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THE HISTORY OF PHYSIOLOGY.

Lectures on the History of Physiology during the Sixteenth, Seventeenth and Eighteenth Centuries. By Sir M. Foster, K.C.B., M.P., M.D., D.C.L., Sec. R.S., Professor of Physiology in the University of Cambridge. Pp. 310. (Cambridge: University Press.)

THERE is no more fascinating chapter in the history of science than that which deals which physiology, but a concise and at the same time compendious account of the early history of the subject has never before been presented to the English reader. Physiologists therefore owe a debt of gratitude to Sir Michael Foster for supplying a want which was widely felt. The following is a short account of the contents of the book, to which no higher praise can be given than to say that it is worthy of the reputation of its author.

As already remarked, the subject itself is a fascinating one, and it is rendered the more so by the manner in which it is treated in these lectures,[1] which abound with interesting biographical details and with quotations from the works of the early masters of science. The work is one which will interest circles far wider than physiological, for so intimately are the natural sciences interconnected that it is impossible to write the history of any one without constantly referring to points in the history of others. This must especially be so with physiology, which is directly based upon anatomy, physics and chemistry. It is not therefore surprising to find that the first lecture is devoted to the work of Vesalius and the early history of anatomy.

Andreas Vesalius was born in Brussels on December 31, 1514; his father was apothecary to the Emperor Charles V., and his mother, "to judge by her maiden name, Isabella Crabbe, was probably of English extraction." He studied at Louvain and at Paris, in the latter place under Jacobus Sylvius and Guinterius. That was a time when neither anatomy nor medicine was recognised outside the pages of Galen: if the facts were not reconcilable with Galen, so much the worse for the facts; it was rank heresy to teach otherwise. But Vesalius early determined to investigate for himself, and, although he had to resort for his material to the graveyard and even to the gibbet, where, he says, "'to the great convenience of the studious, the bodies of those condemned to death were exposed to public view,'" he was not to be deterred from his purpose. At the age of twenty-one he migrated to Venice, and was almost immediately appointed to teach surgery and anatomy at the University of Padua. Here his opportunities for study were far greater than in Paris or Louvain, and after five years' patient labour he produced his great work "On the Structure of the Human Body," which was published at Basel in 1543. "This book," says Foster, "is the beginning, not only of modern anatomy, but of modern physiology."

It is true that Vesalius dealt but little with physiology, being for the most part content to teach the Galenic doctrines, he himself saying that "'he accommodated his statements to the dogmas of Galen, not because he thought that these were in all cases consonant with truth, but because in such a new great work he hesitated to lay down his own opinions, and did not dare to swerve a nail's breadth from the doctrines of the Prince of Medicine.'"

But he no doubt recognised that the new truths about anatomy which he was promulgating involved the modification or rejection of the old dogmas. And it is certain that the publication of his work was so received, for the storm of opposition which it raised from the orthodox teachers of the time proved sufficient to terminate Vesalius' career as an anatomist. In disgust he burnt all his manuscripts, and accepted the post of Court Physician to Charles V. This was in 1544, and, although he lived some twenty years longer and was able to see his work beginning to bear fruit, he himself produced no more.

While it is clear that Vesalius did not really believe that the blood passed from the right heart to the left through the septum, as Galen supposed, it was Servetus, the Unitarian physician who was burnt at the stake by Calvin, who, in a theological work written in 1546 and published in 1553, first clearly enunciated the opinion that the communication occurs through the lungs. But how far this opinion was the result of experiment and observation and how far it was mere conjecture is difficult to say; in any case Servetus' suggestion had little influence upon the progress of physiology, nor was it accepted until, in the course of the following century, the proofs were furnished by Harvey. Like all great discoveries, that of Harvey was led up to by the work of previous observers, more than one of whom arrived very near the truth. This is the case, as we have seen, with Servetus so far as the pulmonary circulation is concerned, with Cæsalpinus, and with Realdus Columbus (who is, however, supposed to have "cribbed" from a manuscript of Servetus). Fabricius of Aquapendente, Harvey's master, supplied in his discovery of the valves of the veins one of the most important facts upon which Harvey's doctrine of the circulation was based. But there can be no difference of opinion as to the fact that the history of physiology itself and all advance in surgery and medicine begins with Harvey, for until the action of the heart and the circulation of the blood were understood there could be no correct understanding of the working of any part of the animal mechanism. To this subject the second lecture is accordingly devoted.

Harvey was born in 1578 at Folkestone. He took his degree at Cambridge in 1597, studied four years under Fabricius at Padua, became physician to St. Bartholomew's Hospital in 1609, and "ventured in 1615 to develope, in his 'Lectures on Anatomy' at the College of Physicians, the view which he was forming concerning the movements of the heart and of the blood. But his book, his *Exercitatio*, did not see the light until 1628." He was physician to Charles I., after whose death "he retired into private life, publishing in 1651 his treatise, *De generatione animalium*, . . . and on June 3, 1667, he ended a life remarkable for its effects rather than for its events."

"His wonderful book, or rather tract, for it is little more, is one sustained and condensed argument." Up

[1] The lectures were delivered as the "Lane Lectures" at the Cooper Medical College in San Francisco in the autumn of 1900.

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to the time of Harvey it was supposed, and was commonly taught, that the heart acted like a suction pump, not like a force pump; that the diastole was the active, the systole the passive, condition; that the blood ebbed and flowed in the veins and arteries; that air and vital spirits passed to the heart by the pulmonary arteries; that the blood, or part of the blood, passed from the right ventricle to the left through pores in the septum. Harvey's results were arrived at partly by anatomical observation and inference, but chiefly by physiological observation and experiment. His arguments were founded,

"not on general principles and analogies, but on the results of 'frequent appeals to vivisection.' 'When first I gave my mind to vivisection, as a means of discovering the motions and uses of the heart, and sought to discover these from actual inspection, and not from the writings of others, I found the task so truly arduous, that I was almost tempted to think, with Frascatorius' (a Veronese doctor of the sixteenth century and more a poet than a man of science), 'that the movement of the heart was only to be comprehended by God. For I could neither rightly perceive at first when the systole and when the diastole took place, nor when and where dilatation and contraction occurred, by reason of the rapidity of the movement, which in many animals is accomplished in the twinkling of an eye, coming and going like a flash of lightning.' But the patient and prolonged study of the heart in many animals showed him that 'the motion of the heart consists in a certain universal tension, both of contraction in the line of its fibres and constriction in every sense, that when the heart contracts it is emptied, that the motion which is in general regarded as the diastole of the heart is in truth its systole,' that the active phase of the heart is not that which sucks blood in but that which drives blood out."

In this way Harvey came to see clearly, what had been already dimly guessed at by more than one of his forerunners, that the right heart receives blood from the venæ cavæ and pumps it through the lungs into the left heart. From it there followed

"another conception, which, however, 'was so new, was of so novel and unheard of a character, that in putting it forward he not only feared injury to himself from the enmity of a few, but trembled lest he might have mankind at large for his enemies.' . . . To this new view he was guided by distinctly quantitative considerations. . . . This is what he says: 'I frequently and seriously bethought me, and long revolved in my mind, what might be the quantity of blood which was transmitted, in how short a time its passage might be effected, and the like; and not finding it possible that this could be supplied by the juices of the ingested aliment without the veins on the one hand being drained, and the arteries on the other hand becoming ruptured through the excessive charge of blood, unless the blood should somehow find its way from the arteries into the veins, and so return to the right side of the heart; I began to think whether there might not be *a motion, as it were, in a circle*. Now this I afterwards found to be true. . . .' To that true view of the motion of blood he was led by a series of steps, each in turn based on observations made on the heart as seen in the living animal."

His argument is essentially a physical mechanical argument, and his demonstration was the "deathblow to the doctrine of the distribution of 'animal spirits' by the blood," although he does not himself deal with that doctrine and only refers to it incidentally.

The revival of the study of physics under Galileo and his pupils in the seventeenth century had a marked influence upon the progress of the new physiology, and forms the subject-matter of the third lecture. In particular Borelli (1608–1679), the famous professor of mathematics at Pisa, influenced largely by his friendship with Malpighi, set to work to apply physical laws to physiological problems. His great work, "De motu animalium," was not published until just after his death, but what is printed in it had been taught publicly long before, and much of the work had long been in manuscript.

A large part of Borelli's work is devoted to the special mechanical problems. He treats in succession of muscular mechanics, of standing, walking, running and locomotion in general, and investigates them by the aid of mathematics (his discussions concerning these problems may still be read with profit); he even attempts to solve the nature of muscular motion by mechanical methods. He estimates the force of muscles and of the heart, shows how the elasticity of the arteries aids the flow of blood through them, deals with the mechanics of respiration, and anticipates the modern attempts to account for all the phenomena of secretion by a mechanical explanation. Even nervous phenomena are explained by him as due to oscillations transmitted by a fluid, and in the same spirit he discusses "the generation and nutrition of both plants and animals, and even the nature of several diseases. . . . He was so successful in his mechanical solutions of physiological problems that many coming after him readily rushed to the conclusion that all such problems could be solved by the same methods."

The work of Marcello Malpighi (1628–1694), the friend of Borelli, and his colleague at Pisa during three years, although the greater part of his life was spent at Bologna (his native city), is dealt with at great length in the fourth lecture of the series. With his character the lecturer has obviously the fullest sympathy.

"Kindly even to softness, ready to give his affections to those who seemed drawn to him, devoted wholly to those who had won his love, modest and retiring even to timidity, bold only in the interests of truth and right, never in his own . . . beloved for the sake of himself, even by those who were not competent judges of his talents and his works."

Four years of his life, viz. from 1662–1666, Malpighi spent at Messina, as professor of medicine, and it was here that he began those researches into the minute anatomy of fishes and invertebrates which "opened up in his mind views as to the real nature of the like but more complex structures of man and the higher animals."

Malpighi's relations to the young Royal Society of London are well known. These relations began in 1667 and continued throughout his life, and the Society "had the honour of publishing and of bearing the expense of publication of the greater part of Malpighi's works." His work was essentially founded upon the use of the microscope, which had but recently been invented, or rather improved and rendered an instrument available for research. He and Nehemiah Grew, independently and almost simultaneously, laid the foundations of our knowledge of the structure of plants. He may also be regarded as the founder of embryology, for he gave the first adequate description of the changes undergone by the developing chick *in ovo*. He described the capillary circulation, and thus completed the immortal discovery of Harvey, and although not the first to observe the corpuscles of the blood, for he was anticipated in this by a few years by Swammerdam, his observation was independent of Swammerdam's, and made long prior to its publication. The extent of his researches into the structure of the tissues and organs is testified to by the number of parts to which his name is attached, *e.g.* the Malpighian tubules of insects, the rete Malpighii of the epidermis, the Malpighian bodies of the spleen and kidney. "Whatever part of natural knowledge he touched he left his mark; he found paths crooked and he left them straight; he found darkness and he left light."

The effect upon physiology of the new knowledge of chemistry which was dawning in the seventeenth century, as the result, in large measure, of the work of van Helmont (1577–1644), mystic though he was in many matters, and of his immediate successors, is dealt with in the fifth and sixth lectures. Practising as a physician, van Helmont was nevertheless mainly occupied, at Vilvorde in Belgium, with carrying out chemical observations and experiments. Although he received the Elijah cloak of Paracelsus, whose spiritualistic doctrines he adopts and even develops, and although he was still imbued with the Galenic doctrines, in spite of the fact that Harvey's work was already published when he wrote and must have been known to him, he nevertheless shows himself to be

"a patient, careful, exact observer . . . who watches, measures and weighs, who takes advantage of the aid of instruments of exact research, who reaches a conclusion by means of accurate quantitative estimations. . . . Throughout the whole of his writings is seen the continued endeavour to weave his exact chemical physical knowledge and his spiritualistic views into a consistent whole. . . . These two sides of van Helmont's character are not unfitly indicated by the two words *gas* and *blas*, 'two new terms,' he himself says, 'introduced by me because a knowledge of them (*i.e.* of the things they indicate) was hidden from the ancients.' By '*blas*' he meant an invisible spiritual agency which directs and governs material changes: this is the *archeus* of Paracelsus. By '*gas*' he clearly meant what we now call carbonic acid gas. . . . He gives it that name because the sound is not so far from that of 'chaos,' the unformed womb of all things."

He shows that gas is produced by the combustion of charcoal, by the fermentation of fruits, by the ignition of gunpowder. He gives an account of digestion, which he likens to fermentation. He recognises the essentially acid nature of the gastric secretion and its chemical action upon food. He describes absorption from the intestines as being due, in part at least, to diffusion. But he does not grasp the idea of the use of air in breathing; he still clings to the old notion of "vital spirits." He anticipates modern physiology in teaching that the tissues prepare their own substance independently from the blood. But, to judge by his writings, van Helmont was at heart more pleased with his blas than with his gas. "He allows to man alone a sensitive soul. The throne of this soul is in the pylorus; 'there it sits and there it abides all life long.' He gives reasons for this conclusion, *e.g.* a great emotion is felt at the pit of the stomach; a severe blow in the pit of the stomach will stop the heart."

Van Helmont was followed by Franciscus Sylvius (1614–1672) in explaining many of the phenomena of the body by the help of chemical science, and by Regner de Graaf (1641–1673) in his observations upon digestion. De Graaf was the first to obtain pancreatic juice, saliva, and bile from artificial fistulæ; his methods are used at the present day. And soon afterwards the knowledge of glands and their functions was still further advanced by the discoveries of Peyer (1653–1712), and von Brunner (1653–1727), of the glands in the intestine now known by their names.

But the progress of chemical science was destined to be arrested for many years by the speculations and teaching of George Ernest Stahl (1660–1734), who was successively court physician at Weimar, professor of medicine at Halle, and physician to the King of Prussia. "He was an accomplished chemist, and his name must always be borne in mind in dealing with the history of science, if for nothing else, for the reason that he was the author of the famous theory of phlogiston, which ruled with a rod of iron, as it were, the thoughts of natural philosophers for a hundred years."

Stahl maintained the view that the chemical changes of the living body were entirely different from those of the laboratory, that they were directly governed by the sensitive soul, which pervaded all parts, which not only set the chemical agent in motion, but was itself the agent. "He thus stands forth at the close of the seventeenth century as the founder of 'animism,'" a doctrine which, under the name of a vital principle, maintained itself through the succeeding centuries, and exists in a modified form even at the present day.

The seventh lecture of the series, which is devoted to the English school of the seventeenth century and deals mainly with the evolution of the physiology of respiration, is one of great interest, bound up as it is with the early history of the Royal Society. The fundamental experiment that a candle goes out, an animal dies, in a space deprived of air is due to Robert Boyle (1660). Robert Hook in 1667 showed the Fellows of the Royal Society that an animal can be kept alive by artificial respiration without any movement of the lung or chest wall; that the air alone, coming in contact with the blood, is the essential part of respiration. Richard Lower (1631–1690), besides his well-known work on transfusion and on the structure and action of the heart, also carried the subject of the physiology of respiration still further by showing that the change of the blood from venous to arterial is merely a change of colour due to air; he concluded that this entrance of fresh air into the blood is as necessary for the body as for the combustion of fuel. But it was left for John Mayow (1643–1679) to prove that it is a part only of the air to which this property is due, and to this part he gave the name of "nitro-aereal or igneo-aereal" spirit, which was neither more nor less than that which we now term oxygen. This was before Stahl had introduced the phlogiston theory, the essence of which was that when a combustible body was burned, phlogiston departed from it: it lost weight. Mayow is quite explicit on this point, showing that when antimonium is burned it increases considerably in weight. "'Now we can hardly conceive that the increase of weight of the antimonium arises from anything else than from the igneo-aereal particles inserted into it during the calcination.'"

Mayow fully identified burning and breathing. He found that either a lighted candle or an animal in an enclosed space exhausts a certain proportion of the air. "'We may infer,'" he says, "'that animals and fire deprive the air of particles of the same kind.'" "'It is clear,'" he adds elsewhere, "'that even the very plants seem to have some need of breathing, some need of drawing air into themselves.'" "In his tract, 'On Respiration,' he gives an exposition of the mechanics of breathing which might almost find its place in a text-book of the present day." He further supposed that the heat of the body is kept up by union of tiny nitro-aereal particles with salino-sulphureous (*i.e.* combustible) particles of the blood—a "sound theory," says Foster, "of animal heat," although now superseded, as will be subsequently seen, by one which places the union in the tissues themselves.

But the "great truth" which had been reached by the labours of these English physicists and physiologists died out with Mayow.

"The world had to wait for more than a hundred years till Mayow's thought arose again, as it were, from the grave in a new dress, and with a new name; and that which in the first years of the latter half of the seventeenth century as igneo-aereal particles shone out in a flash and then died away again in darkness, in the last years of the eighteenth century, as oxygen, lit a light which has burned, and which has lighted the world with increasing steadiness up to the present day."

The rise of the modern doctrines of combustion and respiration, the work of Black, Priestley and Lavoisier, is dealt with in the ninth lecture of the series, the eighth being devoted to the researches of Réaumur, Spallanzani, Stevens and John Hunter on gastric digestion. Although van Helmont had shown the stomach to be a great digestive organ and the acid character of its secretion its essential feature, subsequent authorities had ignored or denied its agency in digestion. It was regarded as having mainly a mechanical function. But Réaumur, who was eminent in other sciences besides physiology, showed clearly, by causing a kite to swallow small metal tubes closed at each end by a grating and filled with food, that without any trituration and with no semblance of putrefaction both meat and bone became dissolved whereas vegetable grains were little altered. He even obtained gastric juice from pieces of sponge included in the tubes, and found it to be acid. Spallanzani, who was born in 1729 and the centenary of whose death was celebrated two years ago, was successively professor of logic at Reggio and of natural history at Modena and at Pavia. He wrote on many subjects of natural history, but in physiology chiefly upon respiration and digestion—experimenting by Réaumur's methods upon all kinds of animals and even upon himself. He obtained gastric juice as Réaumur had done, but was successful in showing its activity *in vitro*, in which Réaumur had not succeeded; he failed, however, to detect its acid character. Similar experiments to those of Spallanzani were made independently by Stevens, of Edinburgh, who announced his results in an inaugural thesis in 1777, the same year as the publication of Spallanzani's first paper on the subject. Stevens also obtained "pure gastric fluid" from the stomach of a dog killed during fasting, and found that at the body temperature it readily dissolved meat, and he made besides numerous experiments by Réaumur's method on digestion *in vivo*. John Hunter, in 1772, "constantly found that there was an acid, though not a strong one," in the gastric juice, but later on he is led to regard this as not essential. The acidity which van Helmont had insisted upon at the beginning of the seventeenth century was not accepted until the nineteenth.

Stephen Hales (1677–1761) was a Fellow of Corpus Christi College, Cambridge, and became perpetual curate of Teddington in Middlesex. "He was devoted to science; he had begun to experiment while at Cambridge in the 'elaboratory' of Trinity College," where Bentley was then master; "and he continued his researches amid his parish duties at Teddington." He was the first to determine by experiment upon the living animal (horse) the pressure of the blood in the arteries, and he dealt also with the flow of sap in plants. "His writings contain the first clear enunciation of the existence of gases in a free and in a combined condition."

It is the merit of Joseph Black (1728–1799), who was professor of chemistry successively in Glasgow and Edinburgh, to have rediscovered the "gas" of van Helmont: to this he gave the name of "fixed air." He proved that it is given off in combustion, in fermentation and in respiration; that it is irrespirable; and he at first thought that it formed the irrespirable portion of the atmosphere. But Rutherford, of Edinburgh, in his inaugural thesis in 1772, showed that after the "fixed air" (caused by combustion) had been removed by caustic alkali, "a very large proportion of air remains which extinguishes life and flame in an instant." This was nothing else than the discovery of *nitrogen*, although its connection with nitre was first shown later by Cavendish.

Just as Black rediscovered the *gas sylvestre* of van Helmont, so Priestley (1733–1804) and Lavoisier (1743–1794) rediscovered the gas which Mayow had termed the igneo-aereal spirit and which was ultimately named by Lavoisier *oxygen*. Priestley was a Unitarian minister—"a man of letters as well as man of science, prolific theologian and ardent politician." He was the first to discover that the something in the air which is removed by the burning of a candle or by the respiration of an animal is restored by vegetation. He obtained from mercuric oxide (*mercurius calcinatus per se*), by heating it with a burning glass, a quantity of "air." "'Having got about three or four times as much as the bulk of my materials, I admitted water to it, and found that it was not imbibed by it. But what surprised me more than I can well express was that a candle burned in this air with a remarkably vigorous flame . . . and a piece of red-hot wood sparkled in it.'"

"He obtained the same gas from red precipitate and from minium; he found that a mouse lived well in it . . . that it was four or five times as good as common air."

Imbued with the phlogistic theory, he regarded it as common air which was freed from phlogiston, "dephlogisticated air," and he endeavoured to explain all his own results as well as the changes occurring in combustion and respiration on the same theory. Thus although in 1774 he prepared oxygen he did not discover it in the true sense of the word, because he failed to understand his discovery. This was reserved for Lavoisier, who, in the year following (1775), published his paper "On the nature of the principle which combines with metals during their calcination," in which he conclusively showed that the principle is taken up from the air, is part of the air. Two years later he demonstrated that the same substance "is the constructive principle of acidity," and he called it the acidifying (or oxygine) principle.

The composition of the atmosphere now became clear; the discovery, or rediscovery, of nitrogen (or *azote*, from its inability to support life) naturally followed, and the gaseous exchanges in the lungs between oxygen from the air and Black's "fixed air," or "aeriform calcic acid," as it was at first termed by Lavoisier, were demonstrated, as we at present understand them. "Thus at a single stroke did this clear-sighted inquirer solve the problem of oxidation, and almost, if not quite, the problem of respiration." This was in 1777.

Three years later Lavoisier and Laplace published their celebrated memoir on heat. In this they definitely state—as the result of measurements of the amount of heat produced by the combustion of a given weight of carbon when burned to carbonic acid, and the amount given out by an animal with the production of a given quantity of carbonic acid—that "respiration is a combustion, slow it is true, but otherwise perfectly similar to the combustion of charcoal. It takes place in the interior of the lung . . . The heat developed by this combustion is communicated to the blood . . . and is distributed over the whole animal system." Later Lavoisier recognised that the combustion of hydrogen, which had been discovered by Cavendish in 1781, takes a part in the production of animal heat. Not until long after Lavoisier—not, in fact, until well into the nineteenth century—was it recognised that the combination of oxygen with carbon and hydrogen occurs, not in the lungs, but in the tissues. Lavoisier was but fifty years old when he was swept away, in 1794, in the maelstrom of the Revolution; all too soon for the science which he had done so much, and in so short a time, to advance.

The tenth and final lecture is devoted to the older doctrines of the nervous system. The views of Vesalius and of Descartes (1596–1650), of Willis (1621–1675) and Glisson (1597–1677), of Borelli, of Stensen (1638–1686) and of Haller (1708–1777) are here set forth, and the history of the doctrine of "irritability" of tissues, first enunciated by Glisson and afterwards by Haller, is described. But, as a matter of fact, the physiology of the nervous system is almost entirely the product of the nineteenth century; before that it can scarcely be said to have a history; everything was obscure, and the place of facts was occupied for the most part by vague speculations.

One of the most prolific subjects of such speculation was the seat of the soul, which was assigned by van Helmont (as we have already seen) to the pit of the stomach, by Descartes to the pineal gland, by Haller, with better reason, to the medulla oblongata. "But we have learned much since Haller's time." . . . "And if he," adds Foster, "with the knowledge and the means at his command, seems to us to-day to have often gone astray, shall not we ourselves one hundred years hence still more often appear to have gone astray?" To which it may perhaps be replied that, although it will always be human to err, yet the means at our command are so much more complete and the methods so much more accurate that it is far less likely that we shall take a start in a wrong direction, or, having taken it, shall continue in it; in this at least we have an advantage over our eighteenth century predecessors, whose methods were, comparatively speaking, rough and their means and opportunities relatively limited.

Whilst endeavouring in the above account to give a general idea of the character of the book with which Sir Michael Foster has enriched the world of science, it is by no means an easy task to do adequate justice to the mine of literary and historic research which the author has laid open to view. But if a perusal of this account serves to induce others to go to the original, we can promise them that they will find it as interesting a story as may be met with for many a long day. And it is to be hoped that the perusal of Sir Michael Foster's history will stimulate the desire of its readers to make the direct acquaintance of the great authors who, during the three centuries under review, laid the foundations of modern physiology and, with it, of the sciences upon which modern physiology is based. E. A. S.

FILTRATION OF WATER.

Water Filtration Works. By James H. Fuertes. Pp. xviii + 283. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1901.) Price 10*s.* 6*d.*

FILTRATION, which is generally regarded as an essential process in the provision of domestic water-supplies for large towns in England, especially when rivers constitute the source of supply, has been neglected to a considerable extent in the United States, and, therefore, the publication of a book, by an American engineer, dealing wholly with this subject, will be particularly valuable if it should lead municipalities in the United States to the more general adoption of this safeguard against the distribution of water to large populations in a condition dangerous to health. Polluted river waters, in their natural condition, have proved very fatal to our troops in South Africa, as shown by the high rate of mortality from enteric or typhoid fever; and the author, at the commencement of his book, draws a very striking contrast between the annual death-rate from typhoid fever per 100,000 persons in cities supplied with pure or filtered water, such as the Hague, Munich, Dresden, and Berlin, with a typhoid death-rate of only from 4·7 to 7, and Washington, Louisville, and Pittsburg, supplied with unfiltered river water, where the yearly typhoid death-rate for several years has averaged 71, 74, and 84, respectively, per hundred thousand of population. River waters are to some extent purified by natural agencies during their downward flow if no fresh causes of contamination are introduced, depending on the extent of their original pollution and the length of their uncontaminated flow; and the impurities in suspension may to a considerable extent be removed by causing the water to remain at rest in a settling basin for a certain period before distribution, so that the larger, heavier particles are deposited at the bottom of the basin. Generally, however, after this subsidence has taken place, the finer, lighter particles and micro-organisms remain in suspension in the water, as well as substances in solution; and the final purification can only be effected by filtration, assisted often by aëration, and sometimes by chemical processes.

After an introductory chapter and a chapter on intakes, sedimentation, and settling basins, the author proceeds to the consideration of his main subject, filtration. Two methods of filtration are described for the purification of water-supplies, namely slow sand-filtration, denoted as the English method, from its first introduction and general use in this country, and rapid sand-filtration, requiring the preliminary addition of a chemical solution, termed a coagulant, to render this rapid system efficient, which, being a distinctly American invention, is called the American method. Two chapters are devoted to the consideration of each of these methods in succession, the first in each case discussing the theory, efficiency, and influences of different arrangements and modifications of slow, and of rapid sand-filtration respectively, and the second chapter dealing with the design, construction, and working of slow, and of rapid sand-filters. Following these four principal chapters of the book, is a chapter giving a summary of the relative merits of the two methods of filtration; instances in which a combination of the two methods might be advantageous; and brief descriptions of the Anderson, Pasteur-Chamberland, Worms, and Maignen filtering processes. The book concludes with a chapter on the location, design, and construction of filtered-water reservoirs.

The slow sand-filtration method for the purification of water is well known, and its efficiency has been fully established by long experience in England; and it appears to be the only method, aided by aëration, by which very turbid and polluted river waters, such, for instance, as the waters of the tidal River Húgli, which have to furnish the supplies for Calcutta and Howrah, can be sufficiently purified to serve for a domestic supply. Rapid sand-filtration is a comparatively novel method of purification; and the sand filters for this process consist usually of a layer of coarse grains of quartz sand, 2½ to 3 feet thick, placed in a tank of steel, iron, or wood, from the bottom of which the filtered water is led, through strainers to prevent the escape of the sand, into pipes for conveying away the supply for distribution. Aluminium sulphate has hitherto proved the most suitable coagulant, in which the sulphuric acid enters into combination with the calcium or magnesium carbonate in the water, setting free the aluminium hydrate which forms flocculent masses with the fine suspended matter in the water, and, adhering to the grains of sand as the water passes through the filter, covers them and the bed generally with a gelatinous film, which arrests the bacteria as well as the finest particles in the water, and ensures the efficiency of the filter. When the filter becomes clogged by these impurities, as indicated by a reduction in the flow through it, the bed of sand has to be stirred up and pure water forced up through it to remove the sediment. A rapid flow is less liable to be interrupted by frost; but the proportion of coagulant required in a rapid filter changes with the varying composition of the river water, and necessitates the constant supervision of an experienced chemist to regulate the dose to the conditions, for too small a quantity would reduce the efficiency of the purification, and too large a dose would impregnate the filtered water with alum, and, during the period of low alkalinity in the flood stage of the river, would leave free sulphuric acid in the water, which would be injurious to the pipes.

INTELLIGENCE AS THE SOUL OF THE UNIVERSE.

Modern Natural Theology; With the Testimony of Christian Evidences. By Frederick James Gant, F.R.C.S., &c. Pp. xii+151. (London: Elliot Stock, 1901.) Price 2*s.* 6*d.* net.

IT is no doubt true that the older form of the "argument from design" is more or less discredited by the doctrine of evolution. Nevertheless, the author of the book before us is justified in holding that the argument itself is not disposed of, and that in a setting more strictly accordant with our present knowledge than that which Paley gave it, it is still a powerful weapon in the hands of the natural theologian. More, indeed, is gained under the conception of organic growth than is lost by the sacrifice of the older teleology; for Paley's statement of the case savours of deism, whereas under the more recent view there are distinct indications in the universe of a purpose which may be called moral. In so far as such a purpose is discoverable in nature, to that extent does deism retire into the background. This is the aspect of the matter which is put forcibly, if not very intelligibly, in the work before us. The difficulties inherent in the materialistic as well as the deistic position are, on the whole, well stated, and the way is shown to be open for the recognition of intelligence as the "mind or soul of the universe." Though the author guards himself in words which are capable of an orthodox interpretation, it may be questioned whether the argument from nature, in his way of presenting it, necessarily excludes pantheism. Mr. Gant would probably appeal to the second part of his book—which, dealing as it does more particularly with historical evidences, is somewhat outside our province—as supplying the needful corrective. On the whole, however, it must be allowed that, though his personal convictions are not in doubt, his reading of natural phenomena is more successful as a criticism of the deistic position than as an attack on pantheistic interpretations.

The book would have been better adapted for its purpose if its author had developed his argument in simpler language and with stricter attention to the ordinary rules of composition. Instances of confused diction are numerous; for example:—

"In all sentient living beings, mind is much moved by suffering for the maintenance, and thence the prolongation of life" (p. 54).

"Thus living beings tell their own story of identification with living species, or declare their bygone existence as extinct species" (p. 62).

Here Mr. Gant's meaning can only be guessed at. In other cases, though the sense may be easy to grasp, the language shows an almost Thucydidean disregard of grammatical construction. The following passage may serve as an instance :—

"This law of orderly sequence . . . is unlimited in the extent of its operation ; and having produced the face of Nature she now presents, so, doubtless, will the portrait change in the future" (p. 68).

Here is a not unfair specimen of the author's way of overloading his sentences :—

"The moveable coccyx terminates in a blunt point, which . . . is a rudimentary *tail*; with which so many animals are provided, with diverse uses, in climbing, *e.g.*, some apes ; as an additional leg in bounding, or a formidable weapon for striking, *e.g.*, the kangaroo" (p. 40).

This calls for criticism in more respects than one.

We pass over Mr. Gant's views on the subject of heredity. They are open to question, but the main point at issue is immaterial with regard to the purpose of the book. The like may be said of a curious misuse of the term "natural selection" on p. 42. The reference to spiders and scorpions as "insects" is less excusable.

It is fair to state that the abrupt and disjointed style—to use no harsher terms—into which the author so frequently falls does not appear to reflect a corresponding incoherence of thought. Within certain limits, his chapters give the impression that what he has to say, if he could only express it fitly, would be worthy of attention. It is unfortunate that he has failed to find a more attractive method of imparting conclusions many of which are in themselves sufficiently sound and sensible.

OUR BOOK SHELF.

The Distribution of Rainfall over the Land. By Andrew J. Herbertson, Ph.D., F.R.S.E. With 13 maps and a plate. (London : John Murray, 1901.)

EVERY meteorologist will be most glad to possess this very valuable work on the distribution of rainfall over the earth's surface. Dr. Herbertson seems to have spared no pains to utilise all the available material, and the result is that he is able to present us with rainfall maps for every month in the year, giving not only the seasonal distribution of rain, but a knowledge of the actual amount. Each map is accompanied by general remarks as to the position of the pressure belts, wind systems, and other useful information which are fundamental in studying the weather from month to month. Further, a map, with descriptions, &c., is given, illustrating the mean annual rainfall over the land surface. The book includes also a very useful set of curves showing the monthly distribution of rainfall in percentages of the annual fall for seventy-four selected stations. From these it can be seen at a glance whether a station receives the majority of its rainfall at one period of the year, such as Bombay, Pekin, Bathurst, &c., or whether there are two periods of rainfall each year, as at Colombo, Lagos, Peshawar, &c. The importance of keeping separate the rainfall that is received at one place during a year at the two monsoons and not combining them when there happen to be two periods of rainfall is of fundamental importance at the present day, and the volume before us will help to show when the yearly mean alone may be used. Dr. Herbertson concludes this valuable addition to the meteorological library by giving the data he used in drawing the maps, namely a useful bibliography, and tables showing each station, latitude and longitude of each, the period over which rainfall observations have been made, the altitude, and, lastly, the mean rainfall for the period for each month.

Tierleben der Tiefsee. Von Oswald Seeliger. Pp. 49. (Leipzig: W. Engelmann, 1901.) Price 2*s*.

THIS is a popular exposition, by a well-known and thoroughly competent zoologist, of the leading features of deep-sea life and of the conditions under which it exists. It is, of course, primarily for German readers, and is evidently, and very properly, intended to direct attention to the recent German Deep-Sea Expedition. The results of the preceding "Plankton" Expedition are also referred to. The little book contains about fifty pages, of which the first thirty constitute the essay proper and the remaining twenty are notes upon paragraphs and statements in the text, and give references to the literature of the subject. In such limited space it is obvious that no exhaustive treatment is possible; many important matters are barely mentioned, and in fact the whole can only be regarded as, at most, a sketch of this large department of oceanography.

The subjects dealt with are :—depths, pressure and its effects, the distribution of temperatures, the penetration of sunlight, the deep-sea deposits, the question of food, the bipolar theory of distribution, the presence of very ancient animal types, the so-called "living fossils," and the "phosphorescence" of the sea, with some account of the light-producing organs of certain Crustacea and fishes. There is also scattered through the pages a certain amount of discussion of the characteristics and distribution of deep-sea animals.

The essay is illustrated by one coloured plate entitled "Tiefsee-Idyll," showing, not too clearly and without sufficient delicacy of detail, about twenty species of deep-sea animals belonging to various groups. It is intended to demonstrate the characteristic colours, and especially the red coloration of so many abyssal Crustacea, Echinodermata and Cœlenterata when they are brought to the surface. Both in drawing and colouring, however, the plate is rather crude, and probably gives an incorrect impression by showing so many different kinds of animals packed so close together in a very small area.

W. A. H.

A Guide to the Shell and Star-fish Galleries (Mollusca, Polyzoa, Brachiopoda, Tunicata, Echinoderma and Worms), in the British Museum (Nat. Hist.). Pp. v+130; illustrated. (London: Printed for the Trustees, 1901.)

THIS admirable little work, written by Messrs. Smith, Bell and Kirkpatrick and sold for sixpence, may be described as the best and cheapest elementary natural history of the groups of which it treats hitherto published. A large number of excellent text-figures (some original and others borrowed from well-known works) illustrate the leading external and anatomical characters of the more important types. And although in certain places the text is necessarily somewhat technical, the diagrammatic illustrations render the meaning and application of the special terms so easily understood that every reader ought to experience little difficulty in gaining a general idea of the various groups described. This feature of the work is specially noticeable in the case of the polyzoans, whose structure often forms a stumbling-block to the beginner ; and we know of no other book containing such a number of excellent figures of this group in such a small space.

The authors have not been unmindful of the economic side of zoology ; and the reader will find much to interest him concerning pearls, cameos and oysters. The nomenclature has been, in the main, brought up to date, the trumpet-shell figuring as *Lotorium variegatum* in place of the familiar *Triton tritonis*, while *Scala*, instead of *Scalaria*, stands for the precious wentletrap.

A Text-book of Astronomy. By Prof. George C. Comstock. Pp. viii + 391. (New York and London: D. Appleton and Co., 1901.) Price 7*s*. 6*d*. net.

IT is an excellent sign that among recent works dealing with astronomy there have been some in which methods of teaching the elementary parts of the subject have formed a notable feature. The book under notice is to be regarded as one of this class, as the author, a well-known American astronomer, has endeavoured to "concentrate attention upon those parts of the subject that possess special educational value." The importance of observations with simple appliances is strongly insisted upon in the preface, but from this point of view the book is distinctly disappointing. It is true that in the earlier chapters an attempt is made to introduce practical exercises, some of them observational and others involving the construction or study of drawings; but this admirable beginning is by no means consistently followed up. In fact, the greater part of the book does not strike us as being other than a general outline of the chief facts and principles of astronomy suitable for ordinary reading, except that at intervals the reader is expected to pause and answer a question, such as "What is the magnitude (of Algol) 43 days after a minimum?" The practical method, however, might well have been further adopted; a telescope of adequate power for the demonstration of many phenomena, such as the sun's rotation, can be cheaply and easily constructed, and graphical exercises might have been more frequently introduced with advantage. We notice, also, that the use of a globe in illustrating celestial motions is not mentioned at all. Nevertheless, so far as it goes, the practical work described will be of great value to students, and will doubtless encourage them to further efforts in the same direction.

The book touches upon nearly every branch of astronomy, and the explanations and descriptions are both concise and clear. The numerous illustrations have been selected and reproduced with great care, and, as the author remarks, are worthy of as careful a study as the text; the diagram on p. 153, illustrating the path of the moon with respect to the sun, deserves special mention.

An Introduction to the Practical Use of Logarithms. By F. G. Taylor, M.A., B.Sc. Pp. vi + 63. (London: Longmans, Green & Co., 1901.) Price 1*s*. 6*d*.

THERE can be little doubt that much time is lost by students and others who have occasion to make numerical calculations through unfamiliarity with the practical advantages of logarithms. In the present little book, however, by the consistent employment of the simplest arithmetical illustrations, the author goes far to remove the mystery in which, to many students, the subject appears to be involved by fuller theoretical treatment. The explanations are clear throughout, and these, together with the numerous carefully selected examples, should enable a student of ordinary intelligence to quickly master the use of logarithmic tables. The tables themselves occupy but six pages, two for logarithms, two for reciprocals and two for anti-logarithms. A chapter on methods of rough calculation, intended to verify the results obtained by the use of logarithms, forms a valuable addition to the book. The general subject is excellently illustrated by the application to problems in mensuration, and the whole is brought well within the range of students who have no knowledge of algebra.

LETTER TO THE EDITOR.

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The Moon and Wet Days.

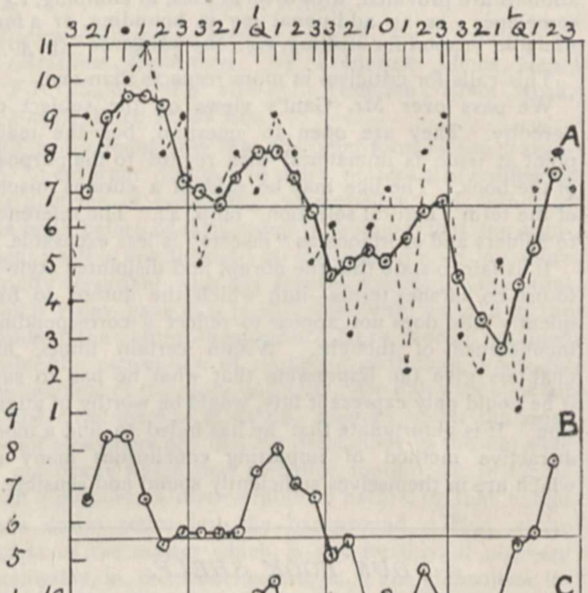
THOUGH it is counted heresy in some quarters to associate weather with the moon, the following results of a recent inquiry into the subject, whether held to be proof of lunar influence or not, might, I think, be of interest to many.

The period considered is the last 24 years. The data (which are for Greenwich) are these:—

(A) Days with ·5 in. of rain, or more, *in the year*.

(B) Days with ·4 in., or more, *in the summer half* (April to September).

(C) Days with ·2 in., or more, in the summer half.



The method in each case was first to ascertain the distribution in seven days about each of the four lunar phases (*i.e.* how often each of those 28 days had rain amounting, *e.g.*, to ·5 in., or more), then smooth the series with averages of *three*.

Both smoothed and unsmoothed curves are given in the case of A; but only the smoothed curves for B and C.

From the fact that four weeks does not quite cover the time of a synodical revolution of the moon (which is about 29½ days), there are a few wet days in each class not coming under any of the above categories. These may perhaps, with regard to the purpose of the inquiry, be left out of account. The totals dealt with are: A, 182 days; B, 158; and C, 433. These come short of the actual totals by A, 7 days; B, 8; C, 28.

Turning now to the curves, the recurrence of four long waves in the smoothed curve for A (less pronounced in C and B), may be noted, in passing, as a remarkable feature.

All the smoothed curves agree in presenting a minimum between the full moon and the last quarter (the third, second, or first day before last quarter). As to the maximum, it is about new moon in A and B, the first quarter being not much below; but in C the first quarter comes into prominence.

The salient facts of A might be put in this way. If all the wet days (182) were uniformly distributed throughout the four weeks, each group of three days would have about 20 cases of that degree of wetness (·5 in. or more). Now the lowest group (about the day before last quarter) has 8, and the highest (say about new moon) has 29, or nearly four times as many. The corresponding numbers for B are: av. 17, min. 10, max. 25; and for C, av. 46, min. 36, max. 58. The contrast becomes less marked as we lower the limit.

Individual days have some interesting features. Thus the third day before the last quarter has never, in these 24 years (summer half) had as much as ·4 in. of rain; and last quarter day has had such only once.

The data of Class A were further dealt with in this way. The odd years were treated as one group, and the even years as another. Both agreed in giving a minimum between full moon and last quarter. The maxima were about new moon in one case, and about first quarter in another.

In view of the present position of the moon-and-weather question, I content myself with merely giving these facts and inviting criticism.

It might happen that another 24 years would obliterate those distinctions, putting others in their place. Should the same relations continue in future, it would appear that in the few days before last quarter we have the best chance of escaping days which would be considered thoroughly wet.

ALEX. B. MACDOWALL.

NORTH AMERICAN FOLKLORE.[1]

ALTHOUGH the habits and surroundings of the American Indians are undergoing a gradual change through the advance of western civilisation, and their original conditions of life are disappearing, yet, thanks to American enterprise in the fields of archæology and folklore, the records of such things are being faithfully kept that they may not entirely die out or become vague tradition. It is with this object that two valuable papers on Arizona have been published in Part 2 of the "Seventeenth Annual Report of the Bureau of American Ethnology," the first dealing with the Navaho *hogáns* or houses, and the second giving an account of excavations in Arizona in 1895. The former, by Mr. Cosmos Mindeleff, contains, not only his material, but also much of the late A. M. Stephen, who lived for many years among the Navaho. The Navaho Indians now occupy a reservation of more than eleven thousand square miles in the north-eastern part of Arizona and north-western corner of New Mexico, the whole tract lying within the plateau region, and under modern conditions they are slowly developing into an agricultural tribe, although they still retain their pastoral habits. It is with the curious customs relating to the building of *hogáns* or houses by this people that the author has concerned himself, and he has elicited many interesting facts about them. The Navaho are accustomed to build two kinds of *hogán*, one for the winter and one for the summer; the former resemble mere mounds of earth hollowed out, yet they are comfortable and excellent for their purpose, and although they are of rough appearance their builders conform, not only to custom, but even to what amounts almost to ritual in their construction, with inaugural ceremonies of the most elaborate description. There is no attempt at decoration; a framework is formed of interlocked forked timbers, to which are added stout poles for the sides, and the whole is covered with bark and earth. Usually a *hogán* can be finished with the help of the neighbours in one day, and in the same evening begins the dedication. The goodwife sweeps and garners the new house, while a fire is kindled inside directly under the smoke hole. The head of the family then comes in and, after rubbing a handful of dry meal on the five principal timbers and strewing some on the floor, begins to chant the following:—

> "May my house be delightful,
> From my head may it be delightful,
> To my feet may it be delightful,
> Where I lie may it be delightful,"

and so on. The Navaho have a tradition that they were taught hut-building by the God of Dawn, while to the tribes of the plain were given skin lodges, and to the Pueblo stone houses. Long ago, when First-man and First-woman were living in the lowest Underworld, their dwelling was the prototype of the present *hogán*, and some say that instead of a covering of bark and earth its poles were wrapped in a film of sunbeams and rainbows. This Underworld was peopled by monsters who also lived in huts built after the same fashion, but of different materials. In the east dwelt *Tiéholtsodi* in a house of cloud, with Thunder guarding his door, while in the south sat the Frog in a dwelling of blue mist. The western mirage afforded a home to the Salt-woman, before whose door the Water-sprinkler dances, and towards the north the Blue Heron built himself a *hogán* of green weed with the Tortoise as his gate-porter. When mankind had ascended to the present or fourth world by the power of the Magic Reed, the kindly Dawn God taught them the methods of building that were best fitted for their several conditions. The *hogán* is but a temporary habitation, as is obvious from the following Navaho custom: When an Indian dies within a house, the beams are pulled down over the corpse while the remainder is usually set on fire, and the ruin then becomes *tabu* to the tribe for a long time to come.

The second and larger part of the volume is an account of the excavations which were carried on in 1895 by Dr. Walter Fewkes among the ruined pueblos and dwellings of Arizona. His object was to examine the ruins in the valley of the Rio Verde and the neighbourhood, as well as various other ruins, in order to solve certain problems connected with American archæology. The Moki or Hopi Indians, who now inhabit the limited area called Tusayan, claim to be descended from the pristine inhabitants of its ancient villages, and Mr. Fewkes was well fitted to conduct such investigations, having spent several summers previously among these tribes.

The ruined dwellings of the Rio Verde may be classified into three divisions. First, the pueblos, or independent habitations, that is to say those dwelling-places, ancient or modern, which are isolated on all sides from cliffs. Secondly come the cliff houses, with some part of their walls formed by the natural rock as it stands; and thirdly we find the cavate dwellings, where the rooms are excavated from the cliff wall. Dr. Fewkes carefully examined the latter class, of which so many exist on the left bank of the Rio Verde, and he considers that this side of the river in ancient times must have swarmed with people. In many of the chambers the fireplace was easily discovered, and many more had their ceilings blackened with smoke. In the neighbourhood were a few pictographs on rocks very similar to those found in Colorado, Utah and New Mexico.

Among his other explorations, Dr. Fewkes excavated part of the ruin of Awatobi, which is the connecting link between the prehistoric civilisation of Sikyatki and modern Tusayan life. It was one of the largest Tusayan pueblos in the middle of the sixteenth century, and notices of its mission occur in contemporary documents. We

[1] "The Annual Report of the Bureau of American Ethnology." J. W. Powell, Director, Washington. (Seventeenth, Part 2. 1898, pp. 277; Eighteenth, Part 1, 1899, pp. lvii+518.

find a certain Don Pedro de Tobar sent on an exploring expedition by Coronado, in the year 1540, into the province called Tusayan, which, in Coronado's letter translated by Hakluyt, is spelt "Tucano." His party consisted of about twenty men, chiefly on horseback, and when they had reached the outskirts, they hid themselves for the night under the edge of the mesa, where the Indians found them next morning armed and drawn up in line. The Indian chief scattered a handful of meal across the path, thereby meaning that they should have no passage into the pueblo; but during the parley by an accident the two parties came to blows, and the Hopi were worsted, though without loss of life. These latter then brought their conquerors presents, and Tobar here received the homage of all the province.

Both at Awatobi and Sikyatki Dr. Fewkes' diggings met with success, and he was fortunate in his discoveries. The latter place yielded up antiquities which, it is maintained, show no Spanish influence, and it is to this place we must look for the aboriginal culture of the fifteenth century. Tradition says that Sikyatki was destroyed before the advent of the Spaniards, and no mention of it can be found in documents relating to this district and period. Further, no fragment of glass or metal, or indeed anything that could give token of European civilisation, was discovered in the excavations. The pottery found at Awatobi resembles that of Sikyatki, but bears little likeness to modern ware, and the symbols used in decoration on vessels found at either of these places are very similar. Comparatively few stone axes, hammers or spearheads were found, but arrowheads were common, and many fragments of obsidian were to be seen scattered over the ruins of Tusayan. From the living rooms of Awatobi were obtained a large number of bone needles, awls and whistles, and it is probably only because the principal excavations at Sikyatki were carried on in the graves that more were not found at this latter place also. Dr. Fewkes has gone very fully into the question of the pottery, and his analysis of the markings and symbols is amplified by excellent illustrations both in black and white and in colours. The whole volume is an earnest of the increasing interest taken by Americans in the science of folklore, and future ethnologists will owe a great debt of gratitude to Mr. Mindeleff and Dr. Fewkes and their staff for their untiring energy in labouring in these fields.

Part I of the eighteenth volume contains part of the material gathered by Mr. E. W. Nelson during several years' sojourn among the Eskimos, and well bears out his statement that "the Eskimauan family or stock constitutes one of the most remarkable peoples of the world." In 1877 Mr. Nelson was stationed at St. Michael, in Alaska, and was thus able to study and observe the Eskimos of the Bering Straits until 1881, when he was appointed naturalist to an expedition to northern Siberia. His researches were continued on this expedition, and it was only through ill health that he was prevented from publishing the results of his labours immediately after his return. Even now, with the publication of this volume of more than five hundred closely-printed pages, a large section of his work remains to be elaborated.

The western Eskimos, with whom Mr. Nelson was principally concerned, inhabit an area which he calls the "Alaskan-Arctic" district, which includes the treeless coast belt, from three to one hundred miles in width, stretching from the peninsula of Alaska northwards to Point Barrow. The aboriginal inhabitants of the greater part of this tract, although separated by no physical barriers, can be divided up into well-defined groups characterised by distinct dialects. As a race they are very hardy and insensible to cold, but from exposure to damp are very liable to consumption and rheumatism, and but few live to an advanced age; in stature they vary in different tribes, some averaging no more than five feet two or three inches. Hitherto, before the arrival of traders, the land provided them with all their needs; reindeer, both tame and wild, and seal afforded most of the necessaries of life, and although wild reindeer are now being gradually exterminated, seals are still a profitable source of income. Eskimo clothes consist, for the most part, of reindeer skin, while a kind of waterproof frock is made from seal intestines. The cold, of course, necessitates the use of ear-flaps, gloves and mittens, while in the matter of personal adornment, besides tattooing, the Alaskan Eskimo wear what are known as "labrets," two small pieces of ivory, generally sickle-shaped, placed in holes specially bored for the purpose in the lower lip. Their implements and domestic utensils have been exhaustively described, but space does not allow of our going into details. We may note, however, the method of obtaining fire by the ubiquitous fire-drill, *i.e.* from the heat set up by the rapid friction of a stick against soft wood, which was in common use among the Eskimos of these regions, and the curious implements known as "snow-beaters," for beating snow from boots and clothing. Stone appears to be still very generally used for wood-cutting and skin-dressing, though the metal tools obtained from traders are now ousting the older material.

Among the fauna of these districts are to be reckoned the reindeer, mountain sheep, bear, wolf, mink, fox, lynx, beaver and marmot, but since the introduction of firearms the reindeer have woefully decreased in numbers. The Eskimos, though they have some idea of sport in some of their pursuits, have little forethought in their methods of hunting, and have sometimes killed off a whole herd of deer that has been driven into a *cul-de-sac*. On the other hand, it is held to be a test of endurance for a hunter to pursue a deer-calf on foot and run it down without shooting it, tiring it out so that it allows itself to be captured. The natives are adepts at all forms of trapping and snaring, and pass no small part of their lives in seal-stalking and tomcod-catching.

But the most interesting part of the volume is that devoted to an account of the habits, customs and traditions of this people. In Eskimo villages the centre of all social life is the *kashim*, a building essentially for men, from which women, although they frequently bring food thither, are at certain festivals rigidly excluded. It is the recognised place of oral instruction where the old men hand down the traditions of the clan to the younger generation, the sleeping place of all the unmarried men of the village, and the common house of welcome for guests. With regard to the views of moral obligation held by the Eskimos, Mr. Nelson considers that the only feeling of conscience appeared to be "an instinctive desire to do that which was most conducive to the general good of the community," which is, after all, an excellent fundamental principle of society. Stealing from the same village or tribe is regarded as wrong, but in the case of a stranger or another tribe there is no moral restraint provided the theft does not inculpate the robber's own community. Blood-feuds exist, and we find a custom very similar to the vendetta of Corsica and Sardinia prevalent among the Eskimos, and it is a commonplace among them that a man who has committed a murder may easily be recognised by the restless and watchful expression of his eyes. Marriages are sanctioned in various ways. Among the Unalit, when a young man falls in love he leaves his parents to arrange matters with those of his inamorata, and then, arrayed in his best, goes down to her house and, after presenting her with a new trousseau, leads her home. Burials vary in different places: at St. Michael the dead are buried in a sitting posture with the knees drawn up, while on the

Lower Yukon the position of the corpse is similar, but the head is forced forward between the knees. At Cape Vancouver exist certain memorial image-posts of drift-wood, set up near the sea, either representing the human figure or with a rude representation of some totem on the top, which are said to be monuments to those who have died either in landslides or at sea, and whose bodies have never been recovered. Among certain tribes a great Feast to the Dead is celebrated, extending over five days. It is the usual thing, when a person dies, for the next of kin to present food, drink and clothing to the departed spirit, through the medium of the dead person's namesake, at the first festival to the Shades after the death takes place. For some years this continues, the men in the village each giving to their ancestors offerings of various kinds, which are saved up by the chief mourners, in whose hands they are deposited, until it is considered that the village possesses a sufficient hoard of gifts to admit of a Great Festival being held. A certain date having been fixed upon, a kind of summons is issued to the Shades at the next minor festival; invitation stakes, decked with the totems of each departed spirit, are planted before their graves, and songs of invitation are sung. After the observance of this great feast, which Mr. Nelson describes in its entirety, an Eskimo is held to be exempt from further rites and duties to the dead until another near relation dies, when the process begins again.

The Eskimos, from the Kuskokwim River northward, have a regular system of totem marks. Mr. Nelson tells of a villager on the Lower Yukon who explained the totems to him thus: "All of our people have marks which have been handed down by our fathers from very long ago, and we put them on all our things." For instance, among the clan which bears the wolf totem the men fasten a wolf tail to their belts, while the women twine pieces of wolfskin in their hair, and it is customary among them to mark their weapons with their totem, that thereby (according to the author) they may assume the qualities of such animals and become especially deadly. With regard to the adoption of totems we may notice the following story, told by a villager whose sign was a red bear. Once upon a time one of his ancestors, who was a celebrated hunter, while out one day after small game with only blunt arrowheads in his quiver, came across a large red bear. Nothing daunted, however, he let fly arrow after arrow, and—so runs the tale—having succeeded in breaking all its bones, killed it. From that time forth he and his descendants used the red bear as their totem.

In the cosmogony of the Eskimos it is held that the earth was created by the Raven-Father, who is said to have come from the sky and fashioned it when everything was a watery chaos. Now although the earth had been formed, it was as yet devoid of inhabitants, and for the first four days Man lay ensconced in the pod of a beach-pea. On the fifth day he burst the pod and came forth a fully developed Man, and while he was still looking about him the Raven flew up. "Where have you come from?" says the Raven; and the Man points to the empty shell of the pea. "Ah!" replies the Raven, "I made that vine, but never expected that anything like you would come forth from it." So he takes Man away and shows him how to satisfy his hunger with berries. Like other animals in the stories, the Raven possesses the power of assuming human form by the simple process of pushing up his beak like a mask, and during his colloquy with Man has availed himself of this. The Raven then fashions some reindeer in clay and, drawing down his mask, waves his wings four times over them and they at once receive life; but as they were only dry in spots when they came into existence, their skins are dappled and they become the tame reindeer of semi-domesticity. A pair of wild reindeer are also formed, and while the bellies are allowed to dry white the remainder is kept moist, and by this means the wild reindeer, which to this day are of a light colour only underneath, are brought into being. Then the Raven thinking of Man's loneliness, retires a short distance and moulds an image in the shape of Man, fastening a long tuft of grass at the back of the head for hair. With a wave of the Raven's wings as before, the clay doll is transformed into a beautiful young woman, who in a short time bears the Man a child. They take the child to the riverside and smear him all over with clay, and in three days he becomes a full-grown man.

One day Man asks the Raven about the sky, and at his request the Raven takes him up to heaven and shows him the land he has made there—a beautiful country peopled by a small race—and after being made welcome there he returns through a star-hole to earth. But after a time the Man hungers to return to the little people in the sky, and he goes up again with the Raven. During his absence, however, the earth-people increase so that the animals are in danger of extermination, and this rouses the anger of both Man and the Raven. So they catch ten reindeer, which at this time have long, sharp teeth, and let them loose one night on earth to ravage and destroy. For two nights these fearful beasts attack houses and destroy the inmates, but on the third the villagers bedaub their walls with a paste made of fat and berries, so that when the wild herd again begin to batter the walls with their teeth, the sour berries cause them to rush about shaking their heads so violently that finally all their sharp teeth drop out, and this is the reason that all reindeer teeth are now small and harmless.

Another quaint story is the tradition which explains the reason why the women in the north are deft with the needle, while those of the south dance so nimbly. Long ago the northland was inhabited by men only and no woman had come among them; but it was noised abroad that far away in the south one woman dwelt alone. So one day one of the northerners set his face southward and journeyed until he reached the woman's dwelling, and in course of time he married her and congratulated himself that he had a wife while the son of the headman of the north was still a bachelor. But meanwhile this same bachelor was travelling south with like purpose, and he came on the house while the man was talking within, and, hiding himself, waited until night fell. Then he forced a way in, and, seizing the woman, began to drag her away; but the noise awoke the husband, who leapt forth and grasped his wife's feet as she was being dragged through the door. Both men pulled violently and to such effect that the poor woman's body was torn in half, and the robber went off home with the upper part, while the legs were left behind. Then the rightful husband carved a body of wood and fastened it to the legs, and the other man completed his half in a similar way, and as soon as they had finished, each addition received life, and out of one woman were made two. But although the woman of the south could dance featly, her wooden fingers prevented her from embroidering; and the woman of the north, by reason of her wooden legs, excelled only in needlework, and it is from these two that the women of the north and south sprang, inheriting their several characteristics.

With this story we must take leave of Part I. Mr. Nelson has done his work excellently, and the matter has been arranged in a careful and scientific manner. The Bureau of American Ethnology is greatly to be congratulated, both on the indefatigable workers whose services it has secured and on the excellent way in which it has published their researches. We shall look forward to the remainder of Mr. Nelson's work on the Eskimos with interest.

SOME SCIENTIFIC CENTRES.

II.—THE LABORATORY OF WILHELM OSTWALD.

THE year eighteen hundred and eighty-seven is memorable in the history of physical chemistry; it witnessed the publication of van 't Hoff's discovery of the identity of the laws of gases with those of dilute solutions; and it was the year in which Arrhenius in a classic memoir enunciated his theory of electrolytic dissociation; for the University of Leipzig it had a special significance, as it was then that Ostwald succeeded Wiedemann in the chair of physical chemistry and founded, with van 't Hoff, the *Zeitschrift für physikalische Chemie.* Heidelberg, it is true, had been the first to devote a special chair to the new subject, and Kopp had held it from 1864; but Kopp devoted his time almost entirely to research, and it remained to Wiedemann, who, in 1871, was appointed in every way unfitted for the carrying on of those delicate experiments which brought Ostwald to the forefront of scientific workers. Research was carried on under countless difficulties; the light was bad, the rooms unventilated, the heating effected by means of stoves difficult to regulate and producing dust which caused much injury to the finer instruments; no precautions had been taken in laying the foundations to ensure the deadening of vibrations; thus many experiments were ruined; the lack of space precluded the use of telescopes for reading scales, and altogether it would have been difficult to construct a laboratory worse adapted for physico-chemical investigations. But in spite of all these drawbacks the laboratories were soon overcrowded, and additional benches had to be fitted up in the corridors and cellars to accommodate the increasing numbers.

In 1897 the University and the Saxon Government

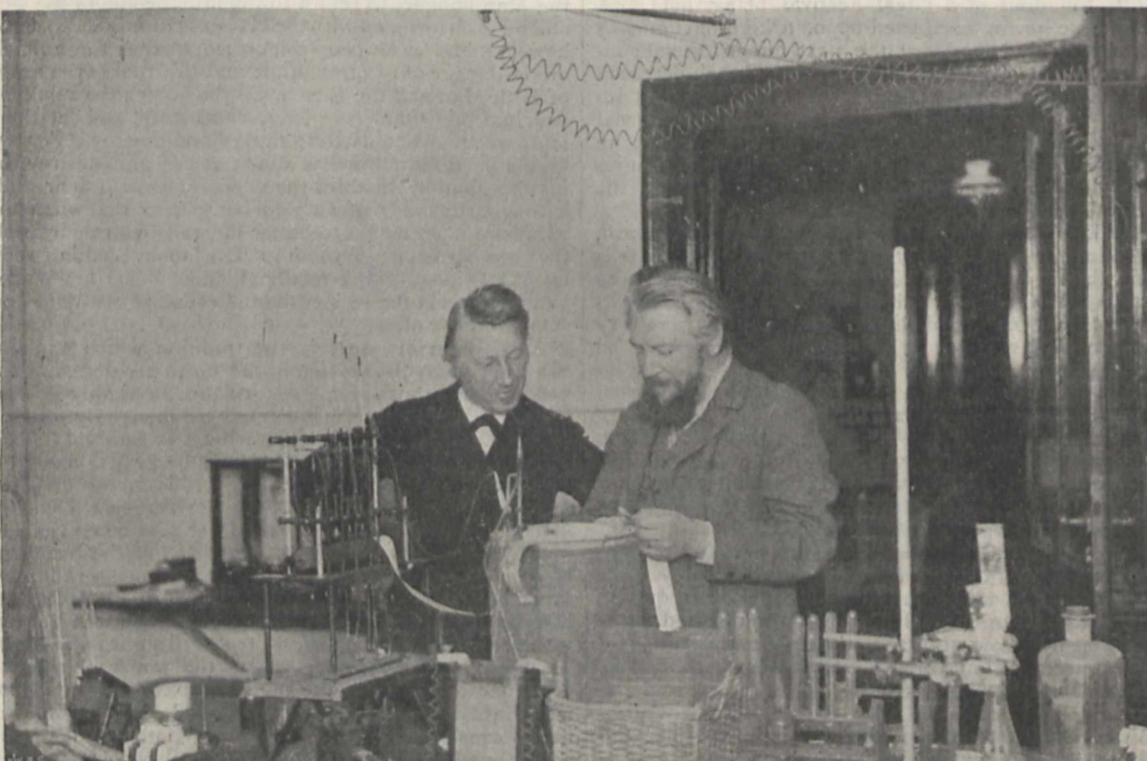


FIG. 1.—Ostwald and van 't Hoff. (Taken in Ostwald's private laboratory.) The illustration shows the two investigators standing by Prof. Ostwald's apparatus for automatically registering on a strip of paper the peculiar phenomena attending the solution of metallic chromium in acids.

(The author of this article begs to acknowledge his indebtedness to Mr. C. W Foulk, who kindly placed this most interesting photograph at his disposal.)

to the newly created chair at Leipzig, to institute a school for the investigation of these new problems. In 1887 he gave place to Wilhelm Ostwald, confining himself thenceforth to the study of pure physics, of which he had been made professor.

Ostwald was born in Riga on September 2, 1853; at an early age he devoted himself to the study of physics and chemistry at the University of Dorpat, where he "*habilitierte*" in 1878. After teaching there for two years he was made "ordentlicher Professor" at the Riga Polytechnic, which position he held until called to Leipzig in 1887.

The Leipzig laboratory, in which he worked until 1897, was situated in the "Landwirtschaftliche Institut," an old pile originally devoted to agricultural chemistry, and gave proof of their appreciation of the importance of the new science and of Ostwald's services by placing at his disposal a new specially erected Physico-Chemical Institute, equipped with all the accessories that modern ingenuity has devised.

The work of Ostwald is intimately associated with the theories of van 't Hoff and Arrhenius. In an address delivered in 1891 before the sections of physics and chemistry at the yearly meeting of the German men of science, Ostwald described what his own and the general attitude was towards the views put forward by these two men.

"The consequences connected with van 't Hoff's discovery being so important and wide-reaching, it had in general a friendly reception, though a few scientific men attempted a slight resistance. . . . All the uneasiness connected unavoidably with important revolutions had been directed against a second idea, which, appearing somewhat later, removed a fundamental difficulty in the theory of solutions, which had until that time made its acceptance impossible for me. This idea has nevertheless shown itself as an aid to investigation to be of unparalleled sweep and value; it is the theory of electrolytic dissociation of Arrhenius. . . . No scientific idea produced in my time has helped me in such measure as these two theories. . . . In particular the extraordinarily manifold and severe test, which lies in the numberless numerical consequences of the theories in all possible fields, has yielded such a number of confirmations that the relatively rare cases where the unprejudiced decision was insufficient entirely vanish."

In 1867 Guldeberg and Waage published their investigations on the subject of mass action, and enunciated the law that the intensity of the interaction of two substances was proportional to the product of their active masses, and to a coefficient which depended on the nature of the substance, temperature, &c.

This induced Ostwald, in 1877, to carry out a long series of experiments with the object of determining, by volumetric and optical methods, the manner of distribution of a base among different acids present in excess, and hence calculate the "specific affinity coefficients" of the latter.

In 1884 he suggested another method for the determination of these coefficients; it consisted in measuring the velocities of reactions induced by them, such as the inversion of cane sugar, the decomposition of acetamide, methyl acetate, &c. The results he obtained in this way were found to confirm generally those obtained in the previous series of experiments, as a comparison of the numbers in the subjoined table shows:—

		Velocity Constants.	
	Avidity.	Sugar Inversion.	Decomp. of Acetate.
Hydrochloric	100	100	100
Nitric	100	100	91·5
Sulphuric	49	53	54·7
Oxalic	24	18·6	17·4
Orthophosphoric...	13	6·2	—
Monochloracetic	9	4·8	4·3
Tartaric	5	—	2·3
Acetic	3	0·4	0·35

In 1887 came the theory of electrolytic dissociation; it explained at once the relationship which had been observed both by Arrhenius and by Ostwald between the affinity coefficients and electric conductivities; the degree of dissociation of an acid being a measure of its strength, and the conductivity being due principally to the hydrogen ions, it would follow from theoretical considerations that the conductivities of solutions of different acids would be proportional to the number of hydrogen ions in the solution, and so to the relative strength of the acid. Ostwald pointed out that the application of Guldeberg and Waage's law to electrolytes should enable us to obtain a "dissociation constant" for each electrolyte, the determination being made by means of conductivity measurements.

He then proceeded to trace the relationships between the "dissociation constants" of organic acids and the structure or constitution of the radicals. He showed that they varied with the nature of the acid radical, and that an increase of the negative group such as O, Cl, Br, I, CN, &c., increased the tendency of the hydrogen

FIG. 2.—Ostwald and Arrhenius.

ion to split off, while an increase of the positive radical, such as H, NH_2, &c., decreased this tendency.

The theory of electrolytic dissociation was further extended by Ostwald to explain the colours of solutions; he found that the absorption spectra of dilute solutions of different salts with similarly coloured ions are identical. In conjunction with Nernst he investigated the absorption spectra of a number of salts of permanganic acid, fluorescein, eosin, &c., and confirmed the corollary of the theory of Arrhenius; the colour of a dilute solution of a salt was thus shown to depend on the colour of the free ions present in the solution, the absorption of a completely dissociated electrolyte being the sum of the absorptions of the positive and negative components.

In 1897 he collected and published in four volumes the more important investigations which had been carried on during the previous ten years under his direction; they included work in nearly every department of physical chemistry; among them were the famous experiments on the theory of the electrical charges of ions; Beckmann's original papers on the theory and use of the ebullioscope and crioscope; Nernst's classical memoir on the osmotic origin of currents, and many other important contributions to our knowledge of electro-chemistry, the theory of cells, polarisation and contact electricity.

But Ostwald's labours have not been confined purely to research. In addition to his great efforts in the development and propagation of the new views on solutions and electrolytic dissociation, his name is associated with a number of treatises of varying scope, all stamped with his own originality. In 1885–1887 appeared his famous "Lehrbuch der allgemeinen Chemie"; and two years later his "Grundriss," which has since passed through three editions and been translated into several languages. In the "Grundlagen der analytischen Chemie" (1894) he approached the subject from an entirely new standpoint, while his "Grundlinien der anorganischen Chemie" (1900) bids fair to become one of the standard text-books.

Prof. Ostwald has told us how, more than fifteen years ago, he and his friend Arrhenius, walking along the banks of the Mälarsee, tried to picture the then nebulous future of physical chemistry. In 1887 the new science had so far advanced that he was able, with the assistance of van 't Hoff, to found a journal to be devoted entirely to it, the *Zeitschrift für physikalische Chemie*. The progress which it has since made has gone far to justify even the wildest hopes; and to that progress few have contributed more than the present director of the Leipzig Institute.

F. H. N.

THE DEVELOPMENT OF CHEMICAL RESEARCH.[1]

IF Justus Liebig had no other claims on the gratitude of posterity, we should still be indebted to him for the part which he played in emphasising the value of chemistry as an educational factor. He it was who first showed the importance of practical work in any scheme of scientific training; and, as Kolbe has pointed out, it was from the Giessen laboratory that that system emanated by which a student commenced with qualitative exercises, passed on to quantitative analysis, then to a series of preparations, leading up finally to independent research. Liebig's success in stimulating pupils to original thought is evident from a brief survey of the classical memoirs that were worked out in his laboratory, and of a few of the more illustrious of his numerous "schüler," including as they did such names as A. W. Hofmann, Strecker, Fresenius, Playfair, Williamson, Wurtz and Frankland.

[1] "A Select Bibliography of Chemistry, 1492–1897." By Henry Carrington Bolton. Section viii. Academic Dissertations. Pp. iv+534. (Published by the Smithsonian Institution, City of Washington, 1901.)

The Giessen methods were at once adopted in the several laboratories which began to arise towards the close of the earlier half of the nineteenth century—at Göttingen in 1836, under the direction of Wöhler, and later at Marburg and Leipzig, by Bunsen and Erdmann. They have been accepted by all the great teachers who followed after, from Kolbe, Kekulé and Wislicenus to Victor Meyer, Hantzsch and Curtius; and they are in vogue to-day, not only throughout Germany, but in nearly every country where chemistry is taught. Germany, however, had a long start; in France it was not till the end of the late 'sixties that Wurtz succeeded in persuading the Government of the necessity for reform in the methods of scientific training; and in Great Britain, although the College of Chemistry—the present Royal College of Science—was founded as early as 1845, it is only comparatively recently that public attention has been aroused to the inevitable result of continued apathy.

The publication of the eighth section of Mr. Bolton's laborious compilation, "A Select Bibliography of Chemistry," the first volume of which appeared in 1893, completes the undertaking begun in 1888; the entire work contains rather more than 25,000 entries. In such a vast undertaking as this, omissions are unavoidable; the collection of titles for a fourth volume is, however, in progress, and will afford an opportunity for making the list more complete.

The present volume, as its title indicates, is devoted exclusively to academic dissertations; it is not intended to serve as an index to the chemical memoirs that have appeared in periodicals, but only as a list of those that have been printed independently, the Russian titles being contributed by Prof. A. Krupsky, of St. Petersburg.

An analysis of the contents reveals the fact that during the period covered by the bibliography, namely from 1492 till 1897, no less than 4800 theses on chemical subjects have been handed in at German universities; allowing for omissions, the correct number would probably be considerably more than 5000.

France comes next on the list with a total of, roughly, 1500. Switzerland follows with 600, and Russia with 120; the other countries are all below 100.

When we remember that Germany has some twenty-two universities with splendidly equipped laboratories, maintained either completely or in part by the Government, not to mention the numerous technical colleges, these figures are not to be wondered at.

A better idea of the respective outputs as regards research of these different countries may be gathered from the fact that Germany has six periodicals devoted to the publication of pure chemical research; these are the *Annalen*, the *Berichte*, the *Journal für practische Chemie*, the *Zeitschrift für physikalische Chemie*, the *Zeitschrift für analytische Chemie* and the *Zeitschrift für Chemie*. France has the *Annales de Chimie et de Physique* and the *Bulletin de la Société Chimique*; a certain number of chemical memoirs appear also in the *Comptes rendus*; the other countries are represented chiefly by the journals of their respective societies.

Looking back over her record, Germany may well be proud of those illustrious teachers who did so much to build up her educational system; the rapid strides of German industries in recent years pay eloquent testimony to the success and value of their efforts. At the present time in England the Government is at last waking up to the necessity for action; the growth of technical schools throughout the country is a move in the right direction. But much still remains to be done. Research in every department of science must be stimulated at all costs, and British manufacturers must abandon their old empirical methods. A "research chemist" is worth more than eighty pounds a year, and we must at last realise that the spirit of economy may be carried to fatal excess. The outlook is far from cheerful, and so long as the development of research is entrusted to indifferent and irresponsible authorities it is difficult to hope for better things. Scientific discoveries may not increase the beauty of the earth, but we live in a practical age and must be practical. To be lulled by a sense of false security is to commit national suicide.

INTERNATIONAL ENGINEERING CONGRESS.

THE International Engineering Congress to be held at Glasgow from Tuesday to Friday next week, September 3-6, will be an important congregation of representatives of all branches of engineering practice. The Congress may almost be regarded as a federated meeting of technical societies, for seven of the nine sections are in charge of such organisations. The suggestion that technical societies should hold simultaneous meetings this year in Glasgow was made by the Institution of Engineers and Shipbuilders in Scotland, and it developed into the scheme for an International Engineering Congress.

Lord Kelvin has accepted the honorary presidency of the Congress, and Mr. James Mansergh, F.R.S., is the president. Mr. Mansergh will deliver a short address on Tuesday, and the members will afterwards meet in their respective sections in the University buildings. A large number of papers are to be read, and among them several of scientific interest. The following is a list of the sections, and of a few of the subjects to be brought forward for discussion :—

Section I.—Railways.—Chairman, Sir Benjamin Baker. The economy of electricity as a motive power on railways at present driven by steam, by Prof. C. A. Carus-Wilson.

Section II.—Waterways and Maritime Works.—Chairman, Sir John Wolfe Barry, K.C.B., F.R.S. Novel plant employed in transporting the excavations on the Chicago Drainage Canal Works, by Mr. Isham Randolph ; the improvement of the Lower Mississippi by the Mississippi River Commission, by Mr. J. A. Ockerson ; irrigation in the Nile Valley and its future, by Mr. William Willcocks, C.M.G.; recent improvements in the lighting and buoying of coasts, by Mr. D. Stevenson, and by Baron de Rochemont.

Section III.—Mechanical Engineering (Institution of Mechanical Engineers).—Chairman, Mr. W. H. Maw. Effect of temperature on cooling water in high speed automobiles, by Prof. H. S. Hele-Shaw, F.R.S. ; trials of steam turbines for driving dynamos, by the Hon. C. A. Parsons and Mr. G. Gerald Stoney ; application of metric system to workshops, by Mr. Arthur Greenwood ; power required to drive marine engine works and for electric lighting, by Mr. James Crighton and Mr. W. G. Riddell.

Section IV.—Naval Architecture and Marine Engineering (Institution of Naval Architects).—Chairman, the Right Hon. the Earl of Glasgow. The chief characteristics of the naval development of the nineteeth century, by Sir Nathaniel Barnaby, K.C.B.

Section V.—Iron and Steel (Iron and Steel Institute).—Chairman, Mr. William Whitwell. Report on the nomenclature of metallography, by the committee of the Iron and Steel Institute ; on the spectra of flames at different periods during the basic Bessemer blow, by Prof. W. N. Hartley, F.R.S., and Mr. Hugh Ramage ; on iron and copper alloys, by Mr. J. E. Stead.

Section VI.—Mining (Institution of Mining Engineers).—Chairman, Mr. James S. Dixon. Presidential address, by Sir William Thomas Lewis, Bart. ; alternating currents, and their possible application to mining, by Mr. S. F. Walker ; a new diagram of work, by Mr. H. W. G. Halbaum.

Section VII.—Municipal Engineering (Incorporated Association of Municipal and County Engineers).—Chairman, Mr. E. George Mawbey. Research into the system of sewage purification by bacterial and other methods, by Mr. K. F. Campbell ; treatment of sewage, by Lieut.-Col. A. S. Jones, V.C. ; sewage disposal, by Mr. A. B. M'Donald.

Section VIII.—Gas Engineering (Institution of Gas Engineers).—Chairman, Mr. George Livesey. Electrolysis of gas pipes, &c., by Dr. Leybold ; water gas as an adjunct in the manufacture of coal gas, by Prof. Vivian B. Lewes ; Emile Gobbe's process for the production of water gas, by Mr. Fernand Bruyere.

Section IX.—Electrical (Institution of Electrical Engineers).—Chairman, Mr. W. E. Langdon. Electricity supply meters of the electrolytic type, by Mr. J. R. Dick ; Kelvin's electric measuring instruments, by Prof. M. Maclean ; continuous-current dynamo design, by Mr. H. A. Mavor ; the use of electricity in the propulsion of road vehicles, by Mr. A. R. Sennett.

Advantage will be taken of the presence of a large number of engineers in Glasgow to open the new "James Watt Engineering Laboratories." These laboratories are being erected and equipped at a cost of more than 40,000*l.*, the funds being raised partly by subscriptions from the citizens of Glasgow and neighbourhood, partly by a grant of 12,500*l.* from the Bellahouston Trust, and the remainder from funds already at the disposal of the University Court. Lord Kelvin will preside at the opening.

Arrangements have been made for visits to works of interest to members of all branches of engineering, and for a number of excursions. There will also be a banquet, a reception by the Lord Provost, and a ball, so that the social aspects of the Congress are pleasing to contemplate. These pleasures, combined with the meetings of the sections and visits to the International Exhibition, should make the Congress memorable to all who take part in it.

NOTES.

THE seventieth birthday of Prof. Eduard Suess, who for more than forty years has occupied the chair of geology in the University of Vienna, and is universally regarded as the greatest of living geologists, has called forth hearty greetings from all parts of the world. Prof. Suess was born in London on August 20, 1831, his father being at that time a merchant in the City ; but, while a sympathetic friend of England, he has always remained a true Austrian, and his life-work as geologist, palæontologist and politician has been carried out in his own country. His researches, while largely palæontological, have covered a wide range, and they have led him to grasp more fully than others the problems in the ancient physical geography of the earth, which he dealt with in his brilliant work, "Antlitz der Erde." As remarked by a correspondent in the *Times*, Prof. Suess, to his own countrymen, "has been much more than a distinguished pioneer in science. He has been a living example of enlightened patriotism and devotion to the public welfare, and an indefatigable reformer, whose works will long remain a monument to his memory."

AMONG the many objects that attracted attention during the recent meeting of the International Congress of Zoologists at Berlin, few were more noteworthy than a large mounted adult male gorilla, exhibited by Herr Umlauff, of Hamburg. This specimen is remarkable not only for its size, which rivals, if it does not exceed, that of any example of the gorilla previously obtained, but also because its exact history is known. It was shot by Herr H. Pascen, of Schwerin, the representative of a Hamburg mercantile firm, in Yaunde, in the interior of the German Colony of Kamerun, about fifteen days' journey from the coast, on April 15, 1900. It has been hitherto generally believed that the gorilla is only to be found in Gaboon and the adjoining districts of French Congo immediately under the Equator; but it now appears that the range of this Anthropoid Ape extends further north into the interior of Kamerun. The specimen in question has, as we are informed, been acquired by Mr. Walter Rothschild for the Tring museum.

THE fifth International Congress of Criminal Anthropology will be held at Amsterdam on September 9–14.

THE death is announced of Admiral de Jonquières, who became a membre libre of the Paris Academy of Sciences in 1863, and was renowned for his works in geometry.

IN addition to the papers already mentioned to be read before the Zoological Section at the forthcoming meeting of the British Association, it is hoped that Mr. J. Stanley Gardiner will give an account of his recent researches upon the coral islands of the Maldives.

A REMARKABLE discovery of Palæolithic implements has lately been made on the estate of the Marquis of Ailesbury, at Knowle Farm, on the borders of Savernake Forest. Between 200 and 300 implements (according to a report in the *Times*) have been obtained from a pit which has been opened in a high-level valley gravel. The implements, which are mostly made of flint, have been well fashioned, and some have been finely polished, as if from the effects of blown sand. They include forms familiar from the Somme valley, and also from Hoxne and other places in this country.

THE new milk standard adopted by the Board of Agriculture will come into force on September 1. The regulations state that when a sample of milk (not being sold as skimmed, or separated, or condensed milk) contains less than 3 per cent. of milk-fat, or 8·5 per cent. of milk-solids other than milk-fat, it will be presumed for the purposes of the Sale of Food and Drugs Act, 1875 to 1899, until the contrary is proved, that the milk is not genuine. Where a sample of skimmed or separated milk (not being condensed milk) contains less than 9 per cent. of milk-solids, it will be regarded as not genuine.

THE death of Dr. Adolf Fick, late professor of physiology at the University of Würzburg, is announced in the *Times*. Dr. Fick was born at Cassel in 1829, became professor of physiology at the University of Zurich in 1856, and in 1868 was called to the chair of physiology at the University of Würzburg, a position that he held until his retirement a few months ago. Among his published works may be mentioned a treatise on medical physics, 1857, which passed through many editions; a compendium of physiology, 1860 (third edition 1882); "Anatomy and Physiology of the Senses," 1862; "Mechanical Work and the Production of Heat during Muscular Action," 1882; "Ursache und Wirkung," 1882; "Versuch über die Wahrscheinlichkeiten," 1883. Prof. Fick was also an active contributor to the leading scientific reviews, and furnished many important papers to the records of his University.

THE Paris correspondent of the *Lancet* announces that legal authority has just been given for the creation of a fund for scientific research. It is divided into two sections, and its object is the promotion of purely scientific work relative (*a*) to the discovery of new methods of treatment of the diseases which attack man, domestic animals, and cultivated plants; and (*b*) to the discovery, apart from the medical sciences, of the laws which govern natural phenomena (mechanics, astronomy, natural history, physics, and chemistry). The income of the fund will be derived from the following sources:—(1) Grants made by the Government, by the departments, by the communes, by the colonies, and by other sections of the population. (2) Gifts and bequests. (3) Individual or collective subscriptions. (4) Grants deducted from the portion of the proceeds of the *pari-mutuel* assigned to philanthropic or charitable purposes locally; the annual amounts of these grants, which will not be less than 125,000 francs (5000*l.*), will be fixed each year on the application of the council of management by the special commission held at the Ministry of Agriculture. (5) Interest of money invested in Government securities or deposited with the Treasury. The fund is subject to the authority of the Ministry of Public Instruction, and is managed by a council assisted by a technical commission concerned with the grants.

THE New York Board of Health has distributed a circular of information, prepared by Dr. H. M. Biggs, upon the cause and prevention of malarial fever. This course has been taken because malarial fever is prevalent in certain boroughs of New York City, and is likely to extend on account of the extensive excavations and consequent formation of rain-pools in various parts of these boroughs, if means are not employed for its prevention. The circular states that the following simple precautions suffice to protect persons living in malarial districts from infection:—(1) Proper screening of the house to prevent the entrance of the mosquitoes. The chief danger of infection is at night, inasmuch as the Anopheles bite mostly at this time. (2) The confinement and continuous screening of persons in malarial districts who are suffering from malarial fever. (3) The administration of quinine in full doses to malarial patients to destroy the malarial organisms in the blood. (4) The removal of the breeding places of the mosquitoes through drainage, filling up of holes and surface pools, and emptying of tubs, pails, &c., which contain stagnant water. (5) In pools which cannot be drained or filled, the destruction of the mosquito larvæ by the use of petroleum thrown upon the surface, by the introduction of minnows and other small fish which eat the larvæ, or by both methods.

THE removal of the astronomical instruments from the Observatory at Pekin, as a part of the German loot, has already been mentioned in these columns. No particulars of the action have come under our notice, but the right of Germany to the instruments has just been questioned, so that the subject is still under discussion.

WITH the intention of directing attention to the cultivation of the vine in the colonies, Sir James Blyth, Bart., contributes to the *Chamber of Commerce Journal* for September an instructive article upon vine culture. His remarks upon the value of scientific investigations in connection with the industry are of interest. It is pointed out that owing to the invasion of phylloxera, and the consequent scientific discoveries for its prevention or extermination, labour on the vineyards has become continuous throughout the year. It is a common remark amongst the present proprietors of the Médoc, that in their fathers' time the vines were simply pruned, the land ploughed four times a year, and the grapes gathered at the vintage, leaving all else to nature and the seasons. Now, from the moment the grapes are gathered, scarcely a week—certainly not a month—passes, but some process for the defence of the roots, the stems, or the leaves takes place. The greater care exercised in planting, and the experience acquired in combating all the enemies to the well-being of the vine, promise not only to conquer these insidious fungoid and insect pests, but vastly to increase the proportional productivity of the areas under vines. For instance, there has been a considerable increase in the fecundity of the vine since steps have been taken to regenerate the vineyards which have been affected by phylloxera. This may be judged by the fact that, whereas in 1875, which, as is well known, was a record year in France for quantity as well as quality, an exceptional average yield of 294 gallons per acre was produced, the average yield in 1900 was as much as 343 gallons per acre.

PROF. OTTO NORDENSKJÖLD is at Malmö, Sweden, making arrangements for his South Polar Expedition. A Reuter message says he has made the following statement to a Press representative as to the plan and object of his expedition :—"As soon as the *Antarctic* returns from the expedition which she has made to Spitsbergen for meridian measurements, we start from Göteborg, certainly not later than October 1. From Göteborg we shall proceed to England, and thence to Buenos Ayres and Tierra del Fuego, whence we shall make our way to the Antarctic regions. We shall endeavour to push as far south as possible with the *Antarctic;* and, when winter comes on, we shall send a party on shore to winter. That party will probably consist of six persons, of whom I shall be one. We shall build a small hut for ourselves, and engage in meteorological, magnetic, hydrographic, and other scientific observations. As soon as we have landed, the *Antarctic* will return to Tierra del Fuego ; and a scientific observer, who will sail with her, will conduct the researches in that hitherto little explored country. In this way we shall be able to work in two detachments, and make as much use of our time as possible. Prof. Ohlin, of Lund, and M. K. A. Andersson will accompany me as zoologists. Dr. Bodman will come as hydrographer and magnetician, M. Skottoberg as botanist, and Dr. E. Ekolof as medical officer. Captain Larsin, who has already made several voyages to South Polar regions, will be in charge of the *Antarctic*."

FROM a note in the *Times* we see that the British Consul-General at Marseilles reports that artificial indigo is killing the natural product on the French market. The artificial dye already regulates prices. The Badische Company have for two years been making indigo near Lyons for local consumption, while the Höchst Farbwerke are manufacturing synthetic indigo by another process in the same city. Artificial indigo is classed for Customs duty with natural indigo, and, since goods dyed with it are not required to be declared as such, they are sold at similar prices to goods dyed with natural indigo. Lyons dyers of cotton and woollen goods and Lyons dealers in indigo say that natural indigo has been ousted from many dye works, especially since artificial indigo has been prepared by crushing. Small dyers favour synthetic indigo, because they can buy small quantities as required and prices do not violently fluctuate. But, as the vegetable dye gives more solidity to the cloth, it is still likely to be used for military uniforms. Dr. Calmette, of Lille, is said to have patented a process for extracting indigotin from vegetable indigo up to thrice the quantity produced by the more primitive methods. It is curious that the Bengal Chamber of Commerce have recently had to ask the Havre Chamber to abolish a rule under which indigo tendered in that important terminal market must be guaranteed to be manufactured by the "old" process—a serious restriction in view of the many new processes recently introduced. The request has been complied with, and certificates will not be needed after April 1 next. From the Consular report on Frankfurt-on-Main for 1900 it appears that the Badische Company has borrowed 12,000,000 marks for the purpose of enlarging the production of artificial indigo and reducing its cost price. The company now claims to be able to supply one-sixth of the world's requirements. The Höchster Farbwerke are also extending their indigo business. Natural and artificial indigo are both 10 per cent. cheaper than last year, the policy of manufacturers being to keep the price of the synthetic rather below that of natural indigo.

A BUST of Dr. G. Armauer Hansen, the discoverer of the leprosy bacillus, was unveiled a few days ago by Prof. Visdal in the garden of the Museum at Bergen, in the presence of many Norwegian and foreign medical men. We learn from the *British Medical Journal* that an address was delivered by Prof. O. Lassar, of Berlin ; and Drs. Sandberg and Lie, of Bergen, also spoke. Congratulatory messages were sent from all parts of the world, and a letter from Prof. Virchow was read, in which the veteran pathologist, after expressing his regret at his inability to be present, went on to say that Dr. Hansen's work had definitively cleared up a large and difficult field of pathology, and that his name was known and celebrated throughout the whole world as a benefactor of mankind. Dr. Hansen was born in Bergen in 1841, and received his early education in the cathedral college of that town. His first investigation was to work out the significance of the so-called globi, or leprous cells of Virchow, and the results of his observations were published in 1869. He then obtained evidence of the contagious and specific nature of the malady, and the Medical Society of Christiania voted a sum of money for him to continue his research. Further investigations of the peculiar bodies (globi-brown corpuscles) previously referred to were rewarded by the discovery, in unstained preparations, of bacilli which were ultimately stained and proved to be the bacilli of leprosy. This discovery was made in 1873—that is, about ten years before the bacillus tuberculosis was made known to the world by Koch. For years Hansen has repeatedly tried to cultivate and inoculate the *Bacillus leprae*, which is known as Hansen's bacillus, but up to the present fruitlessly. One great point, however, has been gained—namely, that it is now practically admitted by all those engaged in the study and observation of leprosy, that the disease is contagious. In Norway, practical legislation on this basis has given the best results, and leprosy there is gradually and surely diminishing. Dr. Hansen celebrated his sixtieth birthday on July 29, and the tribute to his lifelong work and devotion above recorded will be gratifying to all lovers of science. The King of Norway has conferred upon him the distinction of Commander of the Order of Ola.

A LIST of nearly fifty papers accepted by the committee of Section A of the British Association, for reading at the forthcoming meeting at Glasgow, has been received since the publication of the forecast of the work of the other sections in last week's NATURE. Arrangements have been made for discussions on optical glass, to be opened by a paper by Dr. R. T. Glazebrook, F.R.S. ; energetics, to be opened by Dr. J. Larmor, F.R.S., with a paper on the relation of energetics to molecular theory ; and on the proposed new unit of pressure, to be opened by Dr. C. E. Guillaume. A report will be received from the committees on tables of certain mathematical functions, underground temperature, and the determination of magnetic forces. Lord Kelvin will read papers on the absolute amount of gravitational matter in any large volume of interstellar space, and on "Aepinus atomised." Prof. A. Gray, F.R.S., will read several papers, among the subjects being the influence of a magnetic field on the viscosity of magnetisable solids and liquids, elastic fatigue, and induced currents produced by starting a convection current. The following are among other physical papers :—On a new instrument for magnetic work on board ship, by Captain E. W. Creak, F.R.S. ; on the effect of sea temperature on the seasonal variation of air temperature of the British Isles, by Mr. W. N. Shaw, F.R.S. ; the law of radiation, by Dr. J. Larmor, F.R.S. ; the Michelson-Morley effect, by Prof. W. M. Hicks, F.R.S. ; sur les effets magnétique de la convection électrique, by Dr. V. Crémieu ; on the magnetic field due to the motion of a charged condenser, by Dr. F. T. Trouton, F.R.S. ; on resolving power in the microscope and telescope, by Prof. J. D. Everett, F.R.S. ; on the interference of light from different sources, by Dr. G. J. Stoney, F.R.S. ; on a simple method of accurate surveying with a hand camera, by Prof. H. H. Turner, F.R.S. ; on the conduction of electricity through mercury vapour, by Prof. A. Schuster, F.R.S. ; hydrostatic pressure, by Prof. W. Ramsay, F.R.S.; comparison of constant volume and constant pressure scales for hydrogen between 0° and – 190° C., by Dr. M. W. Travers and Mr. G. Sentor; and the laws of electrolysis of alkali salt vapours, by Dr. H. A. Wilson. Mathematical papers are promised by Major P. A. MacMahon, F.R.S., Lieut.-Colonel A. Cunningham, Prof. A. G. Greenhill, F.R.S., Mr. C. V. Boys, F.R.S., and others. There will also be papers on astronomical subjects by Prof. H. H. Turner, F.R.S., Rev. A. L. Cortie, and Prof. D. P. Todd.

THE death-rates from accidents of various kinds in mines in the United Kingdom are dealt with in detail, both numerically and graphically, by Dr. Le Neve Foster, F.R.S., in his latest report, published as a Blue-book. The improvement which has been made may be judged from the fact that, whereas, in the early fifties, the underground death-rate was more than five per thousand, the average death-rate of the underground workers in 1900 was only 1·445. In 1851 about nineteen persons were killed per million tons of coal raised from mines, but last year the death toll on the same quantity of coal was reduced to four persons. Naked lights are still the principal cause of the accidents, more than seventy-five per cent. of the total number of deaths being ascribed to their use. In connection with the description of miscellaneous accidents we notice with interest the remark that during a severe thunderstorm in Staffordshire electricity passed down a shaft, and two men received a severe shock. Flashes of light were seen about pipes near the shaft. The following is a complete list of explosives which have passed the special test for use in mines, under conditions far more stringent than those of the ordinary list: ammonite, amvis, aphosite, cambrite, carbonite, electronite (second definition), kynite, Nobel Ardeer powder, Nobel carbonite, roburite (No. 3), saxonite, special bulldog, thunderite, and virite. As to electric safety lamps Dr. Le Neve Foster says the Sussmann Company have informed him that three or four thousand of their lamps are employed in collieries in the United Kingdom. It is of interest to notice that the total number of mechanical coal-cutters in use in the United Kingdom in 1900 was 311, of which 240 were driven by compressed air and 71 by electricity. The quantity of coal got out by these cutters was 3,321,012 tons. Gold mining is being successfully carried on in North Wales; 19,463 tons of quartz crushed at St. David's mine yielded on an average about 14dwts. of gold to the ton, and the net profits for the year amounted to nearly 40,000*l*.

THE Meteorological Office pilot chart of the North Atlantic and Mediterranean for the month of September shows that West Indian hurricanes have a tendency to keep further out on the ocean in this month than in July and August, the mean point of curvature being in about 28° N., 72° W., and individual cases have been known to curve in the same latitude as far as 52° W. Comparatively few of the centres enter the Caribbean Sea, and of those that do nearly all keep to the northern side. The origin of some of these storms is attributed to shallow disturbances moving westward in the vicinity of the Cape Verde Islands, associated with unsettled weather and strong winds. Hurricanes are rarely experienced on the north coast of South America, Curaçoa island being visited in September 1877, the only instance in seventy years. Local peculiarities in the winds on the African and American coasts are referred to, and there is a summary of the features of the winds of the Grecian Archipelago and also of the currents of the same region. An inset chart represents the third type of thunderstorm conditions over the British Isles, namely those which appear as secondaries to depressions in the north. The ice reports show that in July there was a diminution in the number of bergs seen on the Banks of Newfoundland, few being reported south of the latitude of St. John's. In the strait of Belle Isle and to a distance of about 200 miles north-eastward of Belle Isle itself, the steamer route was infested with great quantities of ice, heavy field ice and large bergs rendering navigation very difficult and tedious. One steamer was detained four days in the ice, another was obliged to retreat and make for the gulf of St. Lawrence by the south coast of Newfoundland. The most southern ice was in 41° N., 47° W., a very small piece, 20 feet by 40 feet, and only 4 feet out of the water.

SOME further particulars are given in *Symons's Meteorological Magazine* for August of the severe thunderstorm which occurred in London on July 25. It was in many respects similar to that which occurred on July 27 last year; both storms occurred after a period of great heat, and after an absolute drought of nearly three weeks. The barometric trace showed distinct disturbance at the two periods of greatest intensity, but there was an absence of the typical thunderstorm curve. The rainfall (2·85 inches in about four hours) has been exceeded on only one day in the forty-four years since the commencement of the Camden Town record, viz. in the great thunderstorm of June 23, 1878, when 3·28 inches of rain fell in an hour and a half. The greatest intensity of rainfall in the recent storm was ·23 inch in two minutes, being at the rate of 6·90 inches per hour. It is remarkable, considering the vividness of the lightning and its great frequency, that so little damage was done.

WE have received the Report of the Director of the Government Observatory, Bombay, for the year ending March 31, 1901. The labours of the observatory are directed in the first place to observations in magnetism, meteorology and seismology, and the discussion and publication of the results; and secondly to astronomical observations for the purposes of timekeeping and navigation. The Dines' pressure-tube anemometer gives very satisfactory results, and serves as a valuable check upon the Robinson velocity anemograph. The seismograph registered twenty-nine earthquakes during the year, besides 447 small and local movements. Among the various important duties performed at the observatory may be mentioned the rating of the chronometers of merchant ships which arrive at the port, and the transmission of weather and other reports to various newspapers and public bodies.

THE *Electrical Review* states that experiments are about to be made on the River Lea with the view to the adoption of a system of electric haulage of barges similar to that in use in France. A power station has been erected at Hertford, from which the current will be supplied by wires supported on poles to a trolley running on a narrow-gauge track along the towpath. It is anticipated that the barges will be towed at a speed of from three to four miles an hour at less cost than by horse traction. The system is to extend to Walthamstow, a distance of eighteen miles.

THE improvements in the locks and bridges, and the deepening of the waterway of the Aire and Calder Navigation, which have been carried out in recent years, have enabled for the first time in the history of the undertaking a sea-going steamer to navigate the canal from Goole to the middle of Yorkshire. The *Pioneer*, after a voyage of 500 miles from Fowey in Cornwall, delivered a cargo of 130 tons of china clay at Leeds. This vessel is 98½ feet long, 17¾ feet beam and draws 7½ feet of water. After the inception of the Manchester Ship Canal, several schemes were proposed for making a ship canal from the Humber to the centre of the manufacturing districts of Yorkshire. A proposal to establish a port at Wakefield was enthusiastically received at a meeting of representatives of the West Riding, the estimated cost of the scheme being six million pounds. The financial results of the Manchester Ship Canal have not given encouragement to the further prosecution of these schemes.

DURING the past few years a series of remarkable papers by Prof. Karl Pearson and his coadjutors has been published by the Royal Society in the *Philosophical Transactions* and *Proceedings*, on the foundations of a very comprehensive mathematical theory of evolution. Mr. R. Worthington (*Journal Anat. and Phys.* vol. xxxv. 1901, p. 455) gives some account of that portion of Prof. Pearson's work which bears an osteology as a branch of physical anthropology, in such a manner as shall be intelligible to non-mathematical readers. The application of mathematical analysis to the problems of evolution was introduced by Dr. Francis Galton and perfected by Prof. Karl Pearson, and the results already obtained are of such importance that biologists cannot afford to neglect them.

THAT portion of the brain where "impulses of diverse nature, coming from all regions of the body and from all the sense organs, may meet and play upon each other," that *sensorium commune* for which the ancient philosophers sought in vain for so many ages, is a region of the hemisphere which is surely worthy of a distinctive name. Such is the plea of Prof. G. Elliot Smith (*Journal Anat. and Phys.* vol. xxxv. 1901, p. 431), who suggests that it might be called the *pars crescens* (hemisphærii), in reference to the peculiar characteristic of its rapid expansion in the Mammalia; but instead of selecting a new phrase he prefers to use the term *neopallium*, as at every epoch in the history of the mammal this part of the brain shows a progressive increase in size, whereas the other superficial parts of the hemisphere become relatively or actually smaller and may even disappear almost entirely without any vital injury to the individual.

To the *Proceedings* of the Royal Physical Society of Edinburgh for 1899–1900, Dr. G. Wilson contributes a preliminary notice of the first appearance of the lung in the Australian lung-fish (*Ceratodus*), and a second on the embryonic kidney of the same. Dr. D. Hepburn notices certain mammalian remains (all referable to existing types) recently collected in a cave in Sutherlandshire.

IN the August number of *The Zoologist*, Mr. R. B. Lodge describes an interesting arrangement by means of which he obtained automatic photographs of the purple heron and spoonbill on the nest. A camera was fixed near the nest, provided with a string and catch so arranged that when the bird alighted it caused a "snap-shot" of itself to be taken. Curiously enough, before the photo of the purple heron was obtained, one of a marsh-harrier, which had come to rob the nest, was taken. With the aid of a flash-light the arrangement would be available for night use.

THE Imperial Department of Agriculture for the West Indies issues a continuation of its publications relating to the insects injurious to cultivators in these islands, in the form of a pamphlet on the "Scale Insects of the Lesser Antilles," of which a second instalment is to follow. The West Indian scale insect and allied members of the Coccidæ form, in spite of their minute size, some of the most troublesome pests against which the West Indian planter has to contend. According to the author, Mr. H. Maxwell-Lefroy, various poisonous or resinous washes, applied as spray, form the most efficient remedies; a list of those most suitable to each kind of crop is appended.

To the January issue of the *Proceedings* of the American Philosophical Society, Dr. R. W. Shufeldt contributes a further instalment of his series of dissertations on avian osteology, this contribution dealing with the skeleton of the cuckoos. Although not committing himself definitely to any opinion, and dwelling upon the imperfect state of our knowledge of the bony structure of this large group of birds, the author is inclined to confirm the view of the near relationship of the cuckoos to the plantain-eaters and bee-eaters. He believes, however, that several families of "picarian" birds "have a cuckoo-vein running all through them, strongly impressed in some cases, barely discernible in others. Indeed, these groups of birds seem to have arisen from some very ancient and common stock, but by the extinction of numerous related types . . . it has left in recent times the most puzzling collection that the systematist has to deal with."

THE second part of vol. vii. of the *Transactions* of the Norfolk and Norwich Naturalists' Society contains a number of papers, for the most part connected with the natural history of the county. Prof. A. Newton has a note on some bones of the crane from the Norfolk fens, and this is followed by an interesting account from the pen of Mr. T. Southwell of the breeding of that bird in the county. Documentary evidence is cited to prove that in 1543 cranes nested in Hickling Broad, and about the same time in the Cambridgeshire fens. Dr. S. F. Harmer describes and figures a dolphin taken in Cornwall, the flanks of which showed certain peculiar scratches. At first it was thought these might be due to the hooks of a cuttlefish, but subsequent investigation tended to show that they were made by other individuals of the same species, probably during the pairing season. The author is, however, of opinion that somewhat similar markings seen on other cetaceans may be due to the struggles of the cuttles on which they feed.

THE bulk of Part I of the Bergen Museum "Aarbog" for 1901 is occupied by a list of the Coleoptera and Lepidoptera of the Bergen district, drawn up by Mr. J. S. Schneider, and illustrated with a coloured plate. Of more general interest is an article by Dr. O. Nordgaard on the hydrography of the North Sea, largely based on the observations of two sealing captains. As the result of the investigations it appears that the effect of the Gulf Stream on the North Sea has been very variable during the last four years of the century. The favourable condition of the ice in 1897 and 1898 seems to have been owing to an influx of warmth characterising these years, while the unfavourable conditions noticed in 1899 and 1900 were due to a lack of the same influence. The years 1898 and 1899 severally represented indeed the maximum and minimum in this respect. This is confirmed by the fact that in the former year the development of the "plankton" was much above the average. Allusion is made to the influence of such temperature variations on the cod and herring fishery, as well as on sealing.

MR. W. W. DAVIS has a paper in "Studies from the Yale Psychological Laboratory" (vol. viii.), on some relationships between temperament and effects of exercise. His tests and observations are scarcely sufficient to establish very definite relations, but the conclusions at which he arrives are not without interest. The observations suggest that nervous persons, in training for the development of strength, require light practice, and phlegmatic persons require vigorous practice. The phlegmatic type of temperament is apparently characterised by the presence of much reserve energy of muscle and nerve cell. The nervous type has less reserve energy but a greater ability to use the energy at hand. It is not difficult to apply these principles to practical physical training. They make necessary on the part of the trainer a personal knowledge, secured either by means of observation or experiment, of the temperament of each man under his charge. The amount of work necessary in each case can then be apportioned with much greater exactness. Mr. Davis points out that it seems quite as certain that there may also be a direct application of these principles in the realm of pedagogy. The experiments show that, in the development of strength, mental factors are more necessary than muscular factors. If the principles can be applied to the development of will power and co-ordination, why not to memory, association, imagination, and reasoning as well? All have a physiological basis, and in so far all are governed, in a given individual, by the same principles of growth. There is at least a wide field here for inquiry and practical investigation. There can be no doubt that the present system of secondary and collegiate instruction, which requires an equal amount of work from all pupils, causes much harm to many individuals. Mr. Davis's results emphasise the importance of recognising the individual in the training of either physical or mental ability.

AN elementary text-book of zoology, which has been prepared for the Cambridge Natural Science Series by Mr. A. E. Shipley of Cambridge and Prof. MacBride of McGill University, Montreal, will be published on September 9 by the University Press in England and the Macmillan Co. in New York.

A CATALOGUE of works on chemistry and chemical technology in the library of the Patent Office has just been published as No. 6 of the Patent Office Library Series. The list comprises the titles of 885 works (79 serials, 806 text-books, &c.), representing about 3300 volumes. The titles are classified under 146 headings and sub-headings, so that students using the Patent Office library can readily find the works available upon any subject in chemistry.

THE United States Board on Geographic Names has issued a special report giving the accepted spellings of 4000 geographical words used in the Philippine Archipelago. When the islands were acquired by the United States in 1898, and new charts had to be prepared, much confusion existed as to the geographical orthography—Spanish, Malay, American and English methods of spelling native names being in use. Acting upon the advice of the Board, the U.S. Hydrographic Office adopted the spelling upon the best Spanish official charts and maps, and a list of about 4000 coastwise names was compiled, chiefly from Spanish sources. This is the list which has now been published. Another list, containing about 6000 Philippine geographical names, was prepared independently by Father Algue, director of the Jesuit Observatory at Manila, and these have been accepted by the U.S. Coast and Geodetic Survey for the atlas of the Philippine Islands shortly to be issued. To ensure uniformity, Father Algue has revised the present list, so that all the names in it now agree with those used in the Coast Survey atlas.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. H. S. Kemp; a Japanese Deer (*Cervus sika*) from Japan, presented by Sir Douglas Brooke, Bart.; a Short-headed Phalanger (*Petaurus breviceps*) from Australia, presented by Captain Gordon Wilson; two Common Kingfishers (*Alcedo ispida*), British, presented by Mr. W. Milne; two Rosy-faced Love-birds (*Agapornis roseicollis*) from South Africa, presented by Mrs. Harry Blades; an Alligator (*Alligator mississippiensis*) from Southern North America, presented by Mr. J. Foster Spence; a New Zealand Parrakeet (*Cyanorhamphus novae-zealandiae*), a One-wattled Cassowary (*Casuarius uniappendiculatus*), a Westermann's Cassowary (*Casuarius westermanni*) from New Guinea, two White-breasted Sea Eagles (*Haliastur leucosternus*) from Australia, an Angulated Tortoise (*Testudo angulata*) from South Africa, two Pale-headed Tree Boas (*Epicrates angulifer*) from Cuba, a Common Roe (*Capreolus caproea*), European, two Getulian Ground Squirrels (*Xerus getulus*) from Morocco, deposited; a Spot-wing (*Psaroglossa spiloptera*) from India, purchased; a Burrhel Wild Sheep (*Ovis burrhel*), an Axis Deer (*Cervus axis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN SEPTEMBER.

Sept.	1.	7h. 36m. Minimum of Algol (β Persei).
	4.	16h. 2m. to 16h. 58m. Moon occults ϵ Tauri (mag. 3·7).
	6.	10h. 48m. to 11h. 13m. Moon occults 71 Orionis (mag. 5·1).
	7.	Pallas in opposition to the sun.
	9.	14h. 32m. to 15h. 25m. Moon occults κ Cancri (mag. 5·0).
	12.	Perihelion passage of Encke's comet.
	15.	Venus. Illuminated portion of disc = 0·795.
	15.	Mars. ,, ,, ,, = 0·933.
	15.	15h. Venus in conjunction with the moon. Venus 1° 15′ N.
	18.	12h. 30m. Minimum of Algol (β Persei).
	21.	9h. 19m. ,, ,, ,,
	27.	6h. 5m. to 9h. 13m. Transit of Jupiter's Satellite III.
	28.	6h. 1m. to 6h. 41m. Moon occults 62 Piscium (mag. 6·0).

NEW ELEMENTS OF COMET 1901 (I.).—From observations made in May and June at the Cape and Cordoba (*Astronomische Nachrichten*, Bd. 156, No. 3734), Herr H. Thiele has computed a new set of elements for this comet, giving the following orbit:—

$$T = 1901 \text{ April } 24{\cdot}28845 \text{ Berlin M.T.}$$

$$\left.\begin{array}{l} \omega = 203^\circ\ 2'\ 15''{\cdot}1 \\ \Omega = 109\ \ 38\ \ 53{\cdot}1 \\ i = 131\ \ 4\ \ 49{\cdot}3 \end{array}\right\} 1901{\cdot}0$$

$$\log q = 9{\cdot}388827$$

An ephemeris is also given founded on these revised elements, so that search for the now faint comet may be continued.

Ephemeris for 12*h. Berlin Midnight.*

1901.			R.A. h. m. s.		Decl. ° ′ ″
Aug.	28	...	8 36 23·21	...	+11 1 14·2
Sept.	1	...	38 55·36	...	10 58 38·1
	5	...	41 16·77	...	10 56 4·5
	9	...	43 27·06	...	10 53 38·9
	13	...	45 25·77	...	10 51 26·9
	17	...	47 12·35	...	10 49 34·0
	21	...	48 46·28	...	10 48 6·1
	25	...	50 7·06	...	10 47 8·3
	29	...	51 14·12	...	10 46 45·9
Oct.	3	...	52 6·91	...	10 47 4·2
	7	...	52 44·72	...	10 48 8·7
	11	...	8 53 6·73	...	+10 50 5·5

BRIGHTNESS OF THE SOLAR CORONA, JANUARY 22, 1898.—In a paper read before the Royal Society, Prof. Turner gives a preliminary description of the results obtained from an investigation into the law of variation of the brightness of the solar corona in relation to the distance from the sun's limb (*Proc.* Roy. Soc., vol. lxviii. pp. 36–44). Instead of the rotating sectors used in previous similar investigations, a graduated gelatine wedge has been employed to diminish the intensity of the comparison beam. An entirely new method has been adopted for representing the results, which has led to the suggestion of a more satisfactory law for the variation of coronal brightness with the distance from the sun.

Up to the present time the relation usually adopted was that formulated by Prof. Harkness in 1878, viz.:—

$$\text{Brightness} \propto \frac{1}{(\text{distance from sun's limb})^2};$$

but this was not in agreement with the visual measures of Thorpe and Abney in 1886 and 1893.

The new relation now suggested is—

$$\text{Brightness} \propto \frac{1}{(\text{distance from sun's } \textit{centre})^6}.$$

Tables giving the measures along six different radii show sufficiently small residuals to warrant the formula being provisionally used to express the variation. It is found that a constant is required to be added to the formula, the physical interpretation of which is most probably the sky-glare present during totality, and which would necessarily give a certain amount of light all over the plate. The total brightness of the corona will thus depend on the area of sky included. Assuming this to be a circular area 5° in diameter, the total brightness of the 1898 corona would be about 2·4 times that of full moon, while the 1893 corona was only about 1·1 times brighter than the full moon.

THE SPECTROSCOPIC BINARY "MIZAR."—During March and April of the present year a series of excellent photographs of the spectrum of this star, ζ Ursæ Majoris, were obtained with Spectrograph IV. and the 33 cm. refractor at the Potsdam Observatory. Dr. H. C. Vogel has measured these, and gives the result of the reductions in the *Astrophysical Journal* (vol. xiii. pp. 324–328). On some of the plates as many as sixty-five lines are recognisable, including several of the strongest iron lines and lines of silicon and magnesium. When the period of maximum separation occurs, however, many of these become faint and the measures are more difficult.

On several of the plates the separated magnesium lines at λ 4481 appeared of unequal width, but no change in their behaviour was discernible after a coincidence.

The values of the relative motion are given for twenty-five plates obtained during the period 1901 March 24–May 1, ranging from 158 to 15 kilometres per second.

The motion of the whole system is given as 16 km. per second. A diagram is given showing the velocity curve most nearly representing the final reduced measures, and the period thus deduced is 20·6 days—considerably less than the period of 104 days deduced by Pickering about 1890.

The following provisional elements have been computed from the curve by Lehman-Filhes' method on the assumed values of

Period = 20·6 days.
Maximum relative velocity of A = 128 km.
" " " B = 156 "

T_0 = 1901 March 28·60 (Rel. motion in line of sight = 0).
T = 1901 March 28·88.
ω = 101°·3.
e = 0·502.
$\log \mu$ = 9·4843.
μ = 17°·476.
$a \sin i$ = 35 million kilometres.

$$m + m_1 = \frac{4\odot}{\sin^3 i}.$$

NOVA PERSEI.—In the *Astrophysical Journal* (vol. xiii. pp. 336–7) Messrs. G. C. Comstock and J. Stebbins give a very exhaustive series of comparisons of the estimated brightness of Nova Persei from February 24 to May 12. The observations were made by the "grade" method of Argelander, the estimated error being 0·1 magnitude for a single comparison. The rapid variation of the star is well shown by the many cases where several observations were obtained during the same evening. The minimum magnitude recorded is 5·7. Most of the estimates were made with the help of an opera-glass, the comparison stars being those given on Hagen's special chart of the region.

THE FUTURE OF ELECTRIC TRACTION.[1]

IT is not so long since the Englishman, and perhaps more particularly the Londoner, first tasted the sweets of electric traction, but he has already found it so satisfactory, whether as a profitable investment or as a method of travelling at once comfortable, convenient and healthy, that he is clamouring for its rapid extension and development. It is beginning to be realised, too, that electricity as a motive power is not destined to be confined to metropolitan railways and suburban tramways. The electrification of our larger railways is now being discussed as a practical problem by the more far-sighted of our engineers, who have recognised that many of the railway systems characteristic of this country are peculiarly suited for electrical running. Mr. Langdon, now president of the Institution of Electrical Engineers, devoted a paper read last November before that society to the subject; and Major P. Cardew, in his recently delivered Cantor Lectures, again gave prominence to the question.

It is interesting to consider what are the conditions of working which would make a railway one in which the adoption of electric traction is likely to prove profitable, for unless the alteration results in the increased economy of the system it is clear that it is not likely to be made. "Electric traction," says Major Cardew, "tends towards the ideal of the continuously moving platform," and one may say that the more nearly a railway tends towards the same ideal the more likely is the adoption of electricity as its motive power. In those most closely approaching this limit, namely, the metropolitan railways, all other systems at present known have long been seen (by all except perhaps the directors of the London underground and district railways) to be doomed. The reason lies in the essential difference between steam and electric driving, namely, that in the one case the train must carry its own power generator whilst in the other the power is generated in bulk for a number of trains. Since the generation of power in bulk is much cheaper than in detail, the tendency with steam locomotives is to make each detail as large as possible, and therefore to run heavy trains at long intervals. With electric working, on the other hand, it is desirable to make the load on the generating station as constant as possible, which can only be done when the number of trains is large and each only takes a small fraction of the total load; for in such a case the stopping and starting of individual trains will only have a small percentage effect on the output of power. It will readily be seen, therefore, that for long-distance traffic the steam locomotive is likely for some time to come to hold its own, for here the number of passengers is not so great as to be able to support a very frequent service of light trains, and, moreover, the time taken over the journey, being nearly the whole of the day or night, practically fixes the starting times. With lines communicating between important towns not too far apart (about 100 miles is the limit given by Major Cardew), electric traction could be introduced with advantage; in this case a frequent service of light trains would be a great benefit, especially if a number of important centres lie on the route between the termini and if there is a field for metropolitan traffic at the ends of the line. In such lines our small but densely populated country abounds.

Many additional advantages are introduced at the same time as the principal gain in the lessening of the cost of power generation. Thus the driving power can be distributed throughout the train, which results in lessening the wear of the permanent way and also in a lessening of the slip of driving wheels, as a greater proportion of the weight of the train is used for adhesion. It is easier, too, to provide power for accelerating the train and for mounting gradients, as the extra power needed in these cases is derived from an outside source, whereas if a steam engine were made powerful enough for very quick acceleration it would be too powerful for economical working during the greater portion of its running time. The concentration of power generation at a few centres leads to many economies in working expenses; coal and water are only used at the generating station, and it is only there in consequence that means for their storage and handling have to be provided.

Those who are more keenly interested in this question will do well to read the paper by Mr. Langdon to which reference has been made above. They will there find the matter thrashed out in considerable detail, both in the paper itself and in the discussion upon it, with the estimated saving worked out from a consideration of the existing traffic over a section of the Midland Railway, fifty miles long, between London and Bedford. Major Cardew discusses the problem more generally, but in his third lecture enters with some detail into the equipment of an imaginary typical full-scale railway fifty miles long; for this he arranges a suitable time schedule and then estimates the amount of power required and the approximate cost of equipment.

Major Cardew equips his imaginary railway on the polyphase system, which he considers, on account of "the advantages obtained in regard to means of conversion and from the use of higher pressure," to be most suited for use on full-scale railways. Space does not permit us to enter into a discussion of the relative merits of three-phase and direct-current working, and we must content ourselves with referring the interested reader to Major Cardew's lectures, where he will find the question fully considered. Here, in England, we are not very familiar with polyphase currents, but on the Continent, and in Switzerland especially, there are many railways thus equipped, and there can be no question of the willingness of Continental engineers to introduce their wares into this country if, as is to be feared,

[1] "On the Supersession of the Steam by the Electric Locomotive." By W. Langdon. (*Journal* of the Institution of Electrical Engineers, vol. xxx. p. 124.)
"Electric Traction." By Major P. Cardew. Cantor Lectures. (*Journal* of the Society of Arts, July 12, 19 and 26.)

we are incapable of supplying our own wants. Major Cardew, after considering and summing up the relative advantages of the two systems, gives his verdict against continuous current and feels "confident in prophesying the successful application of the polyphase system to the working of full-scale railways."

PRIZE-SUBJECTS IN APPLIED SCIENCE.

THE programme of subjects for which prizes will be awarded by the Société industrielle de Mulhouse next year has been issued, and copies can be obtained upon application to the secretary of the Society. In general chemistry, medals will be awarded for the best memoirs or works on the theory of the manufacture of alizarin reds; the synthesis of the colouring matters of cochineal; theoretical and practical study of the carmine of cochineal; study of the colouring matter of cotton; the composition of aniline blacks; physical and chemical modifications which occur when cotton fibre is transformed into oxycellulose; action of chlorine and its oxygen compounds upon wool; constitution of colouring matters employed in linen fabrics; synthesis of a natural colouring matter used in industries; and theory of the natural formation of an organic substance and preparation of the substance by synthesis.

In connection with dyeing, medals will be awarded for the best works presented on the following subjects:—A new mordant which admits of practical use; metallic solutions which give up their bases to textile fibres, and the conditions in which they are most effective; iron mordants and the part they play in dyeing according to their condition of oxidation and hydration; an aniline black which will not deteriorate in the presence of other colours or affect these colours, especially those of albumin; a soluble black for dyeing which will resist the action of light and soap as much as aniline black; a light blue cheap enough to be used to dye wools and not affected by boiling or by light; a blue similar to ultramarine which can be fixed upon cotton by a chemical process; a pure yellow which behaves like alizarin as regards its dyeing properties; a lake-red; a purple; a colouring matter to supersede logwood in its various applications; an assistant especially applicable to wool, capable of being cleared by simple washing, and composed of substances other than tin salts, hydrosulphites, sulphites, and bisulphites; new method of fixing aniline colours; a means of making colours resist the action of soap or of prolonged boiling; a means of producing the sheen of gold and silver upon materials by metallic powders; a manual containing tables showing the densities of as many inorganic and organic compounds as possible, in the crystallised state and in cold saturated solution; the synthesis of a substance having the essential properties of Senegal gum; a substance to supersede egg-white in the dyeing of linen; a colourless blood albumin which can be used instead of egg-white; a manual on the analysis of compounds employed in fabric printing and in dyeing; an indelible ink for marking cotton and similar materials; a practical method of removing grease spots from materials; a memoir on the use of resins in bleaching cotton fibre; a memoir on the bleaching and dyeing of various kinds of cotton; also memoirs dealing similarly with wool and silk; use of hydrogen peroxide for bleaching; improvements in the bleaching of wool and silk; and manuals on the bleaching of cotton, wool, silk, hemp and other fibres.

In connection with fabric printing, medals are offered for an alloy or other substance which has both the elasticity and durability of steel and also the property of not causing any chemical action in the presence of acid colours and colours containing certain metallic salts; a new cylinder machine capable of printing at least eight colours at once; and an application of electricity to bleaching, dyeing or fabric printing.

Among the prize subjects in mechanical arts are:—A means of recording by a graphical method the work done by steam engines in a given period (ordinary indicator diagrams do not fulfil the conditions); memoir on the spinning of combed wool; on the force required to start spinning machines; a motor for driving machines used in printing fabrics.

In electricity medals will be awarded for an electric motor the power and driving rate of which can be easily varied; a memoir on the comparative cost of electricity and gas for lighting a town having a population of at least 30,000; and comparative costs of electricity, gas, acetylene and water-gas for lighting an industrial establishment.

Money prizes as well as medals are awarded for some of the subjects, and all the competitions are open to every one, irrespective of nationality. The memoirs, designs or models submitted for the awards should be sent to the president of the Société industrielle de Mulhouse before February 15, 1902.

PROGRESS OF CIVIL ENGINEERING.[1]

IN response to a request of the Institution of Civil Engineers, Tredgold gave this ever memorable definition of civil engineering in 1828:—

"Civil engineering is the art of directing the great sources of power in Nature for the use and convenience of man; being that practical application of the most important principles of natural philosophy which has, in a considerable degree, realised the anticipations of Bacon, and changed the aspect and state of affairs in the whole world."

After a brief sketch of the objects of civil engineering, he added:—"The real extent to which it may be applied is limited only by the progress of science; its scope and utility will be increased with every discovery in philosophy, and its resources with every invention in mechanical or chemical art, since its bounds are unlimited, and equally so must be the researches of its professors."

A more concise and comprehensive definition of a great truth can hardly be conceived. From a physical and intellectual standpoint, a nobler aim for the exercise of the mental powers cannot be imagined than the direction of the great sources of power in Nature for the use and convenience of man. Psychology deals with mind alone, physics considers the nature and the laws of matter, but civil engineering treats of the intelligent direction of the laws governing matter so as to produce effects which will reduce to a minimum the time and physical labour required to supply all the demands of the body of man and leave more opportunity for the exercise of the mental and spiritual faculties. Philosophy, physics and civil engineering must work hand in hand. The philosopher must imagine, the physicist prove by experiment and mathematical computation, and the engineer apply to practice the laws of matter. Each must keep himself informed of the progress made by the others and must aid them by suggestions as to the lines on which research needs to be carried forward. The civil engineer, in attempting to solve some problem of construction, finds that he needs a material which shall possess a certain quality which he cannot discover that any natural product possesses. He calls the chemist to his aid, and he, from a study of the combinations of existing forms of matter which most nearly approach the desired ideal, reasons that some special combination of elements will entirely fulfil the conditions, and he experiments to find whether such combination can be made. Sometimes he is successful in his first attempt and sometimes not. But, whatever the result, he has added to his knowledge of the laws of combinations and has furnished to the philosopher fresh data for his generalisations and to the engineer a new material for his use.

As the knowledge of the nature of steel and the precise methods in which it can be manufactured have progressed, the engineer has gradually come to know just what he wants and how it can be produced, and, in his specifications, requires that the particular material of this class which he desires shall be of a certain chemical composition and also possess certain characteristics. The same is the case with almost every material which enters into the construction of engineering works of the present day. Matter in its original state is rarely used. Its chemical condition must be transformed before the engineer can utilise it with any confidence. That almost any desired transformation can be effected was not realised until late in last century. Starting with the atom, the ultimate particle of matter so far comprehended by us, the chemist found that several different kinds of atoms could be identified, and that these would combine in certain ways according to laws which could be formulated. But in the application of these laws and the tabulation of the results gaps were found to exist which could not be filled without the supposition that other elements existed than those already known. The existence of such elemental substances was confirmed by the revelations of the

[1] Abridged from an address delivered at the annual meeting of the American Society of Civil Engineers, June 25, by the president, Mr. J. J. R. Croes.

spectrum analysis, and, later on, several of such elements have been actually identified by the use of the electric current in creating vibrations in the ether. The limit is probably not reached yet, but as each new element is discovered its affinities are sought by the chemist, its sensibility to various forms of vibratory motion are investigated by the dynamist, as we may term the physicist who is seeking the laws of either heat or light or electricity, and then it is the function of the civil engineer to study how it can best be applied to the use and convenience of man. For, ever since the beginning of the nineteenth century, the evidence has been cumulative that matter in motion accounts for all physical phenomena, that motion produces energy, that energy is never wasted but is simply transformed, and that it manifests itself to the senses of man in various modes which are appreciable by the several organs of sense.

What our senses recognise as chemical affinity, heat, light and electricity are simply conditions of matter induced by vibrations or quivers or waves or strains, whatever we may call them, of different kinds and at different velocities. Neither matter nor motion can be originated by man, but, by a careful study of the sequence of events, control can be acquired of their modes of interaction, and natural phenomena can be artificially reproduced and other phenomena be produced. The intelligent application and direction of such means of control is the function of the civil engineer.

In considering the means of directing the great sources of power, the psychological element must not be forgotten. A mere intellectual application of the laws discovered by physical research is not enough to make a civil engineer. Breadth of view, the faculty of analysing what has been done so as to discover how and why some enterprises have been successful and others have not, and the ability to forecast the future, are essential. These qualities are largely natural, but may be cultivated to a great extent by study and experience. That there has been a wonderful advance in this direction during the nineteenth century is shown by the great number of civil engineers who hold positions of prominence in the management and control of large enterprises which require the exercise of faculties which cannot be acquired in any other way than by experience in the designing, construction and management of engineering works.

A prominent factor in causing this advance in engineering science which has occurred simultaneously on the Continent of Europe, in Great Britain and in America, has been the collaboration of men of science. Early in the century it became evident that the multiplication of lines of research demanded a differentiation of the labour of their prosecution and a close cooperation of the workers in any special line, and various associations of specialists were formed to promote various branches of scientific research. By the middle of the century it had become apparent that civil engineering was not the prosecution of a speciality, but was the coordination and direction of the work of all specialities in science and its applications.

Recognising, then, that progress is a law of Nature, the acceleration of progress is the aim of civil engineering. It strives to simulate the results of the slow processes of Nature by causing the sources of power to act rapidly in any desired direction. Appreciating, too, the fact that there is constant progress and that what now seems admirably adapted to our needs may in a short time require to be superseded by improved structures and processes, the tendency of the time is toward the production of works which will have a definite term of life, rather than towards the construction of everlasting monuments. We see that in the old nations, where the effort to build for eternity was made, time has outstripped the intent of the builders and what is antiquated is useless, and we see the same thing in our own streets to-day. The idea of building a monumental structure which will hand one's name down to future ages is a fascinating one, but it is simply a survival of the engineering of the Pharaohs.

The most thorough exemplar of the condition of civil engineering at the beginning of the twentieth century is the modern office building in a great city. One hundred years ago, the man of enterprise who resided fifty miles from a large city and wished to consult an engineer regarding a project for a new canal, arose before daylight, struck a spark from his flint and steel, which falling on a scrap of tinder was blown by him into flame and from that a tallow dip was lighted. In the same primitive manner, the wood fire was kindled on the kitchen hearth and his breakfast was cooked in a pot and kettle suspended from the iron crane in the fireplace. Entering the cumbrous stage coach, hung on leather springs, which passed his door, he was driven over muddy roads, crossing the narrow streams on wooden trestle bridges and the navigable rivers on a ferry boat, the paddle wheels of which were turned by a mule on a treadmill. At last he was landed in the city, where he walked through dirty streets paved with cobble stones until he reached his destination, a plain three-story brick building founded on sand, with a damp cellar and a cesspool in the back yard. Entering a dark hall he climbed a wooden staircase and was ushered into a neat room, rag-carpeted, warmed by a wood fire on the open hearth and lighted by a sperm oil lamp with one wick, for it was dark by this time.

To-day, his grandson, living at the old homestead, while comfortably eating his breakfast, which has been cooked over a gas range, reads in his morning paper that the high dam of the irrigation reservoir in Arizona, in which he is interested, sprang a leak the day before, and he telegraphs to his engineer in the city that he will meet him at his office at noon. Then, striking a match, he lights the lamp of his automobile, which is fed by petroleum brought 200 miles underground in pipes from the wells, rolls over macadamised roads to the railroad station, where he enters a luxuriously appointed train, by which he is carried above all highways, through tunnels, under rivers, or across them on long-span steel bridges, and in an hour is deposited in the heart of the city, where he has his choice of proceeding to his destination through clean and asphalt-paved streets in electric surface cars at nine miles an hour, elevated steam cars at twelve miles an hour, or through well-lighted and ventilated tunnels at fifteen miles an hour. Reaching the spot his grandfather had visited, he finds there a huge and highly decorated building, twenty or more stories high. Founded on the primeval rock, far below the surface of the natural ground, the superjacent strata of compressible material having been penetrated by caissons of sheet metal sunk by the use of air, compressed by powerful pumps driven by steam or electricity generated at a power station half a mile or more away, and these caissons filled with a manufactured rock such as the ordinary processes of Nature would require millions of years to produce, there is erected a cage of steel, the composition of which has been specified, and the form and mode of construction of which have been so computed that the force of the elements cannot overthrow the structure or even cause it to sway perceptibly. The meshes of this mighty cage are filled with products of the earth, the mine and the forest, transformed so as to be strong and light and incombustible, and all interwoven with pipes and wires, each in its proper place and noted on the plans. In one set of these pipes there is pure water, which has been collected from a mountain area of igneous geological formation, depopulated and free from swamps, on which a record of the daily rainfall is kept, and in which impounding reservoirs have been constructed by masonry dams across its valleys. From these reservoirs, the water, after filtration through clean sand, is conveyed thirty or forty miles through steel or masonry conduits to covered reservoirs, whence it is drawn as needed through cast-iron pipes to the building where it is to be used, and there distributed to all parts of it, chilled nearly to the freezing point through one system of pipes or heated nearly to the boiling point through another system. Another set of pipes carries steam which, passing through radiators, keeps the temperature of the air throughout the building at the proper standard for comfort. Sanitary conveniences are provided everywhere, and all wastes are consumed within the building by the surplus heat generated, leaving only ashes to be removed. Wires convey electric currents to all points, so that the occupant of a room, sitting at his desk, can by the touch of a button ventilate his apartment, illuminate it, call a messenger, be kept informed of every fluctuation in the markets, converse with anybody who is not "busy" within forty miles of where he sits and if entirely "up to date" can require his autograph and portrait to be reproduced before his eyes for identification. He dictates his correspondence and his memoranda, and "takes his pen in hand" only to sign his name. He need not leave his seat except to consult the photograph hanging on his wall, which shows to him the latest condition of the mine, the railroad, the arid lands irrigated, the swamps reclaimed, the bridge in progress, the steamship, the water-works, the tunnel or the railroad, the dam, the filter or the sewage works, the town, the machine, the power plant or the manufacturing establishment in which he is most interested.

Entering the brilliantly lighted hallway of this building, the air of which is kept in circulation by the plunging up and down of half a dozen elevators, the visitor is lifted at a speed of 500 feet a minute, past floor after floor, crowded with the offices of financiers, managers and promoters of traffic and of trade, lawyers, chemists, contractors, manufacturers, to the headquarters of the controlling genius of the whole organism, the civil engineer. For he it is to whom all the members of this microcosm must apply for aid and advice in the successful operation of their respective occupations. It is not his to mechanically transform elements into matter, or matter into other forms, or to show how energy may be produced, but to direct the application of energy to the various forms of matter, original or produced, in such way as to bring about the most satisfactory results in the most speedy and economical manner.

He has grown with the growth of the nineteenth century, and is, so far as the relations between man and matter are concerned, its most striking product. And so, while the definition given in the "American Edition of the Encyclopædia," which appeared at the beginning of the century, that "Civil engineers are a denomination which comprises an order or profession of persons highly respectable for their talents and scientific attainments and eminently useful under this appellation," is still true, it is hardly probable that the compiler of the Twentieth Century Encyclopædia will be content to let it stand without further explanation.

But the end is not yet: there are still many problems of Nature unsolved. The experience of every day shows that there are sources of power not yet fully developed, and we cannot but say with the great poet:

> "I doubt not through the ages one increasing purpose runs,
> And the thoughts of men are widened with the process of the suns."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A GOOD estimate of the character of the work of a College or University can be obtained from the investigations carried on by its staff and students. The following statement of research work done in the laboratories of the McGill College, Montreal, last session, published in the Annual Calendar of the College and University for the session 1901–1902, furnishes excellent evidence of sound instruction and scientific activity:—The effect of cold on the physical properties of iron and steel; the influence of bending on the torsional strength of metals; the properties of iron and steel as affected by annealing at moderate temperatures; experiments on frictional losses in 1½-inch pipes and bends under varying velocities of flow; experiments on the determination of the "Miner's Inch"; the separation and concentration of chromite, blende, nickeliferous pyrrhotite and certain other minerals by combined gravimetric and magnetic methods; the crushing and sizing of rocks by means of different types of apparatus; the treatment of Nova Scotia mispickel concentrates by cyanide, bromocyanide and chlorination methods; conditions affecting the wave form of alternators; and the effect of change of wave form in alternators on induction and synchronous motors: induction motors used as frequency changers.

THE Massachusetts Institute of Technology has lately introduced the degree of Doctor of Philosophy to supersede the former degree of Doctor of Science. The following statement of the requirements for the new degree is of interest as showing the tendency of technical education in the United States:—"The degree of Doctor of Philosophy certifies to high attainments of a grade which qualifies the recipient as a scientific investigator and teacher. The course of study leading to this degree is mainly one of experiment and research, accompanied by such other theoretical subjects as may be useful adjuncts to the main scheme of work. The candidate must pursue his studies and researches under the direction and oversight of the Faculty for at least two school years, furnishing from time to time such evidences of progress as the Faculty may require. His attendance must be continuous, except in cases of absence previously approved by the Faculty for the purpose of conducting researches and investigations in the field. He must present a thesis embracing the results of an extended original investigation, and must pass such final examinations as the Faculty may require."

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 19.—M. Fouqué in the chair.—The chairman announced the death of two members of the Academy, Admiral de Jonquières and Baron de Nordenskiöld, and added a short account of their life-work.—The relations of psoriasis with neurasthenia: treatment by injections of orchitin, by M. F. Bouffé. Psoriasis is a trophonevrosis having its seat in the nervous centres and especially in the great sympathetic. It presents a great analogy with neurasthenia in its origin; in both diseases there is constantly a diminution in nervous activity, characterised by a fall in the urographic line of phosphoric acid. The treatment of both should consist in the invigoration without stimulation of the nervous system by injections of orchitin, the average dose being from 10 to 12 c.c. three times a week.—On a problem of d'Alembert, by M. F. Siacci.—On a particular critical point of the solution of the equations of elasticity, in the case where the forces on the boundaries are given, by MM. Eugène and François Cosserat.—On the general principles of mechanisms, by M. G. Kœnigs.—On the absolute value of the potential in isolated nets of conductors having a capacity, by M. Ch. Eug. Guye.—Researches on the mechanism of etherification in plants, by MM. E. Charabot and A. Hébert. Etherification in plants is produced by the direct action of the acid upon the alcohol, the action being favoured by a particular substance playing the part of a dehydrating agent, the latter being a diastase the dehydrating action of which is exercised in a chlorophyll medium.—Littoral deposits and movements of the soil during the secondary era in the Quercy and western Rouergue strata, by M. Armand Thevenin.—On the origins of the source of the Loue, by M. André Berthelot. Through the accident of a fire at an absinthe factory and the consequent liberation of a large quantity of absinthe, it became evident that the Loue represents a subterranean arm of the Doubs.—Observations of M. Berthelot on the preceding communication.—Influence of colour upon the production of the sexes, by M. C. Flammarion. A study of the effect of light of various colours upon the development of silkworms.

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