

dissection, with the sacred structures which he would be called upon to invade with his knife in the living body. A dissecting room well provided with the needful material for study has since been an essential equipment of every medical school, and a thorough course of dissection is demanded of every medical student. Meanwhile another kind of anatomy than that which the scalpel displays has come into being—the anatomy which the microscope has revealed and is constantly further revealing. This microscopic anatomy both of healthy and of diseased structures has assumed the greatest importance, and like naked-eye anatomy it requires special provision for its successful study. The materials to be studied cannot well be obtained by the student in his lodgings, and the processes employed for the elucidation of their minute structure are often of a complicated character which he cannot learn unaided, and require costly apparatus which he cannot provide. The requisite facilities for this work will be amply supplied by the laboratories which are to be opened to-day. The necessity for special pathological institutions has long been recognised on the continent, and nowhere has such an establishment been conducted with more signal success than in the Pathologisches Institut of Berlin, presided over for many long years by the illustrious man whom Liverpool is, I am sure, as glad to welcome with reverence as London has been. Many present to-day have sat at the feet of Prof. Virchow, but we may fairly anticipate that Liverpool students at all events will for the future be able to dispense with these pilgrimages to Germany. While the minute anatomy of normal and morbid structures will be thus effectively taught in the new laboratories, much may also be done in them to demonstrate and explain the actions of the living organism. I well remember the effect produced upon me as a member of Dr. Sharpey's class in London, by the repetition before us of Bernard's great experiment on the local circulation, and the converse experiment of Waller. The sympathetic nerve in the neck of an animal being divided, the ear of that side instantly became red and hot, and the blood vessels turgid; while on the application of galvanism to the severed nerve the opposite effect immediately followed, the ear becoming white and cool, and the vessels less conspicuous than those of the other side. Thus was impressed upon us, as mere oral teaching could hardly have done, the immensely important fact that the contractions of the arteries are as much under the control of the nervous system as are those of the muscles of a limb. I need, perhaps, hardly add that the animal being completely under an anæsthetic during such a demonstration no pain whatever is inflicted. In the study of the new science of bacteriology the pathological laboratory will render most important service. The student will see with his own eyes by aid of the microscope the minute living beings which we now know to constitute the essential cause of many infectious diseases, and he will be put through a course of the cultivation of these microbes, which, while it will impress upon him the reality of their existence, and the characters by which the various species may be recognised, will be invaluable as an exercise of the habits of accurate observation and manipulative skill. The new laboratories will also serve as a centre to which practitioners of a wide surrounding district may refer for the authoritative determination of the nature of doubtful specimens of diseased material, which they have neither the needful equipment, time, nor special knowledge to decide for themselves. As important as the services which the laboratories will render to education and medical practice will be the opportunities which they will afford for research. I had occasion, in the address which I gave two years ago in this city, to refer to some of the benefits which have been secured to mankind by recent biological investigation, and I need not say more on the subject at present; but I would remark that every step in advance in science only opens up wider fields for exploring the infinite resources of nature; and these laboratories will afford ample means for the further prosecution of such beneficent inquiries. Some, perhaps, may be disposed to object to such researches because they involve the sacrifice of animal life. This, however, I need hardly remark, is as nothing compared to what occurs for the supply of food to man. Of animal suffering I need hardly speak, because, in truth, the actual pain involved in these investigations is commonly of the most trifling description. Anæsthesia has come to the aid of experiment on animals, as the electric telegraph did for railways. Anæsthesia enables needful operations to be done without disturbance from the struggles of the animal,

while it affords to the operator the unspeakable comfort of knowing that he inflicts no pain. I am bound to add that anti-septic treatment of the wounds has had a similar doubly beneficial influence. By preventing inflammation it renders healing painless, while it leaves the parts uncomplicated by inflammatory changes, and allows the results of operative procedure to be rightly estimated. I greatly surprised a former Chancellor of the Exchequer when, on a deputation to him on this subject, I explained to him that operations for the removal of parts of the brain of monkeys, which he had imagined to be attended with horrible torture, had, thanks to anæsthetics and antiseptics, been probably from the first to last unattended with a twinge of pain. Such operations thus painlessly conducted have, by indicating the precise functions of different parts of the organ, and thus guiding the surgeon in his operations, already led to the saving of many human lives. While I deeply respect the humane feelings of those who object to this class of inquiry, I would assure them that, if they knew the truth, they would commend and not condemn them. The laboratories, though they will be formally opened to-day, have for some time past been in practical operation; with the result that the Biological and Pathological School of Liverpool is already ranking very high among similar institutions in other parts of the world. As an illustration I may mention the fact that a committee of the Royal Society, with the approval of the Secretary of State for the Colonies, has lately selected a pupil of this school as one of two men specially qualified to undertake investigations in Africa on the deadly malaria of those regions. I cannot conclude these remarks without congratulating the Liverpool College on the mighty addition which these laboratories afford to their powers for usefulness. I believe they may be pronounced, both in structure and equipment, equal to any in existence. I must also congratulate you on having so nobly generous a benefactor as Mr. Thompson-Yates. I trust he will be rewarded by the deep satisfaction of knowing that he is doing incalculable good to mankind. If I may make one more observation, it is that while the laboratories have been so nobly constructed and equipped, there is yet much to be desired as regards the means for maintaining them in efficiency; and if any wealthy inhabitant of Liverpool is anxious to bestow his wealth in some manner calculated to do good to his fellow-men, he could hardly do better than by devoting a portion of his resources to the permanent maintenance of these fine institutions.

MECHANICS AT THE BRITISH ASSOCIATION.

THOUGH an admirable President had been secured in Sir John Wolfe Barry, the proceedings in this Section were not up to the usual standard either in interest or importance to the profession. The fact of the matter is that, as in other Sections, too many papers are accepted, involving inordinately long sittings and often tending to hinder due discussion of really valuable papers. Unless the communications are mere notes of some scientific discovery or fact, the programme should be so arranged that not more than four papers are put down for any one day. The organising committee should insist that at least half a dozen copies of any paper intended for reading should be in the hands of the recorder a month before the opening of the meeting: the recorder could then circulate these copies, with a note of the day on which the paper would be taken, amongst those engineers most capable of discussing satisfactorily the facts and conclusions of the author, with a request from the organising committee that they should attend and take part in the discussion. The President would thus have a list of those he could call upon to speak on any paper, and the speakers having had an opportunity of preparing their remarks beforehand, a really valuable discussion would be secured. Few men are able to get up and discuss off-hand a scientific paper, which they have had no opportunity of studying, especially when it has been read often at great speed in an almost inaudible tone; and the result is that we have the poor discussions which so often take all the life out of the proceedings in Section G.

At the Institution of Civil Engineers printed copies of the papers are always circulated a week or two beforehand, and no effort is spared to secure the attendance of every one capable of throwing any light upon the subject under consideration. As a

result discussions often extend over two successive meetings of the Institution. Perhaps the organising committee may be able to do something in this line before the next meeting, and renewed efforts should be made to secure papers from the workers in the engineering laboratories which are such a feature now of all our universities and university colleges. All attempts to secure such help during the past few years have met with most disheartening refusals.

The most important point raised by the President in his valuable address was the suggestion that in order to enable funds to be cheaply raised to carry out the deepening and enlarging of our docks, the great railway companies should practically take over the control of the harbours and docks which they respectively serve. It was pointed out that every year saw an increase in the over-all dimensions not only of ocean liners, but of the ordinary cargo boats; this means that most of the dock authorities will within the next few years have to face very heavy expenditure in enlarging and deepening locks and their water approaches. Sir John doubted if this increased capital would be able to earn a fair interest, and claimed that if they were administered by the railway companies there was more chance of both diminishing establishment charges and of securing a sufficient inducement for the public to invest, on the faith of this new security. He indicated ways of preventing the growth of a dangerous monopoly, but it is very doubtful whether the public would willingly see such an amalgamation; there is already an indictment against the railways of strangling many industries by their excessive charges for carriage of goods, and curiously enough Mr. Forster Brown, in a thoughtful paper on "The economic and mechanical features of the coal question," advocated strongly the State purchase of railways in order to bring about a reduction of freight charges, and thus to make good the ever growing cost of production owing to deeper and thinner seams having to be worked. In the discussion on Mr. Brown's paper several of the speakers reluctantly confessed they were gradually drifting to State purchase as a necessity sooner or later, but the President opposed the proposal very strongly.

The outstanding feature in the proceedings of the Section was the constant cropping up of this all-important question of facilitating the carriage from the sea-board to the factory of the raw products of our great manufactures, and the return transit of the manufactured goods. The extraordinary growth of the manufactures and commerce of Germany during the last twenty years, the still more rapid strides which have been made in the United States during the same period, are forcing us to realise that our supremacy is being challenged in every quarter of the globe; this is the justification of the feverish haste with which schemes are being pressed forward to enlarge our dock facilities, to increase their equipment, and to connect our great inland manufacturing centres to the sea-board by canals suitable for sea-going vessels. The cost of carriage must at all hazards be reduced, hence the papers by Mr. R. C. H. Davison on the new works at Barry Docks (visited by the Section on the Saturday), by Prof. Ryan on Welsh methods of shipping coal, by Mr. Marten on a scheme for the improvement of the waterway between the Bristol Channel and the Birmingham district, and by Mr. Allen on electric canal haulage, and also the paper by Mr. Brown, already alluded to. It was not so much the mechanical and engineering details described in these papers, important though they were, which interested the audiences and gave rise to discussion, but the economic features of the one problem common to them all—the cheapening of the carriage of our raw products and our manufactures. Industrial legislation during recent years, and the upward tendency of wages of skilled labour render inevitable a reduction in some other direction to counterbalance the increased cost of production brought about by the above two tendencies. The two directions in which this reduction can be obtained most readily are in the increase of labour-saving appliances in the process of manufacture, and a lessening the cost of the raw product by facilitating and cheapening its carriage; this latter saving again coming to the help of the manufacturer in the diminishing of the carriage charges on the manufactured goods as they are distributed to our customers. Mr. Brown drew attention to one other direction in which expenses might be cut down, namely in the charge for rates and taxes, but here he was in reality advocating something which would be of benefit to the next generation and not to ours; his claim that local loans should be repaid within a shorter interval of time than is now necessary

would in fact place, perhaps rightly, a heavier burden on our shoulders. It must in this connection be remembered that much of the great increase in local indebtedness which has begun to alarm some of our statesmen, is due to the borrowing of money for remunerative undertakings, and that as long as the general prosperity of the nation lasts, such municipal undertakings as electric lighting works, waterworks, gasworks, tram-lines, &c., are not likely to become a burden to the community. The money sunk in them is in a similar condition to that invested in ordinary commercial undertakings; the rate-payer pays no increased rates in consequence of them, but in reality obtains many absolute necessities of modern life cheaper than he would were these undertakings in private hands.

The visit to Barry, mentioned above, was a most enjoyable and instructive one; the extraordinary change in the district since the Association met in Bath, when a similar visit was made, was a striking object-lesson in the growth of the Welsh coal trade. The new dock was actually opened at this visit, since the three launches in which the party were taken round were the first vessels to steam from the old dock through the connecting cut (the dam closing this was only partly removed) into the new dock. The splendid caisson for closing this cut, which was worked with the utmost ease and perfect truth, and the extensive equipment of cranes and appliances for shipping coal were the objects of much admiration on the part of the visitors. Mr. Davison's paper, well illustrated by lantern slides, in which all the difficulties met with in the construction (and so well overcome) were clearly described, had prepared the members of the Section for this visit, which also made Prof. Ryan's somewhat technical paper on the coal-tips in use in South Wales a much more valuable and interesting contribution.

Monday, as usual, was devoted to electrical engineering, when three papers on the application of the electric motor to the engineering workshop, by Mr. A. Siemens, Mr. H. H. Gibbings and Mr. W. Geipel, were read and jointly discussed. The best discussion in the Section at this meeting rose over these three papers, Prof. Silvanus Thompson arguing that in England, by adhering to the continuous current so rigidly, we were dropping behind continental and American engineers, who found no difficulty in their alternating current systems; he claimed that all the difficulties could be easily met and solved, if we only faced them and made use of the experiences of other workers in the field. This contention was hotly denied by Mr. Parker and other speakers, and in the end the matter was left where it began; but, at any rate, it gave an opportunity of publicly thrashing out once more this vexed question. The novel plan adopted at Bradford of hiring out motors to small customers, with the object of increasing the day load at the central station, and also of stimulating small industries will, perhaps, be widely adopted; but it is very questionable whether the charge made for loan of the motor is in any way sufficient to cover depreciation of these somewhat delicate machines. Mr. Proctor, electrical engineer to the city of Bristol, gave some valuable figures as to the comparative cost of working steam and electric pumps for boiler feeding, &c., in central stations; the economy of the electric pump was very distinctly shown, especially at light loads; the experiments have, however, hardly been of a sufficiently extensive character to justify absolute conclusions in all cases.

Prof. Silvanus Thompson and Mr. Walker contributed a joint paper on electric traction by surface contacts, in which most of the schemes so far brought forward were described; the experiments conducted by the authors on an experimental line at Willesden were explained, and many of the details described by the help of lantern slides. There was a very scanty discussion, turning chiefly on the possible danger of such studs giving electric shocks (the author explained in reply this was impossible), and on the question of the cost of fitting up such apparatus.

There were two papers descriptive of new instruments—one by Mr. Coker describing a very ingenious instrument for attachment to test bars under torsional stresses in order to measure the small strains or twists, while the material was still in the elastic stage. The instrument had been tried in the mechanical engineering laboratory at University College, London, and found to work well and with complete freedom from all back-lash; it is, however, too delicate and complex to place in the hands of students. The other paper was by Prof. Hele-Shaw on a new instrument for drawing envelopes, and its

application to the teeth of wheels and for other purposes. This communication and also Mr. Forster Brown's are to be printed *in extenso* in the *Proceedings* of the Association. The instrument was a very beautiful one, and the difficult problem it solved had been most carefully worked out; but here again a very poor discussion followed, because no one felt able to criticise the instrument or discuss the advantages or disadvantages of such a piece of apparatus after merely hearing the author's short account; a description with sufficient diagrams ought to have been weeks before in the hands of those anxious to become acquainted with it, and to discuss it.

Amongst other papers dealt with was Mr. Dibdin's paper on the treatment of sewage by bacteria, which in the discussion elicited from Sir Alex Binnie the statement that the experiments he was carrying out for the London County Council led him to believe we were on the eve of most important changes in the treatment of town sewage.

SCIENCE IN RELATION TO TRADE.

DURING the last few years numerous references have appeared in the various reports made to the Foreign Office by Her Majesty's diplomatic and consular officers on the methods adopted by the principal trade rivals of the United Kingdom in their competition in foreign trade abroad, and on the apparent supineness of British traders in meeting this competition. Besides calling attention to this, the Consuls suggest the adoption of certain measures which they consider would be advisable for British traders to take with a view of retaining the pre-eminence of this country on foreign markets.

A selection has been made of the views expressed in some of these reports issued during the period comprised between January 1896 and the present time, and has just been published in a Blue Book.

From the 171 extracts in this publication it appears that the following are some of the causes which are considered as tending to place British trade at a disadvantage in those districts where, especially of late years, foreign competition has been more than usually keen:—

- I. The disinclination of British traders—
 - (a) To supply a cheaper class of goods.
 - (b) To be content with a small order at first.
 - (c) To study a customer's wishes.
 - (d) To adopt the metric system in calculations of weight, cost, &c.
 - (e) To grant credit facilities.
- II. The scarcity of British commercial travellers, in comparison with those of other nationalities, their ignorance of the language of the countries they visit, and the endeavour to supply their place by a lavish distribution of catalogues and other matter printed in English only.
- III. The inferiority of the British to the German and American methods of packing.
- IV. The additional cost of goods caused by the high rates or freight on British lines of steamers.
- V. The frequency of strikes in the United Kingdom tending to cause uncertainty in the delivery of orders.
- VI. The development of technical education in Germany and the greater attention paid in schools to modern languages, added to the system of sending young Germans all over the world to acquire a practical knowledge of the language, business habits, &c., of other countries, by means of which they are afterwards able to compete with those countries with a greater chance of success.

The two causes which concern us refer to the use of the metric system and the development of technical education in Germany. On these matters the Blue Book contains the following summary of the views expressed in the reports:—

METRIC SYSTEM.

The Consuls all lay stress upon the uselessness and expense of British exporters forwarding trade circulars and catalogues more or less well-prepared in English, and with English weights and measures calculated in our own currency. British weights and measures are not liked abroad, and are in many cases either not understood at all, or very imperfectly so, and the preference is given to those who accommodate themselves to the metric and decimal systems. On this point the Consul at Naples expresses himself as follows:—"It seems absurd that the first

commercial nation in the world should measure their horses by hands and their dogs by inches, their cloth by ells and their calico by yards; that such impossible numbers should come into their square measure as 301 and 4840, and in their measure of solidity as 1728. And the weights are worse still. It can never be too much impressed upon British traders that all goods for sale on the continent should be marked in metres and kilograms, and all catalogues sent to the continent should be in a language which is understood by the people of the country."

TECHNICAL EDUCATION.

Much has been written respecting the superiority of the German technical education to that of Great Britain, and to this has been attributed the success which is said to have attended German commercial enterprise within the last twenty-five years. That the technical education is better than that in England is denied by many Germans who are competent to express an opinion, having studied the question in both lands; but what they do admit is that the application of this education in Germany is carried out to a more practical and useful conclusion than in England. "Thus," says the Consul at Stettin, "in Great Britain there are numerous public and private schools having a modern side in their curriculum which is an excellent adaptation of what is termed in Germany the "reul gymnasium"; but in how many English schools is the modern side looked down upon by the head master and consequently by the boys themselves; and the classic side held up as the education which befits a gentleman! . . . Undoubtedly the far greater majority of British lads, on the completion of their education, become what is vaguely termed men of business, and at the present day it is an absolute necessity for the carrying on of that business against the keen competition which, owing to European peace, has manifested itself in foreign lands during the last twenty-five years, that we, as a nation of merchants, should be able to deal with our customers in their own tongues; and for this purpose it is of the utmost importance that the youth of Great Britain should be instructed for the most part in living languages."

Again, attention is called in the reports to the fact that Germans have been gradually paving their way to their present position by quiet individual persistence backed up by special education. It is stated that they are in the habit of going as clerks into British houses at home and abroad and gradually obtaining a thorough knowledge of the British way of doing business, of the centres of production, &c., which they subsequently turn to good account; but some doubts are expressed as to whether any German houses would receive an Englishman in the same way even if he possessed the necessary qualifications. On this point the British Vice-Consul at Porto Alegre says: "Germans can generally speak English and French practically and usefully, and were taken into English houses at first because they were content with little, and sometimes even no salary, in order to pick up business. On the other hand, the English clerk usually understands no language but his own, and this deficiency alone would be enough to prevent his being taken on as a clerk in a German house. Twenty or thirty years ago the important export trade of this State was almost exclusively in the hands of British merchants; now it is in German hands."

THE DEVELOPMENT OF THE TUATARA LIZARD.

PROF. A. DENDY, professor of biology in Canterbury College, New Zealand, has been engaged for the past two years in investigating the development of the Tuatara Lizard, perhaps the most remarkable animal now living in New Zealand, and the oldest existing type of reptile. A short summary of the principal scientific results obtained was sent to London just in time to be laid before the Royal Society at its final meeting for the session in June last. The memoir itself, containing a detailed account of the general development, with numerous illustrations, has now arrived in England, and will shortly be published. Meanwhile, the following particulars, published in the *Christchurch Press*, will be of interest to naturalists:—The development of the Tuatara presents several remarkable features. The eggs are laid in November, and on Stephen's Island take about thirteen months to hatch, the embryos passing the winter in a state of hibernation, unknown in any other vertebrate embryos. Before entering upon their winter sleep the nostrils of the embryo