentary grants; but for the permanent Endowment of Research, and the continuous support in a worthy position of the researchers, not only the aid of the nation at large, but the wealth and the prestige of our ancient Universities are required. There is, of course, no reason for any interference with the valuable work at present accomplished by the London Societies, but their work is of a different character. The new organisation would not grow into a monopoly, but would naturally take to itself those departments of knowledge which are least cared for, and in which the benefits of endowments will be most felt. Its wealth would enable it to be liberal, and its public position would impose just that amount of responsibility which should protect it from those dangers to which its wealth might render it exposed.

It is impossible to give a precise account of the actual manner in which the endowment should be distributed. To advance a crude scheme would be disadvantageous to the cause at heart, and to descend into detail would be to offer an unnecessary advantage to the enemy. Much must be left for the future to develop, and much must be left to the men to whom the administration is entrusted. If a scheme were to be worked out in detail in accordance with the demands of Science as understood at the present day, and if strict rules were to be adopted for its application, it might very well happen that before many years have gone our new Foundation would become an obstruction rather than a help to the advancement of Science. That a system may be vague, and yet eminently useful, and that its managers may safely be trusted with powers almost irresponsible, may be learnt from the example of the Smithsonian Institution in the United States.

It is there found that to the Secretary of that institution, who at present is Professor Henry, may be confided the management of about 8,000*l.* a year, subject only to the nominal control of a board of American politicians, upon the trust to further "the advancement and diffusion of knowledge." Many incidental lessons may be gathered from the manner in which the funds of this Institution are applied. There are no professors, and no oral instruction of any kind: money is advanced to individual investigators, not to support them while engaged in their scientific labours, but merely to provide the apparatus and the materials necessary for their researches; but the largest part of the funds would appear to be devoted to the publication of (the work which they have encouraged, and which under the title of "Smithsonian Contributions to Knowledge," are well known all over Europe. In this case, therefore, Research is indirectly endowed by means of a moderate pecuniary assistance to the investigators, whereas in Germany it is indirectly endowed through the professoriate; but our proposal is that nothing but a direct endowment will satisfy the peculiar wants of this country.

There is yet a further reason why any plan now put forward should be purposely indefinite and incomplete. The funds which the colleges will ultimately yield can only fall in very gradually. It is, according to the modern practice, quite impossible to make anything out of the present holders of fellowships, who are in most cases young men, who may retain their appointments if they choose up to the limit of their lives. It would also, for manifest reasons, be inexpedient to divert each several fellowship as it becomes vacant from its present destination. The machinery of the University organisation is so delicate that the occasions for introducing changes into it must of necessity be left to those who are best acquainted with the manner in which it works. Many years must elapse before that portion of the College revenues to which original research is now putting in a claim can be handed over to this account. In the meantime it is the duty of all those who support this claim not to dispute about details, but to force a hearing for that principle which they advocate in common, and which, when once publicly recognised, will render easy the remainder of the task.

It is not, however, difficult to point out roughly the lines in which the endowment will have to proceed, and so to meet by anticipation the apparent objections which are certain to be alleged. The form the endowment should take, the persons who are to be entrusted with the distribution, and the guarantee that the appointments shall not degenerate into sinecures, are all matters which require explanation. With regard to the first question, it is necessary to clear away a prevalent misunderstanding, which would seem to be based upon the existing system of Fellowships. It is not an essential part of the new scheme that a given number of Research Fellowships should be forthwith founded, to be awarded to young students who have passed successful examinations in Science. The very opposite course is the one which would commend itself to those who are aware of the evils of the present practice. The number of the new appointments should not be fixed; at first it should be small, but capable of increase as the suitable candidates come for-

ward: and above all, the principle of selection should be other than that of competitive examination. The man with the peculiar talents and proved industry which are wanted for the post must be carefully sought for, and the place must be made for him, rather than the man manufactured for the place. The managing body must be allowed perfect liberty either to found a new Fellowship for the particular man, or to refuse to fill up a vacant appointment. All our Research Fellows will be, according to the German system, in extraordinary posts. From this it will follow that direct endowment of this kind, though the ultimate aim of our efforts, and by far the principal part of our scheme, is not the manner in which a beginning should be made. This form of endowment, so far as can at present be foreseen, must be comparatively exceptional, and therefore, when the right man is found, his position should be made one of handsome emolument, and it ought to be rendered impossible that he should be negligently passed over.

The other ways in which research should be endowed may be regarded in the ultimate scheme as chiefly subsidiary to this, but in the order of time they must come first. The funds of the Colleges which are not wanted for teaching purposes, may at once be utilised for our object in an infinite number of indirect ways. They ought to be regarded as an abundant reservoir, from which may be continually drawn generous encouragement and ready help for those who happen to be carrying on some special investigation in any branch of Science. The Colleges should take the place which was occupied in England some century ago by those noble and wealthy patrons to whom Science, Art, and Literature all owe so much. They should give in no grudging spirit, for they may be assured that an apparent waste in one direction will be amply compensated by the unlooked-for returns which they will reap in another. By throwing open their libraries, by building museums and laboratories, by supplying instruments or needful materials, by paying for laborious calculations or expensive publications, as well as by subsidising any particular investigation, they would breed up, so far as any artificial means can, that race of men from whom the selection must afterwards be made for their new Fellowships. To those who have had unfortunate experience of the management of college business, and of the sort of matters which come before a college meeting, such a reform as has been sketched out will doubtless appear as a visionary ideal; yet it might be realised with very little trouble if the richest Colleges would transfer some of the attention which they now bestow upon ecclesiastical and educational interests, to the cause of original research, and when realised, the result would be more nearly akin than the present, to that which the original statutes contemplated.

To answer the two other questions proposed need not take long, for an implicit reply to them has already been given. Fortunately, modern Science has taken such definite shape, and is pursued in such full publicity, that each branch has even now, at its head, certain acknowledged leaders, to whose judgments and recommendations in their special subjects, all deference is due. Until the Universities and the Colleges become sufficiently penetrated with the new scientific

spirit, it will be natural that they should endow research under the guidance of the scientific societies, and of course it will be always necessary that they should be fully conscious of their responsibilities to the public for the appointments they confer upon the candidates, however selected. The analogy of the Smithsonian Institution will here again come in, for its assistance is never given in any case unless after a favourable report from a Commission of scientific men, who are experts in the particular matter submitted to them.

With regard to the objection that the plan will inevitably tend to the foundation of a new store of sinecures, it is not incumbent to say more than that scientific posts, where the duty itself is of absorbing pleasure, are the least likely to degenerate in the way suggested, and that the in situation comes with an ill grace from those who are the present recipients of benefactions which they do so little to deserve. C.

ON LOSCHMIDT'S EXPERIMENTS ON DIFFUSION IN RELATION TO THE KINETIC THEORY OF GASES

THE kinetic theory asserts that a gas consists of separate molecules, each moving with a velocity amounting, in the case of hydrogen, to 1,800 metres per second. This velocity, however, by no means determines the rate at which a group of molecules set at liberty in one part of a vessel full of the gas will make their way into other parts. In spite of the great velocity of the molecules, the direction of their course is so often altered and reversed by collision with other molecules, that the process of diffusion is comparatively a slow one.

The first experiments from which a rough estimate of the rate of diffusion of one gas through another can be deduced are those of Graham.* Professor Loschmidt, of Vienna, has recently† made a series of most valuable and accurate experiments on the interdiffusion of gases in a vertical tube, from which he has deduced the coefficient of diffusion of ten pairs of gases. These results I consider to be the most valuable hitherto obtained as data for the construction of a molecular theory of gases.

There are two other kinds of diffusion capable of experimental investigation, and from which the same data may be derived, but in both cases the experimental methods are exposed to much greater risk of error than in the case of diffusion. The first of these is the diffusion of momentum, or the lateral communication of sensible motion from one stratum of a gas to another. This is the explanation, on the kinetic theory, of the viscosity or internal friction of gases. The investigation of the viscosity of gases requires experiments of great delicacy, and involving very considerable corrections before the true coefficient of viscosity is obtained. Thus the numbers obtained by myself in 1865 are nearly double of those calculated by Prof. Stokes from the experiments of Baily on pendulums, but not much more than half those deduced by O. E. Meyer from his own experiments. The other kind of diffusion is that of the energy of agitation of the molecules. This is called the conduction of heat. The experimental investigation

* *Brandé's Journal* for 1829, pt. ii., p. 74, "On the Mobility of Gases," *Phil. Trans.*, 1863.

† *Sitzb. d. k. Akad. d. Wissench.*, 10 März. 1870.