

SCIENCE

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ADDRESS OF THE PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE INFLUENCE OF BRAIN-POWER ON HISTORY.

My first duty to-night is a sad one. I have to refer to a great loss which this Nation and this Association have sustained. By the death of the great Englishman and great statesman who has just passed away, we members of the British Association are deprived of one of the most illustrious of our confrères. We have to mourn the loss of an enthusiastic student of science who conferred honor on our body by becoming its President. We recognize that as Prime Minister he was mindful of the interests of science, and that to him we owe a more general recognition on the part of the State of the value to the nation of the work of scientific men. On all these grounds you will join in the expression of respectful sympathy with Lord Salisbury's family in their great personal loss which your council has embodied this morning in a resolution of condolence.

Last year, when this friend of science ceased to be Prime Minister, he was succeeded by another statesman who also has given many proofs of his devotion to philosophical studies, and has shown in many utterances that he has a clear understanding of the real place of science in modern civilization. We then have good grounds

for hoping that the improvement in the position of science in this country which we owe to the one will also be the care of his successor, who has honored the Association by accepting the unanimous nomination of your council to be your President next year, an acceptance which adds a new lustre to this chair.

On this we may congratulate ourselves all the more because I think, although it is not generally recognized, that the century into which we have now well entered may be more momentous than any which has preceded it, and that the present history of the world is being so largely moulded by the influence of brain-power, which in these modern days has to do with natural as well as human forces and laws, that statesmen and politicians will have in the future to pay more regard to education and science, as empire-builders and empire-guarders, than they have paid in the past.

The nineteenth century will ever be known as the one in which the influences of science were first fully realized in civilized communities; the scientific progress was so gigantic that it seems rash to predict that any of its successors can be more important in the life of any nation.

Disraeli, in 1873, referring to the progress up to that year, spoke as follows: "How much has happened in these fifty years—a period more remarkable than any, I will venture to say, in the annals of mankind. I am not thinking of the rise and fall of Empires, the change of dynasties, the establishment of Governments. I am thinking of those revolutions of science which have had much more effect than any political causes, which have changed the position and prospects of mankind more than all the conquests and all the codes and all the legislators that ever lived."*

* *Nature*, November 27, 1873, Vol. IX., p. 71.

The progress of science, indeed, brings in many considerations which are momentous in relation to the life of any limited community—any one nation. One of these considerations to which attention is now being greatly drawn is that a relative decline in national wealth derived from industries must follow relative neglect of scientific education.

It was the late Prince Consort who first emphasized this when he came here fresh from the University of Bonn. Hence the 'Prince Consort's Committee,' which led to the foundation of the College of Chemistry and afterwards of the Science and Art Department. From that time to this the warnings of our men of science have become louder and more urgent in each succeeding year. But this is not all; the commercial output of one country in one century as compared with another is not alone in question; the acquirement of the scientific spirit and a knowledge and utilization of the forces of Nature are very much further reaching in their effects on the progress and decline of nations than is generally imagined.

Britain in the middle of the last century was certainly the country which gained most by the advent of science, for she was then in full possession of those material gifts of Nature, coal and iron, the combined winning and utilization of which, in the production of machinery and in other ways, soon made her the richest country in the world, the seat and throne of invention and manufacture, as Mr. Carnegie has called her. Being the great producers and exporters of all kinds of manufactured goods, we became eventually, with our iron ships, the great carriers, and hence the supremacy of our mercantile marine and our present command of the sea.

The most fundamental change wrought by the early applications of science was in

relation to producing and carrying power. With the winning of mineral wealth and the production of machinery in other countries, and cheap and rapid transit between nations, our superiority as depending upon first use of vast material resources was reduced. Science, which is above all things cosmopolitan—planetary, not national—internationalizes such resources at once. In every market of the world

“things of beauty, things of use,
Which one fair planet can produce,
Brought from under every star,”

were soon to be found.

Hence the first great effect of the general progress of science was relatively to diminish the initial supremacy of Britain due to the first use of *material* resources, which indeed was the real source of our national wealth and place among the nations.

The unfortunate thing was that, while the foundations of our superiority depending upon our *material resources* were being thus sapped by a cause *which was beyond our control*, our statesmen and our universities were blind leaders of the blind, and our other asset, our *mental resources*, which was within our control, was culpably neglected.

So little did the bulk of our statesmen know of the part science was playing in the modern world and of the real basis of the nation's activities, that they imagined political and fiscal problems to be the only matters of importance. Nor, indeed, are we very much better off to-day. In the important discussions recently raised by Mr. Chamberlain, next to nothing has been said of the effect of the progress of science on prices. The whole course of the modern world is attributed to the presence or absence of taxes on certain commodities in certain countries. The fact that the great fall in the price of food-stuffs in England did not come till some thirty or forty years after the removal of the corn duty between

1847 and 1849 gives them no pause; for them new inventions, railways and steamships are negligible quantities; the vast increase in the world's wealth in free trade and protected countries alike comes merely according to them in response to some *political* shibboleth.

We now know, from what has occurred in other States, that if our Ministers had been more wise and our universities more numerous and efficient, our *mental resources* would have been developed by improvements in educational method, by the introduction of science into schools, and, more important than all the rest, by the teaching of science by experiment, observation and research, and not from books. It is because this was not done that we have fallen behind other nations in properly applying science to industry, so that our applications of science to industry are relatively less important than they were. But this is by no means all; we have lacked the strengthening of the national life produced by fostering the scientific spirit among all classes, and along all lines of the nation's activity; many of the responsible authorities know little and care less about science; we have not learned that it is the duty of a State to organize its forces as carefully for peace as for war; that universities and other teaching centres are as important as battleships or big battalions; are, in fact, essential parts of a modern State's machinery, and as such to be equally aided and as efficiently organized to secure its future well being.

Now the objects of the British Association as laid down by its founders seventy-two years ago are “To give a stronger impulse and a more systematic direction to scientific inquiry—to promote the intercourse of those who cultivate science in different parts of the British Empire with one another and with foreign philosophers—to obtain a more general attention to the ob-

jects of science and a removal of any disadvantages of a public kind which impede its progress."

In the main, my predecessors in this chair, to which you have done me the honor to call me, have dealt, and with great benefit to science, with the objects first named.

But at a critical time like the present I find it imperative to depart from the course so generally followed by my predecessors and to deal with the last object named, for unless by some means or other we 'obtain a more general attention to the objects of science and a removal of any disadvantages of a public kind which impede its progress,' we shall suffer in competition with other communities in which science is more generally utilized for the purposes of the national life.

THE STRUGGLE FOR EXISTENCE IN MODERN COMMUNITIES.

Some years ago, in discussing the relations of scientific instruction to our industries, Huxley pointed out that we were in presence of a new 'struggle for existence,' a struggle which, once commenced must go on until only the fittest survives.

It is a struggle between organized species—nations—not between individuals or any class of individuals. It is, moreover, a struggle in which science and brains take the place of swords and sinews, on which depended the result of those conflicts which, up to the present, have determined the history and fate of nations. The school, the university, the laboratory and the workshop are the battlefields of this new warfare.

But it is evident that if this, or anything like it, be true, our industries can not be involved alone; the scientific spirit, brain-power, must not be limited to the workshop if other nations utilize it in all branches of their administration and executive.

It is a question of an important change of front. It is a question of finding a new basis of stability for the Empire in face of new conditions. I am certain that those familiar with the present states of things will acknowledge that the Prince of Wales's call, 'Wake up,' applies quite as much to the members of the Government as it does to the leaders of industry.

What is wanted is a complete organization of the resources of the nation, so as to enable it best to face all the new problems which the progress of science, combined with the ebb and flow of population and other factors in international competition, are ever bringing before us. Every Minister, every public department, is involved, and this being so, it is the duty of the whole nation—King, Lords, and Commons—to do what is necessary to place our scientific institutions on a proper footing in order to enable us to 'face the music' whatever the future may bring. The idea that science is useful only to our industries comes from want of thought. If anyone is under the impression that Britain is only suffering at present from the want of the scientific spirit among our industrial classes, and that those employed in the State service possess adequate brain-power and grip of the conditions of the modern world into which science so largely enters, let him read the report of the Royal Commission on the War in South Africa. There he will see how the whole 'system' employed was, in Sir Henry Brackenbury's words applied to a part of it, *'unsuited to the requirements of an Army which is maintained to enable us to make war.'* Let him read also, in the address of the president of the Society of Chemical Industry what drastic steps had to be taken by Chambers of Commerce and 'a quarter of a million of working men' to get the Patent Law Amendment Act into proper shape, in spite of all the advisers and officials of the Board of Trade. Very

few people realize the immense number of scientific problems the solution of which is required for the State service. The nation itself is a gigantic workshop, and the more our rulers and legislators, administrators and executive officers possess the scientific spirit, the more the rule of thumb is replaced in the State service by scientific methods, the more able shall we be, thus armed at all points, to compete successfully with other countries along all lines of national as well as of commercial activity.

It is obvious that the power of a nation for war, in men and arms and ships, is one thing; its power in the peace struggles to which I have referred is another; in the latter, the source and standard of national efficiency are entirely changed. To meet war conditions, there must be equality or superiority in battleships and army corps. To meet the new peace conditions there must be equality or superiority in universities, scientific organization and everything which conduces to greater brain power.

OUR INDUSTRIES ARE SUFFERING IN THE PRESENT INTERNATIONAL COMPETITION.

The present condition of the nation, so far as its industries are concerned, is as well known, not only to the Prime Minister, but to other political leaders in and out of the Cabinet, as it is to you and to me. Let me refer to two speeches delivered by Lord Rosebery and Mr. Chamberlain on two successive days in January, 1901:

Lord Rosebery spoke as follows:

" * * * The war I regard with apprehension is the war of trade which is unmistakably upon us. * * * When I look round me I cannot blind my eyes to the fact that so far we can predict anything of the twentieth century on which we have now entered, it is that it will be one of acutest international conflict in point of trade.

We were the first nation of the modern world to discover that trade was an absolute necessity. For that we were nicknamed a nation of shopkeepers; but now every nation wishes to be a nation of shopkeepers, too, and I am bound to say that when we look at the character of some of these nations, and when we look at the intelligence of their preparations, we may well feel that it behooves us not to fear, but to gird up our loins in preparation for what is before us."

Mr. Chamberlain's views were stated in the following words:

"I do not think it is necessary for me to say anything as to the urgency and necessity of scientific training. * * * It is not too much to say that the existence of this country, as the great commercial nation, depends upon it. * * * It depends very much upon what we are doing now, at the beginning of the twentieth century, whether at its end we shall continue to maintain our supremacy or even equality with our great commercial and manufacturing rivals."

All this refers to our industries. We are not suffering because trade no longer follows the flag as in the old days, but because trade follows the brains, and our manufacturers are too apt to be careless in securing them. In one chemical establishment in Germany, 400 doctors of science, the best the universities there can turn out, have been employed at different times in late years. In the United States the most successful students in the higher teaching centers are snapped up the moment they have finished their course of training, and put into charge of large concerns, so that the idea has got abroad that youth is the password of success in American industry. It has been forgotten that the latest product of the highest scientific education must necessarily be young, and that it is the training and not the age

which determines his employment. In Britain, on the other hand, apprentices who can pay high premiums are too often preferred to those who are well educated, and the old rule-of-thumb processes are preferred to new developments—a conservatism too often depending upon the master's own want of knowledge.

I should not be doing my duty if I did not point out that the defeat of our industries one after another, concerning which both Lord Rosebery and Mr. Chamberlain express their anxiety, is by no means the only thing we have to consider. The matter is not one which concerns our industrial classes only, for knowledge must be pursued for its own sake, and since the full life of a nation with a constantly increasing complexity, not only of industrial, but of high national aims, depends upon the universal presence of the scientific spirit—in other words, brain power—our whole national life is involved.

THE NECESSITY FOR A BODY DEALING WITH THE ORGANIZATION OF SCIENCE.

The present awakening in relation to the nation's real needs is largely due to the warnings of men of science. But Mr. Balfour's terrible Manchester picture of our present educational condition* shows that the warning which has been going on now for more than fifty years has not been forcible enough; but if my contention that other reorganizations besides that of our education are needed is well founded, and if men of science are to act the part of good citizens in taking their share in endeavoring to bring about a better state of things, the question arises, has the neglect

* "The existing educational system of this country is chaotic, is ineffectual, is utterly behind the age, makes us the laughing-stock of every advanced nation in Europe and America, puts us behind, not only our American cousins, but the German and the Frenchman and the Italian."—*Times*, October 15, 1902.

of their warnings so far been due to the way in which these have been given?

Lord Rosebery, in the address to a Chamber of Commerce from which I have already quoted, expressed his opinion that such bodies do not exercise so much influence as might be expected of them. But if commercial men do not use all the power their organization provides, do they not by having built up such an organization put us students of science to shame, who are still the most disorganized members of the community?

Here, in my opinion, we have the real reason why the scientific needs of the nation fail to command the attention either of the public or of successive governments. At present, appeals on this or on that behalf are the appeals of individuals; science has no collective voice on the larger national questions; there is no organized body which formulates her demands.

During many years it has been part of my duty to consider such matters, and I have been driven to the conclusion that our great crying need is to bring about an organization of men of science and all interested in science, similar to those which prove so effective in other branches of human activity. For the last few years I have dreamt of a Chamber, Guild, League, call it what you will, with a wide and large membership, which should give us what, in my opinion, is so urgently needed. Quite recently I sketched out such an organization, but what was my astonishment to find that I had been forestalled, and by the founders of the British Association!

THE BRITISH ASSOCIATION SUCH A BODY.

At the commencement of this address I pointed out that one of the objects of the Association, as stated by its founders, was 'to obtain a more general attention to the objects of science and a removal of any

disadvantages of a public kind which impede its progress.'

Everyone connected with the British Association from its beginning may be congratulated upon the magnificent way in which the other objects of the Association have been carried out, but as one familiar with the Association for the last forty years, I cannot but think that the object to which I have specially referred has been too much overshadowed by the work done in connection with the others.

A careful study of the early history of the Association leads me to the belief that the function I am now dwelling on was strongly in the minds of the founders; but be this as it may, let me point out how admirably the organization is framed to enable men of science to influence public opinion and so to bring pressure to bear upon Governments which follow public opinion. (1) Unlike all the other chief metropolitan societies, its outlook is not limited to any branch or branches of science. (2) We have a wide and numerous fellowship, including both the leaders and the lovers of science, in which all branches of science are and always have been included with the utmost catholicity—a condition which renders strong committees possible on any subject. (3) An annual meeting at a time when people can pay attention to the deliberations, and when the newspapers can print reports. (4) The possibility of beating up recruits and establishing local committees in different localities, even in the King's dominions beyond the seas, since the place of meeting changes from year to year, and is not limited to these islands.

We not only, then, have a scientific parliament competent to deal with all matters, including those of national importance, relating to science, but machinery for influencing all new councils and committees dealing with local matters, the functions of which are daily becoming more important.

The machinery might consist of our corresponding societies. We already have affiliated to us seventy societies with a membership of 25,000; were this number increased so as to include every scientific society in the Empire, metropolitan and provincial, we might eventually hope for a membership of half a million.

I am glad to know that the Council is fully alive to the importance of giving impetus to the work of the corresponding societies. During this year a committee was appointed to deal with the question; and later still, after this committee had reported, a conference was held between this committee and the corresponding societies committee to consider the suggestions made, some of which will be gathered from the following extract:

"In view of the increasing importance of science to the nation at large, your committee desire to call the attention of the council to the fact that in the corresponding societies the British Association has gathered in the various centres represented by these societies practically all the scientific activity of the provinces. The number of members and associates at present on the list of the corresponding societies approaches 25,000, and no organization is in existence anywhere in the country better adapted than the British Association for stimulating, encouraging and coordinating all the work being carried on by the seventy societies at present enrolled. Your committee are of opinion that further encouragement should be given to these societies and their individual working members by every means within the power of the association; and with the object of keeping the corresponding societies in more permanent touch with the Association they suggest that an official invitation on behalf of the Council be addressed to the societies through the corresponding societies committee asking them to appoint standing

British Association sub-committees, to be elected by themselves with the object of dealing with all those subjects of investigation common to their societies and to the British Association committees, and to look after the general interests of science and scientific education throughout the provinces and provincial centers. * * *

"Your committee desire to lay special emphasis on the necessity for the extension of the scientific activity of the corresponding societies and the expert knowledge of many of their members in the direction of scientific education. They are of opinion that immense benefit would accrue to the country if the corresponding societies would keep this requirement especially in view with the object of securing adequate representation for scientific education on the Education Committees now being appointed under the new Act. The educational section of the Association having been but recently added, the corresponding societies have as yet not had much opportunity for taking part in this branch of the Association's work; and in view of the reorganization in education now going on all over the country your committee are of opinion that no more opportune time is likely to occur for the influence of scientific organizations to make itself felt as a real factor in national education. * * *"

I believe that if these suggestions or anything like them—for some better way may be found on inquiry—are accepted, great good of science throughout the Empire will come. Rest assured that sooner or later such a guild will be formed because it is needed. It is for you to say whether it shall be, or form part of, the British Association. We in this Empire certainly need to organize science as much as in Germany they find the need to organize a navy. The German Navy League, which has branches even in our Colonies, already has a member-

ship of 630,000, and its income is nearly 20,000*l.* a year. A British Science League of 500,000 with a sixpenny subscription would give us 12,000*l.* a year, quite enough to begin with.

I for one believe that the British Association would be a vast gainer by such an expansion of one of its existing functions. Increased authority and prestige would follow its increased utility. The meetings would possess a new interest; there would be new subjects for reports; missionary work less needed than formerly would be replaced by efforts much more suited to the real wants of the time. This magnificent, strong and complicated organization would become a living force, working throughout the year, instead of practically lying idle, useless and rusting for 51 weeks out of the 52 so far as its close association with its members is concerned.

If this suggestion in any way commends itself to you, then when you begin your work in your sections or general committee see to it that a body is appointed to inquire how the thing can be done. Remember that the British Association will be as much weakened by the creation of a new body to do the work I have shown to have been in the minds of its founders as I believe it will be strengthened by becoming completely effective in every one of the directions they indicated, and for which effectiveness we their successors are indeed responsible. The time is appropriate for such a reinforcement of one of the wings of our organization, for we have recently included Education among our sections.

There is another matter I should like to see referred to the committee I have spoken of, if it please you to appoint it. The British Association, which as I have already pointed out is now the chief body in the Empire which deals with the totality of science, is, I believe, the only organiza-

tion of any consequence which is without a charter, and which has not His Majesty the King as patron.

THE FIRST WORK OF SUCH AN ORGANIZATION.

I suppose it is my duty after I have suggested the need of organization to tell you my personal opinion as to the matters where we suffer most in consequence of our lack of organization at the present time.

Our position as a nation, our success as merchants, are in peril chiefly—dealing with preventable causes—because of our lack of completely efficient universities, and our neglect of research. This research has a double end. A professor who is not learning can not teach properly or arouse enthusiasm in his students; while a student of any thing who is unfamiliar with research methods, and without that training which research brings, will not be in the best position to apply his knowledge in after life. From neglect of research comes imperfect education and a small output of new applications and new knowledge to reinvigorate our industries. From imperfect education comes the unconcern touching scientific matters, and the too frequent absence of the scientific spirit, in the nation generally from the court to the parish council.

I propose to deal as briefly as I can with each of these points.

UNIVERSITIES.

I have shown that so far as our industries are concerned, the cause of our failure has been run to earth; it is fully recognized that it arises from the insufficiency of our universities both in numbers and efficiency, so that not only our captains of industry, but those employed on the nation's work generally, do not secure a training similar to that afforded by other nations. No additional endowment of primary, secondary

or technical instruction will mend matters. This is not merely the opinion of men of science; our great towns know it, our Ministers know it.

It is sufficient for me to quote Mr. Chamberlain:—

“It is not everyone who can, by any possibility, go forward into the higher spheres of education; but it is from those who do that we have to look for the men who, in the future, will carry high the flag of this country in commercial, scientific and economic competition with other nations. At the present moment, I believe there is nothing more important than to supply the deficiencies which separate us from those with whom we are in the closest competition. In Germany, in America, in our own colony of Canada and in Australia, the higher education of the people has more support from the Government, is carried further, than it is here in the old country; and the result is that in every profession, in every industry, you find the places taken by men and by women who have had a university education. And I would like to see the time in this country when no man should have a chance for any occupation of the better kind, either in our factories, our workshops or our counting-houses, who could not show proof that, in the course of his university career, he had deserved the position that was offered to him. What is it that makes a country? Of course you may say, and you would be quite right, ‘The general qualities of the people, their resolution, their intelligence, their pertinacity, and many other good qualities.’ Yes; but that is not all, and it is not the main creative feature of a great nation. The greatness of a nation is made by its greatest men. It is those we want to educate. It is to those who are able to go, it may be, from the very lowest steps in the ladder, to men who are able to devote their

time to higher education, that we have to look to continue the position which we now occupy as, at all events, one of the greatest nations on the face of the earth. And, feeling as I do on these subjects, you will not be surprised if I say that I think the time is coming when Governments will give more attention to this matter, and perhaps find a little more money to forward its interests" (*Times*, November 6, 1902).

Our conception of a university has changed. University education is no longer regarded as the luxury of the rich which concerns only those who can afford to pay heavily for it. The Prime Minister in a recent speech, while properly pointing out that the collective effect of our public and secondary schools upon British character can not be overrated, frankly acknowledged that the boys of seventeen or eighteen who have to be educated in them 'do not care a farthing about the world they live in except in so far as it concerns the cricket-field or the football-field or the river.' On this ground they are not to be taught science, and hence, when they proceed to the university, their curriculum is limited to subjects which were better taught before the modern world existed, or even Galileo was born. But the science which these young gentlemen neglect, with the full approval of their teachers, on their way through the school and the university to politics, the Civil Service, or the management of commercial concerns, is now one of the great necessities of a nation, and our universities must become as much the insurers of the future progress as battleships are the insurers of the present power of States. In other words, university competition between States is now as potent as competition in building battleships, and it is on this ground that our university conditions become of the highest national concern and, therefore, have to be referred to

here, and all the more because our industries are not alone in question.

WHY WE HAVE NOT MORE UNIVERSITIES.

Chief among the causes which have brought us to the terrible condition of inferiority as compared with other nations in which we find ourselves are our carelessness in the matter of education and our false notions of the limitations of State functions in relation to the conditions of modern civilization.

Time was when the Navy was largely a matter of private and local effort. William the Conqueror gave privileges to the Cinque Ports on the condition that they furnished fifty-two ships when wanted. In the time of Edward III., of 730 sail engaged in the siege of Calais, 705 were 'people's ships.' All this has passed away; for our first line of defence we no longer depend on private and local effort.

Time was when not a penny was spent by the State on elementary education. Again, we no longer depend upon private and local effort. The navy and primary education are now recognized as properly calling upon the public for the necessary financial support. But when we pass from primary to university education, instead of State endowment we find State neglect; we are in a region where it is nobody's business to see that anything is done.

We in Great Britain have thirteen universities competing with 134 State and privately endowed in the United States and twenty-two State endowed in Germany. I leave other countries out of consideration for lack of time, and I omit all reference to higher institutions for technical training, of which Germany alone possesses nine of university rank, because they are less important; they instruct rather than educate, and our want is education. The German State gives to one university more than the British Government allows to all the

universities and university colleges in England, Ireland, Scotland, and Wales put together. These are the conditions which regulate the production of brain-power in the United States, Germany, and Britain respectively, and the excuse of the Government is that this is a matter for private effort. Do not our Ministers of State know that other civilized countries grant efficient State aid, and further, that private effort has provided in Great Britain less than 10 per cent. of the sum thus furnished in the United States in addition to State aid? Are they content that we should go under in the great struggle of the modern world because the Ministers of other States are wiser, and because the individual citizens of another country are more generous, than our own?

If we grant that there was some excuse for the State's neglect so long as the higher teaching dealt only with words, and books alone had to be provided (for the streets of London and Paris have been used as class rooms at a pinch), it must not be forgotten that during the last hundred years not only has knowledge been enormously increased, but things have replaced words, and fully equipped laboratories must take the place of books and class rooms if university training worthy of the name is to be provided. There is much more difference in size and kind between an old and new university than there is between the old caravel and a modern battleship, and the endowments must follow suit.

What are the facts relating to private endowment in this country? In spite of the munificence displayed by a small number of individuals in some localities, the truth must be spoken. In depending in our country upon this form of endowment, we are trusting to a broken reed. If we take the twelve English university colleges, the forerunners of universities unless we are to perish from lack of knowledge, we find that private effort during sixty years has found

less than 4,000,000*l.*, that is, 2,000,000*l.* for buildings and 40,000*l.* a year income. This gives us an average of 166,000*l.* for buildings and 3,300*l.* for yearly income.

What is the scale of private effort we have to compete with in regard to the American universities?

In the United States, during the last few years, universities and colleges have received more than 40,000,000*l.* from this source alone; private effort supplied nearly 7,000,000*l.* in the years 1898-1900.

Next consider the amount of State aid to universities afforded in Germany. The buildings of the new University of Strassburg have already cost nearly a million; that is, about as much as has yet been found by private effort for buildings in Manchester, Liverpool, Birmingham, Bristol, Newcastle and Sheffield. The Government annual endowment of the same German university is more than 49,000*l.*

This is what private endowment does for us in England, against State endowment in Germany.

But the State does really concede the principle; its present contribution to our universities and colleges amounts to 155,600*l.* a year; no capital sum, however, is taken for buildings. The State endowment of the University of Berlin in 1891-2 amounted to 168,777*l.*

When, then, we consider the large endowments of university education both in the United States and Germany, it is obvious that State aid only can make any valid competition possible with either. The more we study the facts, the more statistics are gone into, the more do we find that we, to a large extent, lack both of the sources of endowment upon one or other or both of which other nations depend. We are between two stools, and the prospect is hopeless without some drastic changes. And first among these, if we intend to get out of the present slough of despond, must be

the giving up of the idea of relying upon private effort.

That we lose most where the State does least is known to Mr. Chamberlain, for in his speech, to which I have referred, on the University of Birmingham, he said: "As the importance of the aim we are pursuing becomes more and more impressed upon the minds of the people, we may find that we shall be more generously treated by the State."

Later still, on the occasion of a visit to University College School, Mr. Chamberlain spoke as follows:

"When we are spending, as we are, many millions—I think it is 13,000,000*l.*—a year on primary education, it certainly seems as if we might add a little more, even a few tens of thousands, to what we give to University and secondary education" (*Times*, November 6, 1902).

To compete on equal grounds with other nations we must have more universities. But this is not all—we want a far better endowment of all the existing ones, not forgetting better opportunities for research on the part of both professors and students. Another crying need is that of more professors and better pay. Another is the reduction of fees; they should be reduced to the level in those countries which are competing with us, to say, one-fifth of their present rates, so as to enable more students in the secondary and technical schools to complete their education.

In all these ways, facilities would be afforded for providing the highest instruction to a much greater number of students. At present there are almost as many *professors and instructors* in the universities and colleges of the United States as there are *day students* in the universities and colleges of the United Kingdom.

Men of science, our leaders of industry, and the chiefs of our political parties all agree that our present want of higher edu-

cation—in other words, properly equipped universities—is heavily handicapping us in the present race for commercial supremacy, because it provides a relatively inferior brain-power which is leading to a relatively reduced national income.

The facts show that in this country we can not depend upon private effort to put matters right. How about local effort?

Anyone who studies the statistics of modern municipalities will see that it is impossible for them to raise rates for the building and upkeep of universities.

The buildings of the most modern university in Germany have cost a million. For upkeep the yearly sums found, chiefly by the State, for German universities of different grades, taking the incomes of seven out of the twenty-two universities as examples, are:

1st Class.....	Berlin.....	£ 130,000
2nd Class.....	{ Bonn..... }	56,000
	{ Göttingen..... }	
3rd Class.....	{ Königsberg..... }	48,000
	{ Strassburg..... }	
4th Class.....	{ Heidelberg..... }	37,000
	{ Marburg..... }	

Thus if Leeds, which is to have a university, is contented with the 4th class German standard, a rate must be levied of 7*d.* in the pound for yearly expenses, independent of all buildings. But the facts are that our towns are already at the breaking strain. During the last fifty years, in spite of enormous increases in rateable values, the rates have gone up from about 2*s.* to about 7*s.* in the pound for real *local* purposes. But no university can be a merely local institution. NORMAN LOCKYER.

(To be concluded.)

MENDEL'S LAW OF HEREDITY.*

WHAT will doubtless rank as one of the great discoveries in biology, and in the

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