moved off to the right very gradually as the cooler end of the bar became heated, but was brought back to a convenient point on the scale by means of a controlling magnet. When the state of steady flow was reached, the bunsen flame was removed, and water was immediately poured over the heated end of the bar. The spot of light on the galvanometer scale immediately moved off to the right, indicating an immediate rise of temperature at the cooler end of the bar.

The rapidity of the action was a second source of surprise to me, as it far exceeded the velocity of propagation of heat along the bar by conduction. I was obliged to discontinue this line of work for a time, and did not return to it till 1895, when I repeated the experiments described above, this time, however, using brass rods of various dimensions. In the case of the brass rods I failed to observe the same phenomenon, and concluded that the effect was due, as I had supposed in 1888, to much the same cause as recalescence.

I should judge from my results that if the effect exists at all in brass, it is yet much more pronounced in iron or steel.

At the time I made my experiments at Johns Hopkins University, I drew the attention of Prof. Henry A. Rowland and Dr. Louis Duncan to the matter, the latter witnessing the experiments, and later I discussed it with Prof. Ogden N. Rood, of Columbia University, New York City. Prof. Rowland pointed out that theoretically there should be a very slight instantaneous effect, but that it should be a reduction and not an increase of temperature.

That the effect just described is altogether unaccounted for by the present mathematical theory of the propagation of heat in conductors is not very surprising in view of the fact that that theory postulates the constancy of the specific heat and thermal conductivity of the medium, whereas at high temperatures these properties vary considerably with the temperature, and particularly in the case of iron, the physical state undergoes a complete change of what Hopkinson termed the *critical temperature*, which varies in different specimens from 690° C. to 870° C.

In attempting an explanation of the phenomenon which we have been discussing, it seems to me fair to assume that the heat producing the sudden rise of temperature observed, is not transmitted along the rod with the great velocity observed in the tests, but that it exists at the cooler end of the rod before the rise of temperature occurs. When iron or steel which has been heated to redness is suddenly plunged into water a marked change takes place in the properties of the metal, and if this change of character in the metal is in part transmitted from particle to particle to the other end of the rod, and results in a lowering of the heat capacity of the material, a rise of temperature will result as observed. JOHN STONE STONE.

20 Newbury Street, Boston, Mass., U.S.A., September 19.

Animals and Poisonous Plants.

FROM repeated observations in my own garden, I know that song-thrushes will eat ripe mezereon berries greedily. In the winter of 1896 they cleared a small bush containing, perhaps, two hundred berries, in the course of a week or two, returning at once when driven away, and becoming half-stupefied; so that they might, apparently, have been caught with the hand.

Dr. Withering states ("British Plants," ed. 1812) that six berries of this shrub (*Daphne mezereum*) will kill a wolf.

According to the same authority, *Cicuta virosa* is a certain poison to cows; while goats devour it eagerly, and it is not injurious to sheep and horses. As to *Atropa belladonna*, a case which received much attention at the time may be found in the daily papers of some twenty years ago. A family were poisoned by eating rabbit-pie, the symptoms being those of atropine poisoning; and the inquiry, which followed, showed that rabbits do often eat deadly nightshade berries.

J. C. Loughton, Essex.

WITH reference to Mr. Bennett's inquiry as to the consumption of poisonous berries by birds, I remember a young blackbird, some years back, who used to frequent the garden of the house in which I was staying, and who eagerly swallowed the berries of the *Daphne mezereum*. He was rather tame and would take them when I threw them to him, following them as they rolled along the ground, as a chicken would go after peas. I see that Sowerby confirms the ordinary opinion as to the

poisonous nature of these berries: "The whole plant is a powerful irritant, both bark, leaves and fruit acting poisonously if taken in large quantities. A few of the berries have been known to cause death when swallowed." The blackbird did not seem the worse for them.

EDWARD M. LANGLEY.

16 Adelaide Square, Bedford, October 15.

An Osteometric Index-Calculator.

I SHOULD feel obliged if any of your readers could inform me whether there is in use among anthropologists any mechanical appliance by which indices can be determined without loss of time and the possible inaccuracy attending an arithmetical calculation.

I am anxious to obtain information on this subject in order to find out if there is any simpler or possibly better instrument than one I have constructed. It consists of a graduated quadrant and a movable arm, and it is very helpful in doing the purely arithmetic work, as it shows accurately, at a glance, the index required from any two figures, and does not work by logarithms, as does the slide rule of engineers, which might be used for the purpose.

DAVID WATERSTON.

Anatomical Department, University of Edinburgh, October 11.

Capture of Curious Crustaceans.

Two living specimens of that very curious Crustacean *Stenorhynchus phalangium* were taken in a net, off this coast, yesterday.

E. L. J. RIDSDALE.

The Dene, Rottingdean, October 14.

A SHORT HISTORY OF SCIENTIFIC INSTRUCTION.¹

II.

I MUST come back from this excursion to call your attention to the year 1845, in which one of the germs of our College first saw the light.

What was the condition of England in 1845? Her universities had degenerated into *hauts lycées*. With regard to the University teaching, I may state that even as late as the late fifties a senior wrangler—I had the story from himself—came to London from Cambridge expressly to walk about the streets to study crystals, prisms, and the like in the optician's windows. Of laboratories in the universities there were none; of science teaching in the schools there was none; there was no organisation for training science teachers.

If an artisan wished to improve his knowledge he had only the moribund Mechanics' Institutes to fall back upon.

The nation which then was renowned for its utilisation of waste material products allowed its mental products to remain undeveloped.

There was no Minister of Instruction, no councillors with a knowledge of the national scientific needs, no organised secondary or primary instruction. We lacked then everything that Germany had equipped herself with in the matter of scientific industries.

Did this matter? Was it more than a mere abstract question of a want of perfection?

It mattered very much! From all quarters came the cry that the national industries were being undermined in consequence of the more complete application of scientific methods to those of other countries.

The chemical industries were the first to feel this, and because England was then the seat of most of the large chemical works.¹

Very few chemists were employed in these chemical works. There were in cases some so-called chemists at about bricklayers' wages—not much of an inducement to study chemistry; even if there had been practical laboratories, where it could have been properly learnt. Hence when efficient men were wanted they were got from

¹ An address delivered at the Royal College of Science by Sir Norman Lockyer, K.C.B., F.R.S., on October 6. (Continued from page 575.)

¹ Perkin, NATURE, xxxii. 334.

abroad—i.e. from Germany, or the richer English had to go abroad themselves.

At this time we had, fortunately for us, in England, in very high place, a German fully educated by all that could be learned at one of the best equipped modern German Universities, where he studied both science and the fine arts. I refer to the Prince Consort. From that year to his death he was the fountain of our English educational renaissance, drawing to himself men like Playfair, Clark and De la Beche; knowing what we lacked, he threw himself into the breach. This College is one of the many things the nation owes to him. His service to his adopted country, and the value of the institutions he helped to inaugurate, are by no means even yet fully recognised, because those from whom national recognition full and ample should have come, were, and to a great extent still are, the products of the old system of middle age scholasticism which his clear vision recognised was incapable by itself of coping with the conditions of modern civilised communities.

It was in the year 1845 that the influence of the Prince Consort began to be felt. Those who know most of the conditions of Science and Art then and now, know best how beneficial that influence was in both directions; my present purpose, however, has only reference to Science.

The College of Chemistry was founded in 1845, first as a private institution; the School of Mines was established by the Government in 1851.

In the next year, in the speech from the Throne at the opening of Parliament, Her Majesty spoke as follows:—"The advancement of the Fine Arts and of practical Science will be readily recognised by you as worthy the attention of a great and enlightened nation. I have directed that a comprehensive scheme shall be laid before you having in view the promotion of these objects, towards which I invite your aid and co-operation."

Strange words these from the lips of an English sovereign!

The Government of this country was made at last to recognise the great factors of a peaceful nation's prosperity, and to reverse a policy which has been as disastrous to us as if they had insisted upon our naval needs being supplied by local effort as they were in Queen Elizabeth's time.

England has practically lost a century; one need not be a prophet to foresee that in another century's time our education and our scientific establishments will be as strongly organised by the British Government as the navy itself.

As a part of the comprehensive scheme referred to by Her Majesty, the Department of Science and Art was organised in 1853, and in the amalgamation of the College of Chemistry and the School of Mines we have the germ of our present institution.

But this was not the only science school founded by the Government. The Royal School of Naval Architecture and Marine Engineering was established by the Department at the request of the Lords Commissioners of the Admiralty "with a view of providing especially for the education of shipbuilding officers for Her Majesty's Service, and promoting the general study of the Science of Ship Building and Naval Engineering." It was not limited to persons in the Queen's Service, and it was opened on November 1, 1864. The present Royal College of Science was built for it and the College of Chemistry. In 1873 the School was transferred to the Royal Naval College, Greenwich, and this accident enabled the teaching from Jermyn Street to be transferred and proper practical instruction to be given at South Kensington. The Lords of the Admiralty expressed their entire satisfaction with the manner in which the instruction had been carried on at South Kensington; and well they might, for in a memorandum submitted to the Lord President in 1887, the President and Council of the

Institute of Naval Architects state:—"When the Department dealt with the highest class of education in Naval Architecture by assisting in founding and by carrying on the School of Naval Architecture at South Kensington, the success which attended their efforts was phenomenal, the great majority of the rising men in the profession having been educated at that Institution."

Here I again point out, both with regard to the School of Mines, the School of Naval Architecture, and the later Normal School, that it was stern need that was in question, as in Egypt in old times.

Of the early history of the College I need say nothing after the addresses of my colleagues, Profs. Judd and Roberts-Austen, but I am anxious to refer to some parts of its present organisation and their effect on our national educational growth in some directions.

It was after 1870 that our institution gradually began to take its place as a Normal School—that is, that the teaching of teachers formed an important part of its organisation, because in that year the newly-established Departments having found that the great national want then was teachers of Science, began to take steps to secure them. Examinations had been inaugurated in 1859, but they were for outsiders, conferring certificates and a money reward on the most competent teachers tested in this way. These examinations were really controlled by our School, for Tyndall, Hofmann, Ramsay, Huxley, and Warrington Smyth, the first professors, were also the first examiners.

Very interesting is it to look back at that first year's work, the first cast of the new educational net. After what I have said about the condition of Chemistry and the establishment of the College of Chemistry in 1845, you will not be surprised to hear that Dr. Hofmann was the most favoured—he had forty-four students.

Prof. Huxley found one student to tackle his questions, and he failed.

Profs. Ramsay and Warrington Smyth had three each, but the two threes only made five; for both lists were headed by the name of

Judd, John W.,
Wesleyan Training College,
Westminster.

Our present Dean was caught in the first haul.

These examinations were continued till 1866, and upwards of 600 teachers obtained certificates, some of them in several subjects.

Having secured the teachers, the next thing the Department did was to utilise them. This was done in 1859 by the establishment of the Science Classes throughout the country which are, I think, the only part of our educational system which even the Germans envy us. The teaching might go on in schools, attics or cellars, there was neither age-limit nor distinction of sex or creed.

Let me insist upon the fact that from the outset practical work was encouraged by payments for apparatus, and that latterly the examinations themselves, in some of the subjects, have been practical.

The number of students under instruction in Science Classes under the department in the first year in which these classes were held, was 442; the number in 1897 was 202,496. The number of candidates examined in the first year in which local examinations were held, was 650, who worked 1000 papers; in 1897 the number was 106,185, who worked 159,724 papers, chemistry alone sending in 28,891 papers, mathematics 24,764, and physiography 16,879.

The total number of individual students under instruction in Science Classes under the Department from 1859 to 1897 inclusive has been, approximately, 2,000,000. Of these about 900,000 came forward for examination, the total number of papers worked by them being 3,195,170.

Now why have I brought these statistics before you?

Because from 1861 onwards the chief rewards of the successful students have been scholarships and exhibitions held in this College; a system adopted in the hope that in this way the numbers of perfectly trained Science Teachers might be increased, so that the Science Classes throughout the country might go on from strength to strength.

The Royal Exhibitions date from 1863, the National Scholars from 1884. The Free Studentships were added later.

The strict connection between the Science Classes throughout the country and our College will be gathered from the following statement, which refers to the present time:—

Twenty-one Royal Exhibitions—seven open each year—four to the Royal College of Science, London, and three to the Royal College of Science, Dublin.

Sixty-six National Scholarships—twenty-two open each year—tenable, at the option of the holder, at either the Royal College of Science, London, or the Royal College of Science, Dublin.

Eighteen Free Studentships—six open each year—to the Royal College of Science, London.

A Royal Exhibition entitles the holder to free admission to lectures and laboratories, and to instruction during the course for the Associateship—about three years—in the Royal College of Science, London, or the Royal College of Science, Dublin, with maintenance and travelling allowances.

A National Scholarship entitles the holder to free admission to lectures and laboratories and to instruction during the course of the Associateship—about three years—at either the Royal College of Science, London, or the Royal College of Science, Dublin, at the option of the holder, with maintenance and travelling allowances.

A Free Studentship entitles the holder to free admission to the lectures and laboratories and to instruction during the course for the Associateship—about three years—in the Royal College of Science, London, but not to any maintenance or travelling allowance.

Besides the above students who have been successful in the examinations of the Science Classes, a limited number (usually about 60) of teachers, and of students in science classes who intend to become science teachers, are admitted free for a term or session to the courses of instruction. They may be called upon to pass an entrance examination. Of these, there are two categories—those who come to learn and those who remain to teach; some of the latter may be associates.

Besides all these, those holding Whitworth Scholarships—the award of which is decided by the Science examinations—can, and some do, spend the year covered by the exhibition at the College.

In this way, then, is the École Normale side of our institution built up.

The number of Government students in the College in 1872 was 25; in 1886 it was 113, and in 1897 it was 186.

The total number of students who passed through the College from 1882–3 to 1896–97 inclusive was 4145. Of these 1966 were Government students. The number who obtained the Associateship of the Royal School of Mines from 1851 to 1881 was 198, of whom 39 were Government students, and of the Royal College of Science and Royal School of Mines from 1882 to 1897 the number was 525, of whom 323 were Government students. Of this total of 362 Government students 94 were Science teachers in training.

With regard to the Whitworth Scholarships, which, like the Exhibitions, depend upon success at the yearly examinations throughout the country, I may state that six have held their scholarships at the College for at

least a part of the scholarship period, and three others were already associates.

So much for the prizemen we have with us. I next come to the teachers in training who come to us. The number of teachers in training who have passed through the College from 1872 to 1897 inclusive is about 600; on an average they attended about two years each. The number in the session 1872–73, when they were first admitted, was 16, the number in 1885–86 was 50, and in 1896–97 60. These have not as a rule taught Science Classes previously, but before admission they give an undertaking that they intend to teach. In the earlier years some did not carry out this undertaking, doubtless because of the small demand for teachers of Science at that time. But we have changed all that. With but very few exceptions, all the teachers so trained now at once begin teaching, and not necessarily in classes under the Department. It is worthy of note, too, that many Royal Exhibitioners and National Scholars, although under no obligation to do so, also take up Science teaching. It is probable that of all the Government students now who pass out of the College each year not less than three-fourths become teachers. The total number of teachers of Science engaged in classes under the Department alone at the present time is about 6000.

I have not yet exhausted what our College does for the national efforts in aiding the teaching of Science.

When you, gentlemen, leave us about the end of June for your well-earned holidays, a new task falls upon your professors in the shape of summer courses to teachers of Science Classes brought up by the Department from all parts of the four kingdoms to profit by the wealth of apparatus in the College and Museum, and the practical work which it alone renders possible.

The number of Science teachers who have thus attended the summer courses reaches 6200, but as many of these have attended more than one course the number of separate persons is not so large.

Research.

From time to time balances arise in the Scholarship fund owing to some of the National Scholarships or Royal Exhibitions being vacated before the full time for which they are tenable has expired. Scholarships are formed from these balances and awarded among those students who, having completed the full course of training for the Associateship, desire to study for another year at the College. *It is understood that the fourth year is to be employed in research in the subject of the Associateship.*

The gaining of one of the Remanet Scholarships, not more than two on the average annually, referred to, furnishes really the only means by which deserving students are enabled to pursue research in the College; as, although a professor has the power to nominate a student to a free place in his laboratory, very few of the most deserving students are able to avail themselves of the privilege owing to want of means.

The Department only very rarely sends students up as teachers in training for research work, but only those who intend making teaching their profession are eligible for these studentships.

I trust that at some future day, when we get our new buildings—it is impossible to do more than we do till we get them—more facilities for research may be provided, and even an extension of time allowed for it if necessary. I see no reason why some of the 1851 Exhibition Scholarships should not be awarded to students of this College, but to be eligible they must have published a research. Research should naturally form part of the work of the teachers in training who are not brought up here merely to effect an economy in the teaching staff.

Such, then, in brief, are some of our Normal School

attributes. I think any one who knows the facts must acknowledge that the organisation has justified itself not only by what it has done, but also by the outside activities it has set in motion. It is true that with regard to the system of examining school candidates by means of papers sent down from London, the Department was anticipated by the College of Preceptors in 1853, and by Oxford and Cambridge in 1858; but the action of 1861, when Science Classes open to everybody, was copied by Oxford and Cambridge in 1869. The Department's teachers got to work in 1860, but the so-called "University Extension Movement" dates only from 1873, and only quite recently have summer courses been started at Oxford and Cambridge.

The Chemical and Physical Laboratories, small though they were in the Department's schools, were in operation long before any practical work in these subjects was done either at Oxford or Cambridge. When the College laboratories began about 1853, they existed practically alone. From one point of view we should rejoice that they are now third rate. I think it would be wrong of me not to call your attention to the tenacity, the foresight, the skill, the unswerving patience, exhibited by those upon whom has fallen the duty of sailing the good ship "Scientific Instruction," launched as I have stated, out upon a sea which was certain from the history I have brought before you to be full of opposing currents.

I have had a statement prepared showing what the most distinguished of our old students and of those who have succeeded in the Department's examinations are now doing. The statement shows that those who have been responsible for our share in the progress of scientific instruction have no cause to be ashamed.

Conclusion.

I have referred previously to the questions of Secondary Education and of a true London University, soon, let us hope, to be realised.

Our College will be the first institution to gain from a proper system of Secondary Education, for the reason that scientific studies gain enormously by the results of literary culture, without which we can neither learn so thoroughly nor teach so effectively as one could wish.

To keep a proper mind-balance, engaged as we are here continuously in scientific thought, literature is essential, as essential as bodily exercise, and if I may be permitted to give you a little advice, I should say organise your athletics as students of the College, and organise your literature as individuals. I do not think you will gain so much by studying scientific books when away from here as you will by reading English and foreign classics, including a large number of works of imagination; and study French and German also in your holidays by taking short trips abroad.

With regard to the University. If it be properly organised, in the light of the latest German experience, with complete Science and Technical Faculties of the highest order, it should certainly insist upon annexing the School of Mines portion of our Institution; the past history of the School is so creditable that the new University for its own sake should insist upon such a course. It would be absurd, in the case of a nation which depends so much on mining and metallurgy, if these subjects were not taught in the chief national university, as the University of London must become.

But the London University, like the Paris University, if the little history of Science teaching I have given you is of any value, must leave our Normal College alone, at all events till we have more than trebled our present supply of Science teachers.

But while it would be madness to abolish such an institution as our Normal School, and undesirable if not impossible to graft it on the New University, our School, like its elder sister in Paris, should be enabled to gain

by each increase in the teaching power of the University. The students on the scientific side of the Paris School, in spite of the fact that their studies and researches are looked after by fourteen professors entitled *Maîtres de Conférences*, attend certain of the courses at the Sorbonne and the Collège de France, and this is one of the reasons why many of the men and researches which have enriched French science, hail from the *École Normale*.

One word more. As I have pointed out, the French *École Normale* was the result of a revolution, I may now add that France since Sedan has been doing, and in a tremendous fashion, what, as I have told you, Prussia did after Jena. Let us not wait for disastrous defeats, either on the field of battle or of industry, to develop to the utmost our scientific establishments and so take our proper and complete place among the nations.

J. NORMAN LOCKYER.

FELLOWSHIPS FOR RESEARCH.

THE foundation of Research Fellowships by the Commissioners of the Exhibition of 1851 was in this country of the nature of an experiment. Many people more or less enamoured of the system in vogue at the universities, whereby a man is carried on from one examination grind to another, until his freshness and originality of mind are in great measure lost, looked at the scheme for Research Fellowships with distrust, and an inclination to foretell their failure. There might, it was said, be an able man here and there who is benefited by holding a Research Fellowship and who does good work while holding it, but, in general, maturity of mind and knowledge, and an accumulated fund of experience are necessary for the success of a scientific or literary investigator. There is truth in this, of course, but the scholastic training of the best men is frequently carried so far that all enthusiasm is killed out by examinations, or the mind has become too critical and fastidious for the work of original production or continuous investigation.

These prophecies have been falsified in the most conclusive way by the report of the Commissioners. They say that they have received from academic institutions all over the country unanimous testimony to the success of their system of Research Scholarships, and an analysis of the work done by the Research Scholars and their after careers shows that the success has been full and complete. A number of able young men, fairly well trained in theoretical and practical science, have been chosen from the best students of our provincial colleges and given the means of pursuing research, and therefore also higher study of the best kind, for two or three years at approved institutions at home and abroad. The Commissioners most wisely determine that the whole time of the scholars should be given to the research work undertaken, and have steadfastly refused to sanction the employment of their funds to enable students to prepare for University degrees. The scheme and its conditions were the subject of much criticism. It was objected that by spending time in research the prospects in life of such men would be injured, that it would be difficult for them after to find congenial employment. This fear has also proved groundless. Of the large number of young men who have been sent out by the Royal Commissioners nearly all have obtained appointments in which the knowledge, skill, and, above all, resource and self-dependence they have acquired will be of the utmost value. Many have returned to their old colleges to teach, and to encourage among the students rising among them that zeal for the advancement of science they have themselves imbibed, to be an example ever before the eyes of still younger men, and by their association with rising students to create an interest in scientific progress which the studies of the class-room often fail to arouse. Some